

A hand holding a large, dark, angular geometric shape against a background of light rays.

Project Manual

U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON

 **REFRACT HOUSE**
SANTA CLARA UNIVERSITY & CALIFORNIA COLLEGE OF THE ARTS

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SUMMARY OF CHANGES



SUMMARY OF CHANGES

Summary

This deliverable consists of almost entirely new content, and therefore a detailed list of changes shall not be attempted. A brief but certainly not exhaustive list is provided below.

This is the final submission of Construction Documents for Refract House. We believe we have met the stringent documentation and design requirements set forth by the competition, and we look forward to your review.

Major Changes

- Construction Drawings have been completely reformatted for ANSI D, and content from every discipline has been entirely updated to meet rules and code compliance
- Construction Specifications have been included in this submission, formatted in accordance with SectionFormat. Manufacturer data sheets are all linked from the specifications
- This version adheres to PDF bookmarking guidelines and all other formatting requirements
- All Project Manual narratives (subjective contest narratives, energy analysis report, etc) have been updated to reflect our final design
- Grid Interconnection Application, Unlisted Electrical Components, and Water Budget have all been updated

RULES COMPLIANCE CHECKLIST



Rule #	Rule Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
4-2	Construction Equipment	Drawing(s) showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	G-004 and A-118	n/a
4-2	Construction Equipment	Specs for heavy machinery	41 23 23 -- Boom Lift 41 62 23 -- Fork Lifts 41 22 13 -- Mobile Crane	
4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	A-107 (grounding rod)	E5
4-4	Impact on the Turf	Drawing(s) showing the location, contact area, and soil bearing pressure of every component resting directly on the turf	S-121	n/a
4-5	Generators	Specifications for generators	26 32 13	
4-6	Spill Containment	Drawing(s) showing the locations of all equipment, tanks, and pipes that will contain fluids at any point during the event	P-103	n/a
4-6	Spill Containment	Specifications for all equipment, tanks, and pipes that will contain fluids at any point during the event	Refer to specifications referenced on P-103, M-101, and M-601	
4-7	Lot Conditions	Calculations showing that structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	Project Manual Pg. 311 (Structural Calculations)	
4-7	Lot Conditions	Drawing(s) showing shimming methods and materials to be used if 18 in. (45.7 cm) of vertical elevation change exists on the lot	S-501 S-601	C1 and A1 A3
5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	A-201, A202, A-106	n/a
5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	n/a	n/a
6-1	Structural Design Approval	List of, or marking on, all sheets in the complete electronic Construction Documents that have been or will be stamped by the structural engineer in the hard-copy, stamped structural submission; the stamped submission shall consist entirely of sheets or pages that also appear in the complete electronic construction document set	List of marked sheets included in Structural Calculations, Project Manual Pg. 270	
6-2	Maximum Architectural Footprint	Drawing(s) showing all information needed by the Rules Officials to measure the architectural footprint electronically	A-117 A-106	n/a

Rule #	Rule Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
6-2	Maximum Architectural Footprint	Drawing(s) showing all movable components that may increase the footprint if operated during contest week	n/a	n/a
6-2	Maximum Architectural Footprint	Shading calculations and/or diagrams for components that DO NOT shade the building above its finished floor height between 9 a.m. and 5 p.m. EDT on October 1 (shading calculations and/or diagrams are not necessary for components that are either shorter than finished floor height or obviously do not shade the building)	n/a	n/a
6-3	Minimum Conditioned Space	Drawing(s) showing space conditioning means in primary living spaces	A-117 M-101	n/a
6-4	Entrance and Exit Routes	Drawing(s) showing the accessible public tour route and the ground surface area that will be covered by organizer-provided walkway material	A-107	n/a
7-1	Placement	Drawing(s) showing the location of all vegetation and, if applicable, the movement of vegetation designed as part of an integrated mobile system	L-101	n/a
7-2	Watering Restrictions	Drawings showing the layout and operation of greywater irrigation systems	L-102	n/a
8-1	PV Technology Limitations	Specifications for photovoltaic components	26 31 00	
8-1	PV Technology Limitations	Retail price quote for photovoltaic components	Project Manual Pg. 324	
8-3	Thermal Energy Storage	Drawing(s) showing the location of thermal energy storage components	M-101	D4 and E5
8-3	Thermal Energy Storage	Specifications for thermal energy storage components	23 71 13 (thermal storage) 23 71 16 (chilled water buffer)	
8-3	Thermal Energy Storage	Shading calculations and/or diagrams for thermal energy storage components (if necessary)	Not applicable. Tanks will be fully enclosed.	
8-4	Batteries	Drawing(s) showing the location(s) and quantity of stand-alone, PV-powered devices	E-102	n/a
8-4	Batteries	Specifications for all stand-alone, PV-powered devices	26 50 00	
8-5	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	n/a	n/a
8-5	Desiccant Systems	Specifications for desiccant system components	n/a	n/a
8-6	Village Grid	Completed Interconnection Application form.	Project Manual Pg. 328	

Rule #	Rule Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
8-6	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	E-201 A-107	n/a
8-6	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	26 05 00 -- General Electrical 26 27 13 -- Metering 26 28 16 -- Switches/Breakers 26 31 00 -- Photovoltaic 48 19 16 -- Inverters	
8-6	Village Grid	One-line electrical diagram	E-601	n/a
8-6	Village Grid	Calculation of service/feeder net computed load per NEC 220	Project Manual Pg. 329 (Part of Grid Interconnection App)	
8-6	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box	A-106	n/a
8-6	Village Grid	Elevation(s) showing the terminal box, meter housing, main utility disconnect, and other service equipment	E-201	n/a
9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems	L-102	n/a
9-6	Thermal Mass	Drawing(s) showing the locations of water-based thermal mass systems	n/a	n/a
9-6	Thermal Mass	Specifications for components of water-based thermal mass systems	n/a	n/a
10-2	Event Sponsor Recognition	Drawing(s) showing the dimensions, materials, artwork, and content of all communications materials, including signage	G-911	n/a
10-3	Team Sponsor Recognition	Drawing(s) showing the dimensions, materials, artwork, and content of all communications materials, including signage	G-911	n/a
11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route	A-115 A-107	n/a
11-4	Public Exhibit	Drawing(s) showing the dimensions, materials, artwork, and content of the handout	G-912	A1
11-4	Public Exhibit	Drawing(s) showing the artwork and content of the team uniform	G-912	A

CONSTRUCTION SPECIFICATIONS

SECTION 015113 - TEMPORARY ELECTRICAL

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Use Charges: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated.
- B. Electric Power: Available from Owner's existing system without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

PART 2 - PRODUCTS.

2.1 Temporary Electrical Distribution Boxes

- A. CEP 6506GU "G" Series GFCI Protected
 1. "Power On" indicator lights on GFCI's
 2. 240V High Voltage Shut-Off with indicator light
 3. 1 - 50 AMP 125/250 Volt feed through receptacle
 4. 1 - 30 Amp 250 Volt non-GFCI receptacle
 5. 6 - 20 Amp 125 Volt GFCI individually protected receptacles
 6. For more information see: http://www.cepnow.com/pd_g-series.htm

PART 3 - EXECUTION

3.1 TEMPORARY UTILITY INSTALLATION

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

3.2 OPERATION, TERMINATION, AND REMOVAL

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

END OF SECTION 015113

SECTION 015423 - TEMPORARY SCAFFOLDING AND PLATFORMS**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. 01 54 23 70 - Scaffolding
- B. Submittals: Product Data

1.2 REFERENCES

- A. OSHA 1915 Subpart E: Scaffolds, Ladders, and Other Working Surfaces

PART 2 - PRODUCTS**2.1 SCAFFOLDING**

- A. Will have minimum 29 inches working space for safe operation room for workers.
- B. Will have a minimum load capacity of 25 lbs. per square foot, and a maximum load of 500 lbs. per deck.
- C. Structural bars are made from Aluminum.
- D. Manufacturer assured compliance to ANSI Standards.
- E. Manufacturer assured compliance to OSHA Requirements
- F. UL listed.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install according to manufacturer's instructions.

3.2 EXECUTION

- A. Assure that when in use all safety measures are followed.
- B. Before each shift of use, make sure to inspect scaffold for any safety risks including:
 - 1. Level and sturdy footing
 - 2. Secure linkages at every point

END OF SECTION 015423

SECTION 017123 – FIELD ENGINEERING

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

- A. Employ a land surveyor to confirm the survey of the work.

1.2 SUBMITTALS

- A. On request, submit documentation verifying accuracy of the survey work.
- B. Upon completion of the Work, state the elevations and locations of the Work are in conformance with the Contract Documents.

1.3 PROJECT RECORD DOCUMENTS

- A. Maintain a complete and accurate log of control and survey work as it progresses.
- B. Record location data for control points in sketch form and turn over 6 copies of sketches and computations to the Director's Representative.

1.4 TOOLS, EQUIPMENT, AND MATERIALS

- A. Furnish all tools, equipment, and materials required to perform the work of this Section.

1.5 EXAMINATION

- A. Verify locations of control points prior to starting work.
- B. Promptly notify Director's Representative of any discrepancies discovered.

1.6 CONTROL POINTS

- A. Control datum for survey is indicated on the Drawings
- B. Protect control points prior to starting site work; preserve control points during construction.
- C. Promptly report to Director's Representative the loss of destruction of any control point or relocation required because of changes in grades or other reasons.
- D. Replace dislocated control points based on original survey control. Make no changes without prior written notice to the Director's Representative.

1.7 ESTABLISHING CONTROL POINTS

- A. Prior to clearing or earthwork operations, install permanent survey markers at the coordinate locations shown on the drawings. Establish and record the exact coordinates of these markers to within one one-hundredth of a foot horizontally.
- B. Locate each permanent survey marker from at least 3 points of permanent reference.

1.8 SURVEY REQUIREMENTS

- A. Utilize recognized engineering survey practices.
- B. Establish a minimum of two permanent survey markers to be used as bench marks for vertical control on the Site where indicated on the Drawings and referenced to establish control points. Record locations, with horizontal and vertical data to within one-hundredth of a foot, on Project Record Documents.
- C. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
 - 1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
 - 2. Grid or axis for structures
 - 3. Building foundations, column locations, ground floor elevations.
- D. Verify disturbed layouts be same means.

1.9 FIELD ENGINEERING FOR GENERAL EARTHWORK

- A. Provide not less than one stake for each 2,500 square feet where rough and finished grades are flatter than one foot of rise per 10 feet of run.
- B. Provide not less than one stake for each 2,000 square feet where rough and finished grades are greater than one foot of rise per 10 feet of run but less than one foot of rise per 4 feet of run.
- C. Provide not less than one stake for each 1,000 square feet where rough and finished grades are greater than one foot of rise per 4 feet of run.
- D. Provide stakes spaced not more than 50 feet apart along centerline of ditches and swales. Provide additional stakes at right angles to centerline, and opposite each centerline stake, to mark bottom and top of slopes.
- E. Mark each stake with the correct finished grade elevation and the appropriate cut or fill at that stake.

PART 2 - PRODUCTS

- A. None

PART 3 - EXECUTION

- A. None.

END OF SECTION 017123

SECTION 017413 – PROGRESS CLEANING**PART 1 - GENERAL****1.1 SUMMARY OF WORK**

- A. This section includes:
 - 1. Cleaning requirements during construction operations
 - 2. Final cleaning prior to turning project over.

1.2 QUALITY ASSURANCE

- A. Utilize non-toxic cleaning materials and methods.
 - 1. Comply with GS 37 for General purpose cleaning and bathroom cleaning
 - 2. Use natural cleaning materials where feasible. Natural cleaning materials include:
 - a. Abrasive cleaners: substitute ½ lemon dipped in borax
 - b. Ammonia: substitute vinegar, salt and water mixture, or baking soda and water
 - c. Disinfectants: substitute ½ cup borax in gallon water
 - d. Drain cleaners: substitute ½ cup baking soda and ½ cup vinegar in boiling water
 - e. Upholstery cleaners: substitute dry cornstarch.

1.3 FINAL CLEANING

- A. At completion of Work, remove all remaining waste materials, rubbish, tools, equipment, machinery and surplus materials, and clean all exposed surfaces; leave Project clean and ready for occupancy.
 - 1. Provide final cleaning in accordance with ASTM E1971 and the approved IPM plan.

PART 2 - PRODUCTS

- A. None

PART 3 - EXECUTION

- A. None.

END OF SECTION 017413

SECTION 034100 - PRECAST STRUCTURAL CONCRETE**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Submittals: Product Data.

1.2 REFERENCES

- A. California Code of Regulations, Title 25 and C.B.C. 2007, Chapter 16.

PART 2 - PRODUCTS**2.1 SEISMIC PIERS**

- A. Steel Component, see SECTION 055000 Metal Fabrications
- B. Concrete Component
 - 1. Central Piers Inc. Engineered Foundations System: Meets design loads consistent with local requirements where installed.
 - 2. Seismic design category D
 - 3. Basic wind speed and exposure design values for 85 - 100 mph
 - 4. Concrete Pads: Achieved strength of 2500psi at 28 days according to manufacturer Starlite Weight Concrete.
- C. The Central Piers Seismic Pier shall be listed and labeled for the following ultimate loads at 7" thru 18 inch piers:
 - 1. 3203 lbs. in the strong direction
 - 2. 2273 lbs in the weak direction
 - 3. 16,000 lbs vertical load

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Foundation system is designed to be constructed on a fairly level site with no existing soil problems.
- B. Footings are to be supported by firm, unsaturated, undisturbed soil or compacted fill, asphalt or concrete. Footings are designed for 1000psf bearing capacity and shall be compatible with local soil conditions. All footings shall be founded in accordance with H.C.D. guidelines and title 25 or prepare subgrade per soil report, when available.
- C. The size, type, and location of standard vertical support piers and footings must be installed per the home manufacturer's installation manual. Without manual, spacing of standard piers to be determined by title 25, section 1335.5 of CBC.
- D. Use of bearing pads such as ply or ABS pads is acceptable for leveling purposes.
- E. The foundation pads shall be oriented with bolts in the transverse direction.
- F. See <http://www.centralpiers.com/30-5F%202007CBC.pdf> , for details.

3.2 EXAMINATION

- A. All dimensions included on the plan, including coach size, roof height, and pier height, should be field verified by the local building official. The project engineer should be immediately noted of any discrepancies.
- B. The building pad should be inspected to ensure that proper soil conditions and drainage patterns have been established in accordance with Title 23 and the home installation manual.

END OF SECTION 034100

SECTION 050523 - METAL FASTENINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Quality of structural bolts used on Project.

1.2 REFERENCES

- A. American National Standards Institute / American Welding Society:
 - 1. ANSI /AWS D11-92 'Structural Welding Code - Steel.'
 - 2. ANSI / AWS D1.3-89, 'Structural Welding Code - Sheet Steel.'
- B. American Society For Testing And Materials:
 - 1. ASTM A 36-00, 'Standard Specification for Carbon Structural Steel.'
 - 2. ASTM A 307-00, 'Standard Specification for Carbon Steel Bolts and Studs 60 000 psi Tensile Strength.'

1.3 QUALITY INSURANCE

- A. Qualifications: Welders shall be certified 30 minimum before beginning work on Project. If there is doubt to proficiency of welder, Architect may require welder to take another test, at no expense to Owner. Certification shall be by Pittsburgh Laboratories or other authority approved by Architect.
- B. Certifications: Maintain welder's certifications on job-site.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Bolts And Threaded Fasteners:
 - 1. Anchor Rods For Steeple Base Connections: Conform with ASTM A 36
 - 2. Bolts conform to requirements of ASTM A 307, Grade A.
- B. Z Clips
 - 1. Dimensions:
 - a. Offset: 1/4"
 - b. Drop: 3/8"
 - c. Length: Manufacture's Length
 - 2. Mill Finish, Per American Society for Testing and Materials (ASTM)
 - 3. Punched Holes 8" on Center to Accommodate #8 Screws
 - 4. <http://www.orangealuminum.com/orange/panel-clips/panel-clips-1.html>
- C. 3/8th in Lag Screw:
 - 1. 7 Threads per inch
 - 2. Maximum 0.388 body or shoulder diameter
 - 3. 9/16 in width across flats
 - 4. Maximum head height of 0.25 in
 - 5. Shoulder length of 0.125

PART 3 - EXECUTION

3.1 PERFORMANCE

- A. Installation of bolts shall meet AISC requirements.

- B. Z clips will be 6063 Ultra-Corrosive Resistant Architectural Grade Alloy, T5 Temper

END OF SECTION 050523

SECTION 051200 - STRUCTURAL STEEL FRAMING**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. 05 12 23.79 - Structural Steel
- B. 05 50 00 - Steel Support Angles
- C. 05 12 23.65.2100 - Plates

1.2 SECTION REQUIREMENTS

- A. Submittals:
 - 1. Product Data: For each type of product indicated.
 - 2. Shop Drawings: Show fabrication of structural-steel components.
 - a. Include details of cuts, connections, and other pertinent data.
 - b. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 3. Welding Certificates
- B. Comply with applicable provisions of the following:
 - 1. AISC 303.
 - 2. AISC 341 and AISC 341s1.
 - 3. AISC 360.
 - 4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

PART 2 - PRODUCTS**2.1 STRUCTURAL STEEL**

- A. W-Shapes: ASTM A 992
- B. Channels, Angles -Shapes: ASTM A 36
- C. Plate and Bar: ASTM A 36
- D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- E. Steel Pipe: ASTM A 53, Type E or S, Grade B.
- F. Products produced by SOS Steel Co Inc.

2.2 ACCESSORIES

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325M, Type 1, heavy-hex steel structural bolts; ASTM A 563M, Class 8S heavy-hex carbon-steel nuts; and ASTM F 436M, Type 1, hardened carbon-steel washers.
- B. Anchor Rods: ASTM F 1554, Grade 36.
 - 1. Configuration: Straight
 - 2. Nuts: ASTM A 563M -hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: 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.

2.3 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 0.038 mm. Do not prime surfaces to be embedded in concrete or mortar or to be field welded.

PART 3 - EXECUTION

3.1 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
- C. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M].
- D. 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
- E. 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

SECTION 051213 – ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

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

PART 2 - PRODUCTS**2.1 STRUCTURAL STEEL**

- A. Channels
1. Unistrut P1000T
 - a. Physical dimensions
 - 1) 1-5/8" x 1-5/8",
 - 2) 12 Gage low-carbon strip steel
 - b. Weight: 185 Lbs/100 Ft
 - c. Hot Dip Galvanized to 2.6 MIL coat.
 - d. For more information see http://www.unistrut.com/Browse/cat_detail.php?S=S02&P=P1000T

2.2 ACCESSORIES

- A. Channel Nuts
1. \emptyset " Channel Nut w/Spring (1-5/8" Series)
 - a. Unistrut channel nuts are manufactured from mild steel bars, and after machining operations are completed, they are case hardened, assuring positive biting action into the inturned edge of the Unistrut channel.
 - b. The standard channel nut conforms to ASTM A576 GR 1015 modified and A1011 SS GR 45.
 - c. Screws conform to SAE J429 GR 2 (also meets and exceeds ASTM A307).
 - d. Slip resistance 1500lbs
 - e. Pull out resistance 2000lbs
 - f. For more information see: http://www.unistrut.com/Browse/cat_detail.php?S=S04&P=P1006
- B. 90° Fittings
1. P1357
 - a. Hole Diameter: 9/16" (14.3mm)
 - b. Hole Spacing (From End): 13/16" (20.6mm)
 - c. Hole Spacing (On Center): 1-7/8" (47.6mm)
 - d. Width: 1-5/8" (41mm)
 - e. Thickness: 1/4" (6.4mm)
 - f. For more information see: http://www.unistrut.com/Browse/cat_detail.php?S=S05&P=P1357
 2. P1130
 - a. Hole Diameter: 9/16" (14.3mm)
 - b. Hole Spacing (From End): 13/16" (20.6mm)
 - c. Hole Spacing (On Center): 1-7/8" (47.6mm)
 - d. Width: 1-5/8" (41mm)
 - e. Thickness: 1/4" (6.4mm)
 - f. For more information see: http://unistrut.com/Browse/cat_detail.php?S=S05&P=P1130

- C. Standoffs
 - 1. 3" Diameter Flange Standoff
 - a. Physical dimensions
 - 1) 3" square base plate
 - a) 4X 3/8" diameter holes on corner of base plate
 - 2) 4" high 1 11/16" diameter raised cylinder,
 - b. For more information see: <http://www.unirac.com/pdf/ii227.pdf>

2.3 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.

PART 3 - EXECUTION

3.1 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
- C. 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.

END OF SECTION 051213

SECTION 051413 - ARCHITECTURALLY EXPOSED STRUCTURAL ALUMINUM FRAMING**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Comply with applicable provisions of the following:

PART 2 - PRODUCTS**2.1 STRUCTURAL ALUMINUM**

- A. Solar Mount Heavy Duty Rails
1. Anodized Aluminum
 2. Able to support 40 plf with a 12 ft span.
 3. For more information see: <http://www.unirac.com/pdf/ii227.pdf>
- B. Solar Mount Rails
1. Anodized Aluminum
 2. Able to support 220 plf with a 4 ft span.
 3. For more information see: <http://www.unirac.com/pdf/ii227.pdf>
- C. Solar Thermal Racking
1. For composite shingle, S-Tile, and mission tile roofing
 2. Components made from Aluminum and Stainless Steel.
 3. Modular Design, with single bolt installation
 4. For more information, see: http://www.schueco.com/web/us/architects/products/solar_energy_systems/mounting_systems/products/solarez

2.2 ACCESSORIES

- A. High-Strength Bolts, Nuts, and Washers
- B. L-Foot 90° Mounting brackets.
1. High Strength aluminum alloy
 2. 3" x 2" X 2" wide
 3. For more information see: <http://www.unirac.com/pdf/ii227.pdf>
- C. Rail Splices
1. Heavy Duty Metal Connectors
 2. For more information see: <http://www.unirac.com/pdf/product-price-list.pdf>

PART 3 - EXECUTION**3.1 ERECTION**

- A. 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.

END OF SECTION 051413

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Shop Drawings showing details of fabrication and installation.

PART 2 - PRODUCTS

2.1 METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 240/A 240M or ASTM A 666, Type 304.
- C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- D. Rolled Steel Floor Plate: ASTM A 786/A 786M.
- E. Steel Tubing: ASTM A 500.
- F. Steel Pipe: ASTM A 53, standard weight (Schedule 40), black finish.
- G. Slotted Channel Framing: Cold-formed steel channels, 41 by 41 mm by 1.7 mm thick, complying with MFMA-4.
- H. Cast Iron: ASTM A 48/A 48M or ASTM A 47/A 47M.
- I. Aluminum Extrusions: ASTM B 221M, Alloy 6063-T6.
- J. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- K. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.2 FABRICATION

- A. General: Shear and punch metals cleanly and accurately. Remove burrs and ease exposed edges. Form bent-metal corners to smallest radius possible without impairing work.
- B. Welding: Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. At exposed connections, finish welds and surfaces smooth with contour of welded surface matching those adjacent.
- C. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
- D. Fabricate nosings from cast iron with an integral abrasive finish.
 - 1. Apply bituminous paint to concealed surfaces of units set into concrete.

2.3 MANUFACTURED PRODUCTS

- A. Standard Pier
 - 1. Mobilehome & Accessory Structure Building Components
 - 2. Health and Safety Code, Division 13, Part 2
 - 3. State of California Department of Housing and Community Development Division of Codes and Standards
 - 4. Tested at BSK Associates with list number #01600002
 - 5. Rated for 6000lbs with a 3 to 1 Safety Factor
 - 6. Made from 12ga steel and painted with a rust preventive coating.

7. Used with ScrewJack Pier Top; Part Number 244 from Central Pier catalog
 8. For Details see Central Piers catalog, <http://www.centralpiers.com/CP%20Catalog%20%20110dpi%209.2M%20.pdf>
- B. Seismic Pier
1. For concrete component, see SECTION 03 41 00 Precast Structural Concrete
 2. Steel complies with ASTM A36
 3. $F_y = 36$ ksi minimum
 4. Fabricated according to AISC
 5. Welded to AWS specifications.
 6. 3203 lbs. in the strong direction
 7. 2273 lbs in the weak direction
 8. 16,000 lbs vertical load
 9. See <http://www.centralpiers.com/30-5F%202007CBC.pdf> for details
- C. Pier Accessories
1. Pier Pads: Plastic
 - a. 24" X 24" X 1"
 - 1) Rated for 1778 lbs
 - 2) UV stabilized
 - b. 16" X 16" X 1"
 - 1) Rated for 4000 lbs
 - 2) UV stabilized
 - c. For more information see: <http://www.centralpiers.com/piers.html>

2.4 STEEL AND IRON FINISHES

- A. Prepare uncoated ferrous metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning," and paint with a fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.
- B. 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 0.038 mm. Do not prime surfaces to be embedded in concrete or mortar or to be field welded.

2.5 MECHANICAL SKID

- A. Materials:
1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 2. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 240/A 240M or ASTM A 666, Type **304**.
 3. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
 4. Rolled Steel Floor Plate: ASTM A 786/A 786M.
 5. Steel Tubing: ASTM A 500.
- B. Dimensions:
1. Width: 5 ft
 2. Length: 2 sections of 9 ft to make a total of 18 ft
 3. Height of Northeast corner: 7 ft 4 in
 4. Height of Southwest corner: 9 ft 4 in
- C. Location: Behind North wall of Module B. See Site Plan A-106 for exact location.
- D. Mounting Attachments
1. Unistrut rails will be mounted vertically to frame of skid every 16" to allow for easy equipment attachment.
 2. Unistrut rails will be mounted horizontally to frame of skid every 24" to allow for easy equipment attachment.

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION 055000

SECTION 057500 - DECORATIVE FORMED METAL

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product data.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Stainless Steel Mesh

2.2 EXTERIOR METAL

- A. Product:
 - 1. Omega 1510: AISI Type 316 stainless steel
 - 2. Manufacturer: GKD Metal Fabrics
 - 3. See Manufacturer's Specifications for details:
http://www.gkdmetailfabrics.com/assets/2005/October/Omega1510_0105.pdf
- B. Product:
 - 1. Aluminum Sheet # 5052-H32
 - 2. Manufacturer: Speedy Metals
 - 3. Finish: Clear Anodized Aluminum
 - 4. Description: Break shapes per shop drawing
 - 5. See Manufacturer's Specifications for details:
<http://www.speedymetals.com/pc-1935-8374-0025-5052-h32-aluminum-sheet.aspx>

2.3 INTERIOR METAL

- A. Product:
 - 1. Aluminum Sheet # 5052-H32
 - 2. Manufacturer: Speedy Metals
 - 3. Finish: Clear Anodized Aluminum
 - 4. Description: Break shapes per shop drawing
 - 5. See Manufacturer's Specifications for details:
<http://www.speedymetals.com/pc-1935-8374-0025-5052-h32-aluminum-sheet.aspx>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate with shop drawings the size and shape drawings of individual metal pieces.
- B. Install metal level, plumb, true, and aligned with adjacent materials. Scribe and cut to fit adjoining work. Refinish and seal cuts.
- C. Select and arrange paneling for best match of adjacent units. Install with uniform tight joints.

END OF SECTION 057500

SECTION 060523 – WOOD AND PLASTIC FASTENINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Pre-engineered metal connectors used to support a wood, plated truss, or composite wood member(s) from a concrete, masonry, steel, wood, or composite wood supporting member(s).

1.2 RELATED SECTIONS

- A. Section 03300 – Cast-In-Place Concrete – Concrete provides support or anchorage.
- B. Section 04050 – Basic Masonry Materials and Methods – Masonry provides support or anchorage.
- C. Section 04200 – Masonry Units – Masonry provides support or anchorage.
- D. Section 05120 – Structural Steel – Steel provides support or anchorage.
- E. Section 06100 – Rough Carpentry – Wood supported by fastenings or providing support or anchorage.

1.3 REFERENCES

- A. ASTM A36 – Carbon Structural Steel
- B. ASTM A167 – Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- C. ASTM A193-B7 – Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
- D. ASTM A307 – Carbon Steel Bolts and Studs
- E. ASTM A500 – Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- F. ASTM A625 – Tin Mill Products, Black Plate, Single Reduced
- G. ASTM A653 – Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- H. ASTM A706 – Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
- I. ASTM A924/A 924M – General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
- J. ASTM A1011 – Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
- K. ASTM F1667 – Driven Fasteners: Nails, Spikes, and Staples
- L. ASTM D1761 – Standard Test Methods for Mechanical Fasteners in Wood
- M. ICBO AC13 – Acceptance Criteria for Joist Hangers and Similar Devices
- N. ICBO AC95 – Acceptance Criteria to Determine Bending Yield Moment for Nails
- O. ICBO AC120 – Acceptance Criteria for Wood Screws
- P. AISI 1996 – Cold-Formed Steel Specification
- Q. 1997 NDS – National Design Specification

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to job site in manufacturer's or distributor's packaging undamaged, complete with installation instructions.
- B. Protect and handle materials in accordance with manufacturer's recommendations to prevent damage or deterioration.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

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

2.2 MATERIALS

- A. Simpson Tie model SDS25600 screws with hot-dip zinc coating complying with ASTM A 153/A 153M or ASTM F 2329 unless otherwise indicated.
 - 1. Complies with:
 - a. Complies with 2006 International Building Code® (IBC)
 - b. 2006 International Residential Code® (IRC)
 - c. 2003 International Building Code® (2003 IBC)
 - d. 2003 International Residential Code® (2000 IRC)
 - e. 2000 International Residential Code® (2000 IRC)
 - f. 1997 Uniform Building Code™ (UBC)
 - 2. Rolled threads (10 threads per inch, approx. 2/3 of nominal screw length), unslotted hex washer head, type 17 drill point or proprietary four-cut point
 - 3. Data is in accordance with the ICC-ES Acceptance Criteria for Alternate Dowel-type Threaded Fasteners (AC233), dated February 2007.
 - 4. Carbon-Steel Bolts: ASTM F 568M with ASTM A 563M hex nuts and, where indicated, flat washers all hot-dip zinc coated.
 - 5. Product found at: http://www.icc-es.org/reports/pdf_files/ICC-ES/ESR-2236.pdf
- B. Simpson Tie Hangers model U310
 - 1. Complies with:
 - a. 2006 International Building Code® (IBC)
 - b. 2006 International Residential Code® (IRC)
 - c. 2003 International Building Code® (2003 IBC)
 - d. 2003 International Residential Code® (2000 IRC)
 - e. 2000 International Residential Code® (2000 IRC)
 - 2. Manufactured from galvanized steel complying with ASTM A 653, SS designation, Grade 33, with a minimum yield strength, F of 33,000 psi and minimum tensile strength 45,000 psi.
 - 3. Have minimum G90 zinc coating specification in accordance with ASTM A 653
 - 4. Product found at: http://www.icc-es.org/reports/pdf_files/ICC-ES/esr-2549.pdf
- C. Simpson Tie straps model ST series
 - 1. Complies with:
 - a. 2003 International Building Code® (2003 IBC)
 - b. 2003 International Residential Code® (2000 IRC)
 - c. 2000 International Residential Code® (2000 IRC)
 - d. 2000 International Building Code® (2000 IBC)
 - e. 1997 Uniform Building Code™ (UBC)
 - 2. Simpson Tie straps are fabricated from ASTM A 635, SS, Grade 33, galvanized steel
 - 3. Product found at: http://www.icc-es.org/reports/pdf_files/ICC-ES/esr-2105.pdf
- D. Simpson Tie hold downs model HDU2-SDS2.5
 - 1. Complies with:
 - a. 2003 International Building Code® (2003 IBC)
 - b. 2003 International Residential Code® (2000 IRC)
 - c. 2000 International Residential Code® (2000 IRC)
 - d. 2000 International Building Code® (2000 IBC)
 - e. 1997 Uniform Building Code™ (UBC)
 - 2. HDU hold downs are fabricated from ASTM A 635, SS, Grade 33, galvanized steel with a minimum yield strength of 33,000 psi and a minimal tensile strength of 45,000 psi.
 - 3. The load transfer base plates are manufactured from ASTM A 1101, SS, Grade 33, steel with a minimum yield

- strength of 33,000 psi and a minimal tensile strength of 52,000 psi.
4. Product found at: http://www.icc-es.org/reports/pdf_files/ICC-ES/esr-2330.pdf
- E. Simpson Tie A35 Framing Angles
1. Complies with:
 - a. 2006 International Building Code® (IBC)
 - b. 2006 International Residential Code® (IRC)
 - c. 2003 International Building Code® (2003 IBC)
 - d. 2003 International Residential Code® (2000 IRC)
 - e. 2000 International Residential Code® (2000 IRC)
 2. Framing angles are manufactured from galvanized steel complying with ASTM A 653, SS designation, Grade 33, with a minimum yield strength, F of 33,000 psi and minimum tensile strength 45,000 psi.
- F. Standard threaded rod, 5/8"
1. Complies with ASTM standards
 2. Product ordered from: <http://www.pineconelumber.com/>
- G. 1997 Uniform Building Code™ (UBC)
1. Sheet: ASTM A625, ASTM A653, ASTM A1011
 2. Fasteners: ASTM F1667, SAE C1022 (SDS Screws)
- H. Stainless Steel:
1. Sheet: ASTM A 167
- I. Finishes:
1. Gray paint
 2. Hot-dipped galvanized or electro-plated galvanized: G60, G90, G185 (ZMAX)
 3. Powder-coated paint.
 4. Zinc and dichromate for SDS screws

PART 3 - EXECUTION

3.1 FABRICATION

- A. Shop assembly to occur per the manufacturer's approved production drawings.
- B. Fabrication tolerances per manufacturer.
- C. Fabrication requiring welding shall be performed in accordance with the current American Welding Society's standards.
- D. The manufacturer's identification shall be stamped into the metal part and/or a label may be attached to the part with adhesive.

3.2 TESTING

- A. Allowable loads published in manufacturer's catalog to be determined using the minimum load from static and/or cyclic analysis and one or more of the following test methods:
 1. Static load tests in wood assemblies
 2. Static load tests in steel jigs
 3. Static load tests of products embedded in concrete or masonry
 4. Cyclic or static load tests in wood assemblies (Anchor Tiedown System)
- B. Testing to determine allowable loads shall be performed as per ICBO Acceptance Criteria 13 (AC13) and/or ASTM D1761.
- C. Allowable loads for hangers are determined by a static load test resulting in not more than a 1/8" deflection of the joist relative to the header, or the lowest test ultimate load divided by 3, or the fastener allowable load as determined by the NDS, whichever is lower.
- D. Testing shall be conducted under the supervision of an independent laboratory.
- E. Manufacturer to provide code testing data on all products that have been code tested upon request.

3.3 EXAMINATION

- A. Unless otherwise noted in the manufacturer's catalog, allowable loads are for Douglas Fir-Larch under continuously dry conditions. Allowable loads for other species or conditions must be adjusted according to the code. See manufacturer's catalog for additional notes and requirements.
- B. Built-up lumber (multiple members) must be fastened together to act as one unit to resist the applied load.
- C. Verify that the dimensions of the supporting member are sufficient to receive the specified fasteners.

3.4 INSTALLATION

- A. Unless otherwise noted in the manufacturer's catalog, bolts and nails shall not be combined.
- B. All nails shall be common unless otherwise noted in the manufacturer's catalog or substituted, by the engineer of record, with a reduction taken.
- C. Unless otherwise noted in the manufacturer's catalog, bending steel in the field may cause fractures at the bend line. Fractured steel will not carry load and must be replaced. When bending is allowed or required in the catalog, the connector shall be allowed one cycle bend, one time only.
- D. Galvanized connectors should not be placed in contact with treated wood unless the treated wood is adequately verified to be suitable for such contact. Some wood treatments may accelerate metal deterioration. See wood material supplier for specific recommendations.
- E. A fastener that splits the wood will not take the design load. Evaluate splits to determine if the connection will perform as required. Dry wood may split more easily and should be evaluated as required. If wood tends to split, consider pre-boring holes with diameters not exceeding 0.75 of the nail diameter (1997 NDS 12.1.3.1).
- F. SDS series wood screws are installed with a $\frac{3}{8}$ -inch hex head driver and a low-speed drill. Predrilling wood members is not required for installation. Edge distances, end distances, and spacing of the screws must be sufficient to prevent splitting the wood and must be within the parameters described in the following table:

CONDITION		MINIMUM DISTANCE OR SPACING (inches)
Edge distance	Perpendicular to grain loading	1 \bar{D}
	Parallel to grain loading	1
End distance	Perpendicular to grain loading	4
	Parallel to grain loading	3
Spacing	Between fasteners in a row	3
	Between rows	3
	Between staggered rows	1 \bar{D}

The screws must be overdriven. Fasteners installed in preservative-treated wood shall have corrosion protection in accordance with recommendations of the evaluation report holder. Should an HDG coating be recommended, the coating weight shall be in accordance with ASTM A 153.

- G. Wood shrinkage shall be taken into account when designing and installing connections.
- H. Built-up lumber (multiple members) must be fastened together to act as one unit to resist the applied load.
- I. Top flange hangers may cause unevenness. Possible remedies should be evaluated by a professional and include using a face mount hanger, routing the beam, or cutting the subfloor to accommodate the top flange thickness.
- J. Do not overload by exceeding the manufacturer's catalog allowable load values.
- K. Unless otherwise noted in the manufacturer's catalog, fill all fastener holes with fastener types as specified in the manufacturer's catalog.
- L. All specified fasteners must be installed according to the instructions in the manufacturer's catalog.
- M. Bolt holes shall be a minimum of 1/32" and a maximum of 1/16" larger than the bolt diameter (NDS 8.1.2.1)
- N. Install all specified fasteners before loading the connection.

- O. Use proper safety equipment.
- P. Welding shall be in accordance with the American Welding Society (AWS) standards.
- Q. Welding galvanized steel may produce harmful fumes; follow proper welding procedures and safety precautions.
- R. Nail tools with hole-location mechanisms may be used to install connectors, provided the correct quantity and type of nails are properly installed in the nail holes.
- S. Joist shall bear completely on the connector seat, and the gap between the joist end and the header shall not exceed 1/8".
- T. Installer of ATS system to cut rods to length as required.
- U. Modifications to products or changes in installation procedures should only be made by a qualified designer. The performance of such modified products or an altered installation procedure is the sole responsibility of the designer.

3.5 FIELD QUALITY CONTROL

- A. Determine that the proper part is being used in the correct application and has been fabricated by the approved manufacturer by observation of the stamp into the metal part and/or the adhesive label on the product denoting part and manufacturer name.
- B. Before substituting another brand, confirm load capacity based on published testing data and calculations per section 2.04. The engineer/designer of record shall evaluate and give written approval for substitution prior to installation.

END OF SECTION 060523

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: ICC-ES evaluation reports for treated wood.

PART 2 - PRODUCTS**2.1 WOOD PRODUCTS, GENERAL**

- A. Lumber: Provide dressed lumber, S4S, marked with grade stamp of inspection agency.
- B. All lumber will be No. 2: Douglas fir-larch (north): NLGA with maximum moisture content of 15% U.O.N.

2.2 TREATED MATERIALS

- A. Preservative-Treated Materials: AWP A C2 except that lumber not in ground contact and not exposed to the weather may be treated according to AWP A C31 with inorganic boron (SBX).
 - 1. Use treatment containing no arsenic or chromium.
 - 2. Kiln-dry lumber after treatment to a maximum moisture content of 15 percent.
 - 3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- B. Provide preservative-treated materials for items indicated on Drawings, and the following:
 - 1. Wood members in connection with soil.
 - 2. Concealed members in contact with masonry or concrete.
 - 3. Wood framing members that are less than 24 in above the ground.
- C. Fire-Retardant-Treated Materials: Comply with performance requirements in AWP A C20.
 - 1. Use Exterior type for exterior locations and where indicated.
 - 2. Use Interior Type A, High Temperature (HT) where indicated.
 - 3. Use Interior Type A unless otherwise indicated.
 - 4. Identify with appropriate classification marking of a testing and inspecting agency acceptable to authorities having jurisdiction.
- D. Provide fire-retardant treated materials for items indicated on Drawings.

2.3 PLYWOOD BACKING PANELS

- A. Telephone and Electrical Equipment Backing Panels: Plywood, Exterior AC, fire-retardant treated, not less than 1/2" nominal thickness.

2.4 FASTENERS

- A. Fasteners: Size and type indicated. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
 - 1. Power-Driven Fasteners: CABO NER-272.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Set miscellaneous rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Securely attach miscellaneous rough carpentry to substrates, complying with the following:
 - 1. CABO NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in the IBC.

END OF SECTION 061053

SECTION 061063 - EXTERIOR ROUGH CARPENTRY**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: ICC-ES evaluation reports for wood-preservative treated wood, plastic decking, expansion anchors, and metal framing anchors
- B. For decking fasteners see related section 06 05 23 Wood, Plastic, and Composite Fasteners.

PART 2 - PRODUCTS**2.1 WOOD PRODUCTS, GENERAL**

- A. Lumber: Provide dressed lumber, S4S, marked with grade stamp of inspection agency.
- B. For supplier see, <http://www.pineconelumber.com/>

2.2 TREATED MATERIALS

- A. Preservative-Treated Boards and Dimension Lumber: AWWA C2.
 - 1. Use treatment containing no arsenic or chromium.
- B. Preservative-Treated Timber: AWWA C15, waterborne preservative.
 - 1. Use treatment containing no arsenic or chromium.
 - 2. Treatment with CCA shall include post-treatment fixation process.
- C. After treatment, re-dry boards, dimension lumber, and timber 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, items indicated on drawings, and the following:
 - 1. Framing members less than 18 in above grade.
 - 2. Sills and ledgers.
 - 3. Posts.
 - 4. Decking.
 - 5. Stair treads.

2.3 LUMBER

- A. Dimension Lumber:
 - 1. Maximum Moisture Content: 19 percent
 - 2. Deck and Stair Framing:
 - a. Interior Floor decking framed with Douglas Fir 2 x 12, NLGA, WCLIB
 - b. Exterior floor decking framed with No. 2 Reclaimed Redwood 2x6 beams with 2x8 ledgers
 - 3. Dimension Lumber Posts: No. 2 Reclaimed Redwood
 - 4. Dimension Lumber Decking and Stair Treads: Elm wood
 - a. For supplier, see <http://www.woodanchor.com/cim/3101.dhtm>
 - 5. Dimension Lumber Railing Members: Redwood No. 2
 - a. Provide material hand selected for freedom from characteristics, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

B. Boards:

1. Maximum Moisture Content: 19 percent.
2. Board Decking and Stair Treads: 1.25 in. thick, radius-edged decking will be of Elm wood
3. Stair Treads: 32-mm- thick stepping with half-round or rounded-edge nosing and made of Elm wood
4. Railing Boards: Redwood No.2

2.4 MISCELLANEOUS PRODUCTS

A. Fasteners: see section 06 05 23

1. Provide nails or screws, in sufficient length, to penetrate not less than 1.5 in into wood substrate.
2. Power-Driven Fasteners: CABO NER-272.
3. Carbon-Steel Bolts: ASTM F 568M with ASTM A 563M hex nuts and, where indicated, flat washers all hot-dip zinc coated.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction" unless otherwise indicated.
- C. Securely attach rough carpentry to substrates, complying with the following:
 1. CABO NER-272 for power-driven fasteners.
 2. Published requirements of metal framing anchor manufacturer.
- D. Secure decking to framing with concealed decking fasteners.
- E. Secure stair treads and risers by gluing and screwing to carriages. Countersink fastener heads, fill flush, and sand filler. Extend treads over carriages.
- F. Railing Installation: Countersink fastener heads, fill flush, and sand filler.
 1. Fit balusters to railings, glue, and screw in place.
 2. Secure newel posts to stringers and risers with through bolts.
 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 061063

SECTION 061100 - WOOD FRAMING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: ICC-ES evaluation reports for wood-preservative treated wood, fire-retardant treated wood, and engineered wood products and metal framing anchors.
- B. For decking fasteners see related section 06 05 23 Wood, Plastic, and Composite Fasteners.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

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

2.2 TREATED MATERIALS

- A. Preservative-Treated Materials: AWPA C2, except that lumber not in ground contact and not exposed to the weather may be treated according to AWPA C31 with inorganic boron (SBX).
 - 1. Use treatment containing no arsenic or chromium.
 - 2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
 - 3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- B. Provide preservative-treated materials for items indicated on Drawings, and the following:
 - 1. Wood members in connection with soil.
 - 2. Concealed members in contact with masonry or concrete.
 - 3. Wood framing members that are less than 460 mm above the ground.
 - 4. Wood floor plates that are installed over concrete slabs-on-grade.
- C. Fire-Retardant-Treated Materials: Comply with performance requirements in AWPA C20.
 - 1. Use Exterior type for exterior locations and where indicated.
 - 2. Use Interior Type A, High Temperature (HT) for enclosed roof framing, and where indicated.
 - 3. Use Interior Type A unless otherwise indicated.
 - 4. Identify with appropriate classification marking of a testing and inspecting agency acceptable to authorities having jurisdiction.
- D. Provide fire-retardant treated materials for items indicated on Drawings.
- E. Provide preservative-treated materials for all exterior rough carpentry unless otherwise indicated, items indicated on drawings, and the following:
 - 1. Framing members less than 18 in above grade.
 - 2. Sills and ledgers.
 - 3. Posts.
 - 4. Decking.
 - 5. Stair treads.

2.3 LUMBER

- A. Dimension Lumber:
 - 1. Dimension lumber will be No. 2: Douglas fir-larch (north): NLGA with 19% maximum moisture content.
 - 2. Exposed Framing: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
 - a. Species: Redwood No. 2
 - b. See SECTION 061063 Exterior rough carpentry
 - 3. Deck and Stair Framing:
 - a. Exterior floor decking framed with No. 2 Reclaimed Redwood 2x6 beams with 2x8 ledgers

2.4 ENGINEERED WOOD PRODUCTS

- A. Engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be demonstrated by comprehensive testing.
- B. Parallel Strand Lumber: Manufactured with exterior-type adhesive complying with ASTM D 2559. Allowable design values determined according to ASTM D 5456.
 - 1. Extreme Fiber Stress in Bending, Edgewise: 2900 psi for 12 in nominal depth members.
 - 2. Modulus of Elasticity, Edgewise: 2,000,000 psi.
- C. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research/evaluation report for I-joists.
 - 1. Material: Any veneer product, glued-laminated wood or product made from any combination solid lumber, wood strands, and veneers.

2.5 PLYWOOD BACKING PANELS

- A. Telephone and Electrical Equipment Backing Panels: Plywood, Exterior AC, not less than $\frac{5}{8}$ " nominal thickness.
- B. See SECTION 061600 - Sheathing

2.6 MISCELLANEOUS PRODUCTS

- A. Fasteners: Size and type indicated. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
 - 1. Power-Driven Fasteners: CABO NER-272.
 - 2. Bolts: Steel bolts complying with ASTM F 568, Property Class 4.6; with ASTM A 563M hex nuts and, where indicated, flat washers.
- B. Metal Framing Anchors: Structural capacity, type, and size indicated.
 - 1. Use anchors made from hot-dip galvanized steel complying with ASTM A 653/A 653M, Z180 coating designation for interior locations where stainless steel is not indicated.
 - 2. Use anchors made from stainless steel complying with ASTM A 666, Type 304 for exterior locations and where indicated.
- C. Sill Sealer: Closed-cell neoprene foam, 6.4 mm thick.

PART 3 - EXECUTION**3.1 INSTALLATION**

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

1. CABO NER-272 for power-driven fasteners.
 2. Published requirements of metal framing anchor manufacturer.
 3. Table 2304.9.1, "Fastening Schedule," in the IBC.
- C. Secure decking to framing with concealed decking fasteners.
- D. Secure stair treads and risers by gluing and screwing to carriages. Countersink fastener heads, fill flush, and sand filler. Extend treads over carriages.
- E. Railing Installation: Countersink fastener heads, fill flush, and sand filler.
1. Fit balusters to railings, glue, and screw in place.
 2. Secure newel posts to stringers and risers with through bolts.
 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 061100

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: ICC-ES evaluation reports for preservative-treated plywood and foam-plastic sheathing.

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS, GENERAL

- A. Plywood: DOC PS 1.
- B. For Supplier see, <http://www.pineconelumber.com/>

2.2 TREATED PLYWOOD

- A. Preservative-Treated Plywood: AWPA C9.
 - 1. Use treatment containing no arsenic or chromium.
 - 2. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

2.3 WALL SHEATHING

- A. Plywood Wall Sheathing:
 - 1. Thickness: 15/32" inch.
- B. For Supplier see, <http://www.pineconelumber.com/>

2.4 ROOF SHEATHING

- A. Plywood Roof Sheathing: Structural sheathing.
 - 1. Thickness: 19/32 inch
- B. For Supplier see, <http://www.pineconelumber.com/>

2.5 SUBFLOORING AND UNDERLAYMENT

- A. Radiant-Floor Heating Panel:
 - 1. Subfloor weather-resistant plywood sheathing panel
 - 2. Code Compliance:
 - a. IBC Section 2303.1.4
 - b. IRC Section R503.2
 - c. UBC Standard 23-3
 - d. DOC PS-2
 - e. Section 2312
 - f. UBC
 - 3. Grooves accommodate radiant-floor tubing:
 - a. Barrier PEX Tubing 1/2"
 - b. See SECTION 22 11 16 for tubing specifications
 - 4. For Supplier see, <http://www.warmboard.com/wp-content/uploads/2008/10/0908-warmboard-brochure.pdf>

2.6 MISCELLANEOUS PRODUCTS

- A. Sheathing Joint-and-Penetration Treatment Materials:
 - 1. Sealant for Fiber Cement Sheathing: Joint sealant recommended by sheathing manufacturer for application indicated.
 - 2. Sheathing Tape for Fiber Cement 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.
- B. Adhesives for Field Gluing Panels to Framing: APA AFG-01.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Securely attach to substrates, complying with the following:
 - 1. CABO NER-272 for power-driven fasteners.
- B. Fastening Methods:
 - 1. Combination Subfloor-Underlayment:
 - a. Glue and nail to wood framing.
 - 2. Wall and Roof Sheathing:
 - a. Nail to wood framing.
- C. Fiber Cement Sheathing Joint-and-Penetration Treatment: Seal sheathing joints and penetrations according to sheathing manufacturer's written instructions.

END OF SECTION 061600

SECTION 061753 - SHOP-FABRICATED TRUSSES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, Shop Drawings, structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation, and ICC-ES evaluation reports for metal plate connectors and metal truss accessories.
- B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction.
- C. 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."
 - 4. Code Compliance: AC14 2004, AC162 2000, ASTM 5055-00a (2000)

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads indicated without exceeding TPI 1 deflection limits.

2.2 MATERIALS

- A. Open Web Bamboo I-Joists: Prefabricated units, made with solid or structural composite bamboo flanges and webs, let into and bonded to flanges. Provide units complying with material requirements of and with structural capacities established and monitored according to ASTM D 5055.
 - 1. For manufacture, see <http://www.teragren.com/>
 - 2. Structural Properties: Provide units with depths and design values not less than those indicated in structural calculations
 - 3. Provide units complying with APA PRI-400, factory marked with nominal joist depth, joist class, span ratings, mill identification, and compliance with APA standard.
- B. Connector Plates: TPI 1, fabricated from hot-dip galvanized-steel sheet complying with ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); Z180 coating designation; and not less than 0.9 mm thick.
- C. Fasteners: Where trusses 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, Z180 coating designation.

2.3 FABRICATION

- A. Assemble trusses using jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted. Fabricate wood trusses within manufacturing tolerances in TPI 1.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install and brace trusses according to TPI recommendations and as indicated. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- B. Anchor trusses securely at bearing points; use metal framing anchors. Install fasteners through each fastener hole in metal framing anchor.
- C. Securely connect each truss ply required for forming built-up girder trusses. Anchor trusses to girder trusses.
- D. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
 - 1. Install bracing to comply with Division 06 Section "Rough Carpentry."
- E. Do not cut or remove truss members.
- F. Remove bamboo trusses that are damaged or do not meet requirements and replace with trusses that do meet requirements.

END OF SECTION 061753

SECTION 061800 - GLUED-LAMINATED CONSTRUCTION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Standards: Comply with ANSI/AITC A 190.1, "Structural Glued Laminated Timber."
- C. Comply with AITC 111, "Recommended Practice for Protection of Structural Glued Laminated Timber during Transit, Storage, and Erection."

PART 2 - PRODUCTS

2.1 STRUCTURAL GLUED-LAMINATED UNITS

- A. Structural Performance: Provide structural glulam timber capable of withstanding design loads indicated according to AITC 117 or as determined according to ASTM D 3737.
- B. Species: Any Species U.O.N.
- C. Balanced lay-ups are for cantilevered and continuous span applications but can be used for simple spans; unbalanced lay-ups are for simple spans.
- D. Appearance: Industrial grade.
- E. Adhesive: Wet-use adhesive complying with AITC A190.1.
- F. End-Cut Sealing: After end cutting each member to final length, apply a saturation coat of end sealer to ends and other cross-cut surfaces.
- G. Seal Coat: After fabricating and sanding each unit, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit.
- H. Wiped Stain Finish: Manufacturer's standard, dry-appearance, penetrating acrylic stain and sealer; oven dried and resistant to mildew and fungus.
- I. Clear Finish: Manufacturer's standard, two-coat, clear varnish finish; resistant to mildew and fungus.
- J. For Supplier see <http://www.pineconelumber.com/>

2.2 **Parallel Strand Lumber: Manufactured with exterior-type adhesive complying with ASTM D 2559. Allowable design values determined according to ASTM D 5456.**

- A. Manufactured with exterior-type adhesive complying with ASTM D 2559. Allowable design values determined according to ASTM D 5456.
- B. Extreme Fiber Stress in Bending, Edgewise: 2900 psi for 12 in nominal depth members.
- C. Modulus of Elasticity, Edgewise: 2,000,000 psi.

2.3 CONNECTORS

- A. General: Fabricate from structural steel complying with ASTM A 36/A 36M; steel bars complying with ASTM A 575, Grade M 1020; and steel sheet complying with ASTM A 1011/A 1011M, Structural Steel, Type SS, Grade 33. Finish with rust-inhibitive primer.

- B. Use 16d nail connection to double top plates
- C. Use Simpson A35 clips for connection to rim joists, see SECTION 060523 Wood and Plastic Fastenings

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install structural glued-laminated timber for a close fit and neat appearance of joints. Carefully trim ends to fit connectors, mark and drill for bolts, and seal cuts with end sealer.
- B. Handle and temporarily support members to prevent visible surface damage. When hoisting members into place, use padded slings, and protect corners with wood blocking.
- C. Brace members as they are placed to maintain safe condition until full stability is provided.

END OF SECTION 061800

SECTION 062000 - FINISH CARPENTRY**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product data.

PART 2 - PRODUCTS**2.1 MATERIALS, GENERAL**

- A. Hardwood Plywood: HPVA HP-1.
- B. Bamboo Plywood: HPVA HP-1

2.2 MINIMUM MATERIAL STANDARDS

- A. ASTM D 1037, Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
- B. ASTM D 3043, Standard Test Methods for Flexural Structural Panels in Flexure.
- C. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. ASTM D 4442, Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
- E. ASTM D 3500, Standard Test Method for Structural Panels in Tension.
- F. ASTM E 1333, Standard Test Method for Determining Formaldehyde Rates from Wood Using a Large Chamber. Concentrations in Air Emission

2.3 EXTERIOR FINISH CARPENTRY

- A. Plywood Exterior Siding: Plytanium Sanded Project Panels
 - 1. 15/32 inch APA-rated siding
 - 2. 4' X 8' panels
 - 3. Smooth, sanded face
 - 4. Manufacturer: Georgia-Pacific
 - 5. Finish: Painted, see specification # 099100 for detail.
 - 6. See manufacturer's specifications for details:
<http://www.gp.com/build/product.aspx?pid=1397>

2.1 INTERIOR PANELING

- A. Bamboo Plywood: Factory finished, 1/4", complying with AHA 135.5, Class I finish.
 - 1. Products:
 - a. PlybooStrand plywood; 3/4" 3-ply Species: Havana
 - b. See Manufacturer's Specifications: http://www.plyboo.com/images/plyboo/downloads/s&f_Plyboo_bamboo-plywood-spec-5.01.09.doc

2. Surface-Burning Characteristics: Fire Resistance Classification: [Class A] [Class C]. Test surface burning characteristics in accordance with ASTM E 84.
3. Natural Wax Sealer

2.2 SHELVING AND CLOTHES RODS

- A. Shelving: 3/4" Plyboo as specified for hardboard paneling
- B. Clothes Rods: 1" diameter, white finish; ClosetMaid Selectives # 7042
 1. See Manufacturer's Specifications:

<http://www.homedepot.com/webapp/wcs/stores/servlet/ProductDisplay?storeId=10051&langId=-1&catalogId=10053&productId=100597836&N=10000003+90401>
- C. Shelf and Rod Support:
 1. Finish: Chrome
 2. See manufacturer's specifications:

<http://www.schultestorage.com/catalog/option.asp?poid=226>

2.1 STAIRS AND RAILINGS

- A. Exterior Railings: Clear, kiln-dried, pressure-preservative-treated Douglas fir

2.2 MISCELLANEOUS MATERIALS

- A. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer.
 1. Use waterproof resorcinol glue for exterior applications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Condition finish carpentry in installation areas for 24 hours before installing.
- B. Install finish carpentry level, plumb, true, and aligned with adjacent materials. Scribe and cut to fit adjoining work. Refinish and seal cuts.
- C. Select and arrange paneling for best match of adjacent units. Install with uniform tight joints.

END OF SECTION 062000

SECTION 064316 - WOOD RAILINGS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Banister and Post: Pine, FSC Certified
- B. Rails: Steel rod, ⅝"
- C. Exterior Signage: Brushed Aluminum

2.2 FINISH

- A. Clear, Natural Wax
 - 1. Deck Boss
 - See Manufacturer's Specifications
 - <http://www.weatherbos.com/coverage.html>

END OF SECTION 064316

SECTION 064913 - WOOD SCREENS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. SUMMARY
 - 1. Vertical, Wood, Ventilated Façade:
 - 2. Custom fabricated Rainscreen
 - 3. See http://www.metalconstruction.org/pubs/pdf/mca07_Rainscreen.pdf

PART 2 - PRODUCTS

2.1 LUMBER

- A. Species: Elm, FSC Certified
- B. Dimensions
 - 1. Thickness: 8 in
 - 2. Width: 5 in
 - 3. Length: Manufacturer's length

2.2 MOUNTING

- A. Hidden Z-CLIP fastening system.
 - 1. See SECTION 050523 Metal Fastenings

2.3 WATERPROOFING

- A. See SECTION 071300 for waterproofing information.

2.4 FINISH

- A. Clear, Low VOC Polyurethane
 - 1. See SECTION 099100 Painting

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Individual Planks of the façade will be attached to a larger panel with screws.
- B. Install panels level, plumb, and at indicated alignment with adjacent work.
- C. Use hidden fastening system with hanger system.
- D. Fasten on light gauge metal framing.

END OF SECTION 064913

SECTION 071300 - SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MINIMUM PRODUCT STANDARDS MET

- A. Tensile Strength: 250 psi minimum; ASTM D 412, Die C, modified.
- B. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
- C. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D 1970.
- D. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
- E. Puncture Resistance: 40 lbf minimum; ASTM E 154.
- F. Hydrostatic-Head Resistance: 150 feet minimum; ASTM D 5385.
- G. Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.

2.2 MATERIALS

- A. Vidiflex-F/2000, Prefabricated corners and membrane.
 - 1. See Manufacturer's Specifications:
<http://tetrainc.info/page6.html>
- B. Fasteners:
 - 1. Vidiflex-F 2000, Flashing tapes

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Surface preparation: The Substrate shall be clean, smooth, dry, free of sharp edges, oil and grease.
- B. Placement of waterproofing tape:
 - 1. Place Vidiflex-F tape at the sill. Secure with minimal staples at interior edge. Seal interior leg to interior vapor retarder with field applied sealant. Seal outside leg to the face of the building and to the sill.
 - 2. Install prefabricated corner on the bottom of the building opening. Secure as you have secured the sill strip.
 - 3. Install Vidiflex-F tape at the jamb. Secure as you have secured the tape at the sill.
 - 4. Install the prefabricated corners at the head. Secure the same as the bottom corners.
 - 5. Install Vidiflex tape at the head. Secure as it the jamb.See Manufacturer's Instruction Details:
http://tetrainc.info/Vidiflex-F%20Detail%20Win%20Flash%20N%20Const_031403.pdf

END OF SECTION 071300

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Building Code Approvals (ICC): http://www.icc-es.org/reports/pdf_files/ICC-ES/ESR-2600.pdf

1.2 RELATED SECTIONS

- A. 072113 - Board Insulation
- B. 072116 - Blanket Insulation
- C. 072126 - Blown Insulation

PART 2 - PRODUCTS

2.1 BOARD INSULATION

- A. Basis of Product Design: Thermablok Aerogel Insulation Strips. Acoustiblok, Inc.
- B. Description: Thermablok Insulation strips virtually eliminate thermal bridging, a prime factor in energy loss. Thermablok is a flexible, nanoporous aerogel insulation.
- C. Physical Properties:
 - 1. Size: Strip Form- 8 in. x 1 1/2 in. x 4 ft.; Blanket Form- 8 in. x 57 in. x 125 ft.
 - 2. Fire Rating (ASTM E84): Class A, Flame Spread 20, Smoke Index 50
 - 3. Application Temperature Range: -328 deg F to + 400 deg F
 - 4. Density: 9.4 lb/ft.³
- D. Manufacturer info:
 - 1. Thermablok
 - 2. Product info at: http://thermablok.com/thermablok_insulation_installation.html

2.2 BLANKET INSULATION

- A. Basis of Product Design: Aspen Aerogel Spaceloft Blanket Insulation
- B. Description: A flexible, nanoporous aerogel blanket™ insulation. It has extremely low conductivity, high hydrophobicity, flexibility, and compression resistance. Though it repels water, it allows vapor to pass through, making it breathable.
- C. Physical Properties:
 - 1. Useable up to 390°F.
 - 2. Density 9.4 lb/ft.³
 - 3. R-value of 10.3 per inch
- D. Manufacturer info:
 - 1. Aspen Aerogel
 - 2. Product info at: http://www.aerogel.com/products/pdf/Spaceloft_DS.pdf

2.3 BLOWN INSULATION

- A. Basis-of-Design Product: Sealection Agribalance Spray Foam Insulation. Demilec (USA) LLC.
- B. Description: Sealection Agribalance is a two-component, open-cell, spray-applied, semi-rigid polyurethane foam system

that contains more than 20% renewable agricultural-based materials (refined vegetable oils) in the resin. This product is a water-blown foam with nominal density 0.7 pcf and installed density of 0.6-0.8 pcf. The polyurethane foam is produced by combining a polymeric isocyanate and a resin.

- C. Thermal Resistance: R-Value of 24.5 (°F.ft².h/Btu) for 5.5 in. thickness.
- D. Surface-burning Characteristics: The insulation at a maximum thickness of 5.5 inches has a flame spread index of less than 25 and smoke-developed index of less than 450 when tested in accordance with ASTM E 84.
- E. Manufacturer info:
 - 1. Demilec USA
 - 2. Product info at: <http://www.demilecusa.com/Default.aspx?ip=3&sip=46>

2.4 ACCESSORIES FOR BLOWN INSULATION

- A. Basis-of-Design Product: Andek Firegard Intumescent Coating. Andek Corporation.
 - 1. Description: Andek Firegard intumescent coating is a water-based liquid coating with specific gravity of 1.37. Andek Firegard is supplied in 5-gallon pails and has a shelf life of one year.
- B. Manufacturer info:
 - 1. Demilec USA
 - 2. Product info at: <http://www.demilecusa.com/Default.aspx?ip=3&sip=46>

PART 3 - EXECUTION

3.1 INSTALLATION OF BOARD INSULATION

- A. Thermablok may be installed either on the exterior or interior side of the wall framing. Apply the insulation to the full length of framing members, all wall, floor or ceiling framing edges: headers, footers, trusses, window and door frames, floor joist and roof rafters.
- B. Cut and fit Thermablok encapsulated strips tight to any protrusions or interruptions. Allow no gaps between thermal bridging barrier insulation. Remove release backing from adhesive tape and apply directly to metal or wood framing. Apply pressure to the layer strip to ensure firm and uniform adhesion to surfaces.

3.2 INSTALLATION OF BLANKET INSULATION

- A. Use any conventional textile cutting tool to cut into form desired from blanket roll.
- B. The material is dusty so gloves, safety glasses, and dust mask is recommended for handling.
- C. Standard blanket installation applies.

3.3 INSTALLATION OF BLOWN INSULATION

- A. Sealection Agribalance Application: The insulation is spray-applied on the jobsite using a volumetric positive displacement pump. The insulation can be installed in one pass to the maximum thickness. The foam plastic must not be used in electrical outlet or junction boxes or in contact with rain, water, or soil. During insulation, the polymeric isocyanate and the resin are combined in a chemical expansion process. During and after installation, the insulation must be protected from the weather.
- B. Andek Firegard intumescent coating installed in accordance with manufacturer's published installation instructions.
- C. The insulation must be separated from the interior of the building by an approved 15-minute thermal barrier, except as when installation is in attics and crawl spaces.

END OF SECTION

SECTION 072600 – VAPOR RETARDERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Air and Vapor Barrier
1. Grace Perm-A-Barrier® Wall Membrane
See Manufacturer's Specifications:
http://www.na.graceconstruction.com/vaporret/download/PAB-002K_2.pdf

PART 3 - EXECUTION

3.1 INSTALLATION

- A. SAFETY
1. Perm-A-Barrier products must be handled properly. Vapors from the mastic and solvent based primer are harmful and flammable. For these products, the best available information on safe handling, storage, personal protection, health and environmental considerations has been gathered. Material Safety Data Sheets (MSDS) are available upon request. Carefully read detailed precaution statements on product labels and MSDS before use. Contact Grace Construction Products for additional information.
- B. STORAGE & HANDLING
1. All materials must be protected from rain and physical damage. Pallets of Perm-A-Barrier Wall Membrane must not be double stacked on the jobsite. Provide cover on top and all sides, allowing for adequate ventilation. Store membrane where temperatures will not exceed 90 degrees F (32 degrees C) for extended periods. All products must be stored in a dry area away from high heat, flames or sparks. Store only as much material at point of use as is required for each day's work.
- C. PREPARATORY WORK
1. Surface Preparation
 - a. Surface must be smooth, clean, dry and free of voids, spalled areas, loose aggregate, loose nails, sharp protrusions or other matter that will hinder the adhesion or regularity of the wall membrane installation. Clean loose dust or dirt from the surface to which the wall membrane is to be applied by wiping with a clean, dry cloth or brush. If the substrate is damp, allow to dry or use Bituthene Primer B2 or Bituthene Primer B2 LVC to prepare the area to receive the membrane
 2. Temperature
 - a. Perm-A-Barrier Low Temperature Membrane may be applied only in dry weather when air and surface temperatures are between 25 degrees F (-4 degrees C) and 60 degrees F (16 degrees C). Perm-A-Barrier Wall Membrane may be applied only in dry weather when air and surface temperatures are above 40 degrees F (5 degrees C).
- D. APPLICATION
1. Conditioning and Priming
 - a. Perm-A-Barrier Surface Conditioner is supplied ready to use. It should not be diluted with water or solvent. Mix and apply a light coating with a portable spray unit, brush or roller. Conditioner will cover 300 ft²/gal (7.5 m²/L) when applied with a low pressure, portable sprayer. Allow surface conditioner to dry completely before membrane application. The surface conditioner is considered dry when the substrate returns to its original color (minimum 1 hour). To test for dryness, rub small conditioned area by hand. Wet conditioner will ball up under the fingertips. Let dry until conditioner cannot be rubbed off. Condition only areas that can be covered the same day. Conditioned areas not covered the same day should be reconditioned. Perm-A-Barrier WB Primer is a water based primer which imparts an aggressive, high-tack finish on the treated substrate. It is packaged ready to use and is specifically designed to facilitate tenacious adhesion of Perm-A-Barrier flashing tapes and wall membranes to cementitious substrates, glass mat surfaces and exterior gypsum boards, such as Dens-Glass Gold®.

- b. Apply Perm-A-Barrier WB Primer by roller at a coverage rate of 6 - 8 m²/L (250 - 350 ft²/gal). Allow to dry for a minimum of 1 hour (longer at low temperatures). Apply Bituthene Primer B2 to clean surfaces at a coverage rate of 6 - 8 m²/L (250 - 350 ft²/gal). Apply Bituthene Primer B2 LVC to clean surface at a coverage rate of 7.5 - 10.0 m²/L (325 - 425 gal/ft²). Allow primer to dry completely (approximately 1 hour, depending on weather conditions).
 2. Membrane Application
 - a. Cut membrane into easily handled lengths. Apply membrane horizontally or vertically to primed substrates receiving post-applied masonry anchors (ties), such as gypsum sheathing. Remove release paper from membrane and press firmly into place with a hand roller. RIPCORDER, a split release on demand feature embedded in the membrane, also makes Perm-A-Barrier Wall Membrane easy to position. Apply Perm-A-Barrier Wall Membranes horizontally to the primed block work between projecting masonry anchors (ties), beginning at the base of the wall. Each length of the membrane must be installed so that the upper edge runs continuously along the underside of the line of masonry anchors (ties). Subsequent sheets applied above must overlap the sheet below by 2" (50 mm) immediately below the line of reinforcing. Since the membrane width appropriate for this application of 18" (450 mm) is wider than the typical spacing between the lines of anchors (ties) 16" (400 mm), it will be necessary to cut the membrane at the location of the tie wires projecting from the wall to enable the sheet to be laid in place. End laps that occur in subsequent lengths that follow should maintain a minimum overlap of 2" (50 mm). See Figures 1 and 2. The membrane must be pressed firmly into place with a hand roller or the back of a utility knife as soon as possible, ensuring continuous and intimate contact with the substrate to prevent water from migrating under the membrane. In certain applications such as on soffits, ceilings or on substrates such as oriented strand board (OSB), backnail the membrane along the side lap prior to installing the next sheet of membrane to ensure positive contact to the substrate.
 - b. Apply Bituthene Mastic to seal around the tie wire projections. Fit the Perm-A-Barrier Wall Membrane tightly around all penetrations through the membrane and seal using Bituthene Mastic. Continue the membrane into all openings in the wall area, such as windows, doors, etc., and terminate at points that will prevent interior visibility. The installation must be made continuous at all framed openings. Coordinate installation of the Perm-A-Barrier Wall Membrane with the roofing trade to ensure continuity with the roofing system at this critical transition area. At the end of each working day, if the wall has been only partially covered, apply a bead of Bituthene Mastic along the top edge of the membrane at its termination to prevent vertical drainage of precipitation from penetrating the end and undermining the membrane adhesion. Tool the Bituthene Mastic to ensure it is worked into the surface. Inspect the membrane before covering and repair any punctures, damaged areas or inadequately lapped seams.
- E. MEMBRANE REPAIRS
1. Repairs must be made using Perm-A-Barrier Wall Membrane sized to extend 6" (150 mm) in all directions from the perimeter of the affected area. If repairs are required, carefully cut out affected areas and replace in similar procedure as outlined above. The repair piece must be pressed into place with a hand roller as soon as possible to ensure continuous and intimate contact with the substrate.
- F. MEMBRANE PROTECTION
1. Perm-A-Barrier Wall Membranes must be protected from damage by other trades or construction materials.

END OF SECTION 072600

SECTION 075000 – MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Warranties: Provide manufacturer's standard written warranty, signed by manufacturer agreeing to promptly repair or replace roof specialties that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Thermoplastic Membrane Roofing, Firestone UltraPly TPO
 - 1. See Manufacturer's Specifications:
<http://technicaldatabase.fsbp.com/productData/ultraplytpomembrane/>
 - 2. See Manufacturer's Warranty:
<http://www.firestonebpco.com/templateFiles/includes/common/displayFile.ashx?fileId=2445>
- B. Self-Adhering Sheet Underlayment, High Temperature: Butyl or SBS-modified asphalt; slip-resisting-polyethylene surfaced; with release paper backing; cold applied. Stable after testing at 116 deg C and passes after testing at minus 29 deg C; ASTM D 1970.
 - 1. See Grace Ice Shield's Manufacturer's Specifications.
<http://www.na.graceconstruction.com/underlayments/download/GIWS-062D%20GIWS%20Specification.pdf>
- C. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements.
 - 1. Exposed Penetrating Fasteners: Gasketed screws with heads matching color of metal.
 - 2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel.
- D. Butyl Sealant: ASTM C 1311, solvent-release butyl rubber sealant.
- E. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 ROOF SPECIALTIES

- A. Copings: Galvanized aluminum fabricated on site; as specified in 076200.
- B. Roof Drain: Siphonic Roof Drain
 - 1. Cast Iron Dome: 15 Ø" Diameter – Low Profile Dome
http://www.jrsmith.com/green_building/1005_siphonic_roof_drain_rwh.htm
- C. Downspouts: Built in wall as called out by floorplan.
 - 1. Steel: 4 inches in diameter.
- D. Counterflashings: Fabricated on site; as specified in 076200

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install the membrane directly on a clean, dry, continuous structural deck. Some suitable structural deck materials include

plywood, wood composition, wood plank, metal, concrete, or gypsum sheathing. Remove dust, dirt, loose nails, and old roofing materials. Protrusions from the deck area must be removed. Decks shall have no voids, damaged, or unsupported areas. Repair deck areas before installing the membrane.

- B. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement.
- C. Coat back side of galvanized roof specialties with bituminous coating where they will contact wood, ferrous metal, or cementations construction.
- D. Separate dissimilar metals with a bituminous coating or polymer-modified, bituminous sheet underlayment.
- E. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- F. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 38 mm, except where pretinned surface would show in finished Work.

END OF SECTION 075000

SECTION 075552 - MODIFIED BITUMINOUS PROTECTED MEMBRANE ROOFING**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.
- B. Warranties: Provide manufacturer's standard written warranty, signed by manufacturer agreeing to promptly repair or replace roof specialties that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Self-Adhering Sheet Underlayment, High Temperature: Butyl or SBS-modified asphalt; slip-resisting-polyethylene surfaced; with release paper backing; cold applied. Stable after testing at 116 deg C and passes after testing at minus 29 deg C; ASTM D 1970.
 - 1. See Grace Ice Shield's Manufacturer's Specifications.
<http://www.na.graceconstruction.com/underlayments/download/GIWS-062D%20GIWS%20Specification.pdf>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. SURFACE PREPARATION
 - 1. Install Grace underlayments directly on a clean, dry, continuous structural deck. Some suitable deck materials are plywood, wood composition, wood plank, metal, concrete, or gypsum sheathing. For all other sheathings, contact a local Grace representative.
 - 2. Remove dust, dirt, loose nails and old roofing materials. Protrusions from the deck area must be removed. Decks shall have no voids, damaged or unsupported areas. Repair deck areas before installing the membrane. Wood planks should be closely butted together.
 - 3. Prime concrete, masonry surfaces and Dens-Glass Gold[®] with Perm-A-Barrier[®] WB Primer if adhesion is found to be marginal. Apply at a rate of 250 - 350 ft²/gal (6 - 8 m²/L). Priming is not required for other suitable surfaces provided that they are clean and dry.
- B. MEMBRANE INSTALLATION
 - 1. Apply Grace underlayments only in fair weather when the air, roof deck and membrane are at temperatures of 40 degrees F (5 degrees C) or higher. Apply roof covering material at temperatures of 40 degrees F (5 degrees C) or higher.
 - 2. Cut the membrane into 10' - 15' (3 - 5 m) lengths and reroll loosely. Peel back 1' - 2' (300 - 600 mm) of release liner, align the membrane, and continue to peel the release liner from the membrane. Press the membrane in place with heavy hand pressure. Side laps must be a minimum of 3 1/2" (90 mm), and end laps must be a minimum of 6" (150 mm). For valley and ridge application, peel the release liner, center the sheet over the valley or ridge, drape, and press in place. Use RIPCORDER[®] to split the release paper for faster and easier installation in these detail areas. Work from the center of the valley or ridge outward in each direction and start at the low point and work up the roof.
 - 3. Alternatively, starting with a full roll of membrane, unroll a 3' - 6' (1 - 2 m) "starter strip," leaving the release liner in place. Align the membrane and roll in the intended direction of membrane application. Carefully cut the release liner on top of the full roll in the cross direction being careful not to cut the membrane.
 - 4. Peel back about 6" (150 mm) of the release liner in the opposite direction of the intended membrane application exposing the black adhesive. Hold the release liner with one hand and pull the roll along the deck with the release liner, leaving the starter strip behind. Use the other hand to apply pressure on the top of the roll. Stop frequently to press the membrane in place with heavy hand pressure. When finished with the roll, go back to the beginning, reroll it, and pull the remaining release paper from the material, finishing the installation.
 - 5. Consistent with good roofing practice, install the membrane so that all laps shed water. Always work from the low point to the high point of the roof. Apply the membrane in valleys before the membrane is applied to the eaves. Following placement along the eaves, continue application of the membrane up the roof. The membrane may be installed either vertically or horizontally.
 - 6. Use smooth shank, electroplated galvanized nails for fastening shingles. Hand nailing will provide a better seal than power activated nailing. If nailing of the membrane is necessary on steep slopes during hot weather, backnail and cover the nails by overlapping with the next sheet.

7. Extend the membrane on the roof deck above the highest expected level of water back-up from ice dams and above the highest expected level of snow and ice on the wall sheathing on vertical side walls (dormers) and vertical front walls for ice dam protection.
8. Consider a double layer of membrane in critical areas, such as along the eaves or in valleys, in climates where severe ice dams are anticipated. Apply the membrane to the entire roof deck for wind driven rain protection. Apply a new layer of Grace underlayment directly over the old Grace underlayment in retrofit applications following the standard membrane application procedure. Place metal drip edges or wood starter shingles over the membrane.

END OF SECTION 075552

SECTION 076200 - SHEET METAL FLASHING AND TRIM**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

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

PART 2 - PRODUCTS**2.1 SHEET METAL**

- A. Metallic-Coated Steel Sheet: Galvanized structural-steel sheet, ASTM A 653/A 653M, Z275, or aluminum-zinc alloy-coated structural-steel sheet, ASTM A 792/A 792M, Class AZM150 coating designation, Grade 275; 0.56-mm nominal thickness.
 - 1. Finish: Manufacturer's standard epoxy primer and silicone-modified, polyester-enamel topcoat.
 - 2. Concealed Finish: Manufacturer's standard white or light-colored acrylic or polyester backer finish.

2.2 ACCESSORIES

- A. Felt Underlayment: ASTM D 226, Type I (No. 15), asphalt-saturated organic felts.
- B. Self-Adhering Sheet Underlayment, High Temperature: Butyl or SBS-modified asphalt; slip-resisting-polyethylene surfaced; with release paper backing; cold applied. Stable after testing at 116 deg C and passes after testing at minus 29 deg C; ASTM D 1970.
- C. Slip Sheet: Building paper, 0.16-kg/sq. m minimum, rosin sized.
- D. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners.
 - 1. Exposed Fasteners: Heads matching color of sheet metal roofing using plastic caps or factory-applied coating.
 - 2. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - 3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
 - 4. Fasteners for Zinc-Tin Alloy-Coated Stainless-Steel Sheet: Series 300 stainless steel.
- E. Solder for Copper: ASTM B 32, Grade Sn50.
- F. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
- G. Solder for Zinc-Tin Alloy-Coated Stainless Steel: ASTM B 32, 100 percent tin.
- H. Butyl Sealant: ASTM C 1311, solvent-release butyl rubber sealant.
- I. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION

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

- B. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 25 mm deep, filled with butyl sealant concealed within joints.
- C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with SMACNA's "Architectural Sheet Metal Manual." Allow for thermal expansion; set true to line and level. Install Work with laps, joints, and seams permanently watertight and weatherproof; conceal fasteners where possible.
- B. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
- C. Fabricate nonmoving seams in sheet metal with flat-lock seams.
- D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 38 mm, except where pretinned surface would show in finished Work.
 - 1. Do not solder metallic-coated steel sheet.
 - 2. Do not pretin zinc-tin alloy-coated stainless steel.
 - 3. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
- E. Aluminum Flashing and Trim: Coat back side of aluminum flashing and trim with bituminous coating where it will contact wood, ferrous metal, or cementitious construction.
- F. Separate dissimilar metals with a bituminous coating or polymer-modified, bituminous sheet underlayment.

END OF SECTION 076200

SECTION 077126 - REGLETS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 HARDWARE**

- A. Product:
 - 1. Fry Reglet, Architectural Metals
 - a. "Z" Flashing
 - b. See Manufacturer's Specifications
<http://www.fryreglet.com/shape/pop/254.htm>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. none

END OF SECTION 077126

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. 07 92 10.10 Caulking and Sealants

1.2 SECTION REQUIREMENTS

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

PART 2 - PRODUCTS

2.1 JOINT SEALANTS

- A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under service and application conditions.
- B. Sealant for Use in Building Expansion Joints:
 - 1. Single-component, neutral-curing silicone sealant, ASTM C 920, Type S; Grade NS; Class 100/50; for Use NT.
See Tremco Spectrem® 1 Low Modulus Silicone Joint Sealant
<http://www.tremcosealants.com/filesshare/pds/Spectrem1DSEnglish.pdf>
- C. Sealant for General Exterior Use Where Another Type Is Not Specified
 - 1. Single-component, non-sag urethane sealant, Type S; Grade NS; Class 25; for Use NT.
See Sikaflex®521 UV UV Resistant Low Modulus Sealant
<http://www.sikaindustry.com/pds-ipd-Sikaflex521uv-us.pdf>
- D. Sealant for Use in Interior Joints in Ceramic Tile and Other Hard Surfaces in Kitchens and Toilet Rooms and Around Plumbing Fixtures:
 - 1. Single-component, mildew-resistant silicone sealant, ASTM C 920, Type S; Grade NS; Class 25; for Use NT; formulated with fungicide.

See Tremco Tremsil® 200 General Construction Grade Silicone Sealant
<http://www.tremcosealants.com/filesshare/pds/TREMSIL2.PDF>
- E. Sealant for Interior Use at Perimeters of Door and Window Frames:
 - 1. Siliconized acrylic latex sealant, ASTM C 834, Type OP, Grade NF.

See Tremco Tremsil® 834 Siliconized Interior Latex Sealant
<http://www.tremcosealants.com/filesshare/pds/tflex834.pdf>

2.2 MISCELLANEOUS MATERIALS

- A. Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION 079200

SECTION 081116 - SWINGING ALUMINUM-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Provide AAMA-certified, swinging aluminum-framed glass doors with an attached label.

PART 2 - PRODUCTS

2.1 SWINGING ALUMINUM-FRAMED GLASS DOORS

- A. Products:
 - 1. Kawneer. 2000T Terrace Doors
 - a. 3'1"W - In-swinging door flush mount to interior, NW.
See Door Schedule: #6
 - b. 2'9" - Swing door, NE
See Door Schedule: #7
See Manufacturer's Specifications:
http://www.kawneer.com/kawneer/north_america/catalog/pdf/2000T__E--A.pdf
- B. Performance Requirements: AAMA/WDMA/CSA 101/I.S.2/A440.
 - 1. Performance Class: HC.
 - 2. Performance Grade: N/A.
 - 3. Condensation Resistance: CR determined according to NFRC 500 of 45
 - 4. Thermal Transmittance: Maximum whole fenestration product U-factor of 0.36 when tested according to AAMA 1503.
- C. Roller Assemblies: Comply with AAMA 906.
- D. Lock: Install manufacturer's keyed cylinder lock and locking device on each movable panel, lockable from the inside and outside.
- E. Glaze units with clear, low-e coated, HeatMirror88 Suspended film, krypton-filled, safety glass complying with Division 08 Section "Glazing" and with testing requirements in 16 CFR 1201 for Category II materials.
- F. Finish: Class II, clear anodic finish; AA-M12C22A31.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set doors level, plumb, and true to line, without warp or rack of frames and panels. Provide proper support and anchor securely in place.
- B. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
- C. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
- D. Adjust operating panels, screens, and hardware to provide a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
- E. Clean aluminum surfaces and glass immediately after installing sliding aluminum-framed glass doors. Remove nonpermanent labels from glass surfaces.

END OF SECTION 081116

SECTION 081376 -BI-FOLDING METAL DOORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data

PART 2 - PRODUCTS

2.1 FOLDING DOORS

- A. Bifold Doors: Formed-steel panels, hinged together in pairs, supported on pivots at jambs, and with manufacturer's standard track and hardware. Channel form vertical panel edges and weld cross bracing to panel face and edges.
1. Products: Milgard; Series 420, Custom Bi-folding Aluminum door, NE

See manufacturer's specifications:

http://pro.milgard.com/_doc/products/specifications/doc/specifications-thermally-improved-aluminum-patiodoor.doc

2. Surface Profile: Flush.
3. Sheet Metal Texture: Smooth.
4. Finish: Class II, clear anodic finish; AA-M12C22A31.
5. Skin: Elm Rain Screen Panels attached using Z-Clips on the exterior frame of the door.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install track in one piece.
- B. Install folding doors with floor clearances of \varnothing to \varnothing inch
- C. Adjust units as necessary to ensure smooth, quiet operation without warping or binding. Adjust operating hardware so latches engage accurately and securely without forcing or binding.

END OF SECTION 081376

SECTION 081473 - SLIDING WOOD DOORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 POCKET DOORS

- A. Products:
1. Manufacturer: Plyboo
 - a. Product: 3/4" PlybooStrand plywood
 - b. Havana; 48" X 72", 3 Ply
 - c. See Manufacturer's Specifications:

http://www.plyboo.com/images/plyboo/downloads/s&f_Plyboo_bamboo-plywood-spec-5.01.09.doc
- B. Roller Assemblies: Comply with AAMA 906.
1. KN Crowder, C- 300 sliding door track

<http://kncrowder.com/slidingdoor/c300.html>
- C. Lock: Install manufacturer's keyed cylinder lock and locking device on each movable panel, lockable from the inside [only] [and outside].
- D. Finish: Clear wax natural sealer.

2.2 BARN DOORS

- A. Products:
1. Custom Aluminum Framed Door with Horizontal Wood Louvers
 - a. Similar to HAWA custom Sliding Shutter
HAWA-Frontslide 60/A-Telescopic
 - b. Poplar Louvers

LMB Clear width: Shutter width: Shutter thickness: Fixing type: Guide arrangements: Trolley capacity: Number of shutters:	1829 mm 964 mm 28-40 mm Type 2 Type G 60.00 kg [132.00lbs.] 2	
Article	Description	Quantity
19721	Covering screen 3500 mm, aluminum plain anodized	1
19904	Z-guide profile 6000 mm, aluminum plain anodized,	1
19910	Floor guide, rattle proof, short, for z-guide profile	2
19911	Floor guide, rattle proof, long, for z-guide profile	2
20211	HAWA-Frontslide 60/A-Tele-scopic, partial set for	1
21373	Top track 3500 mm, aluminum plain anodized, predrilled	2
21383	Angled profile support for two sliding level	1
21467	Special fixing screws for securing top track to	1
21468	Parts for fitting top track cover for manual	2
21469	Front cover plates, aluminum plain anodized, for wall	1

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set doors level, plumb, and true to line, without warp or rack of frames and panels. Provide proper support and anchor securely in place.

END OF SECTION 081473

SECTION 083213 - SLIDING ALUMINUM-FRAMED GLASS DOORS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.
- B. Provide AAMA-certified, sliding aluminum-framed glass doors with an attached label.

PART 2 - PRODUCTS**2.1 SLIDING ALUMINUM-FRAMED GLASS DOORS**

- A. Products:
 - 1. Milgard; Series 420.
 - a. Location: South West and South East on end caps
 - 1) Dimensions: 72" x 97"
 - b. Location: South walls of Modules A and C
 - 1) Dimensions: 31 13/16" x 95 1/8"
 - c. See door schedule for detail.
 - 2. See manufacturer's specifications:

http://pro.milgard.com/_doc/products/specifications/doc/specifications-thermally-improved-aluminum-patiodoor.doc
- B. Performance Requirements: AAMA/WDMA/CSA 101/I.S.2/A440.
 - 1. Performance Class: LC
 - 2. Performance Grade: N/A
 - 3. Condensation Resistance: CRF when tested according to AAMA 1503 of 45.
 - 4. Thermal Transmittance: Maximum whole fenestration product U-factor of 0.36, when determined according to NFRC 100.
 - 5. Solar Heat-Gain Coefficient (SHGC): Whole-fenestration product SHGC maximum of 0.25 determined according to NFRC 200.
- C. Roller Assemblies: Comply with AAMA 906.
- D. Floor Track: Exterior type, low profile, ADA-ABA compliant.
- E. Lock: Install manufacturer's keyed cylinder lock and locking device on each movable panel, lockable from the inside only. Coordinate glass requirements in first paragraph below with Division 08 Section "Glazing."
- F. Glaze units with clear, low-e coated, argon-filled, sealed insulating, safety glass complying with Division 08 Section "Glazing" and with testing requirements in 16 CFR 1201 for Category II materials.
 - 1. HeatMirror88 Suspended Film used in N facing doors.
- G. Finish: Class II, clear anodic finish; AA-M12C22A31; complying with AAMA 611

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Set doors level, plumb, and true to line, without warp or rack of frames and panels. Provide proper support and anchor securely in place.
- B. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
- C. Set sill members in bed of sealant or with gaskets, as indicated, to provide weather tight construction.
- D. Adjust operating panels, screens, and hardware to provide a tight fit at contact points and weather stripping for smooth operation and weather tight closure. Lubricate hardware and moving parts.
- E. Clean aluminum surfaces and glass immediately after installing sliding aluminum-framed glass doors. Remove nonpermanent labels from glass surfaces.

END OF SECTION 083213

SECTION 085113 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Provide AAMA- or WDMA-certified aluminum windows with an attached label.

PART 2 - PRODUCTS

2.1 ALUMINUM WINDOWS

- A. Products:
 - 1. Milgard; Series 1120 HS. 83" x 24"
 - a. Location: North Wall
 - 2. Milgard; 921 PW: 21 5/8" x 83 9/16" Picture
 - a. Location: NE and NW Walls
 - 3. Milgard; 921 PW: 65 5/8" x 17 3/8" x 15" 1/4"
 - 4. Milgard; 921 PW: 36" x 18" x 17 5/8"
 - 5. Milgard; 921 awn: 36" x 18"
 - 6. Milgard; 921 PW: 40 3/8" x 15 5/8" x 18 1/8"
 - 7. Milgard; 921 PW: 40 3/8" x 13" x 15 5/8"
 - 8. Milgard; 921 PW: 34" x 10 5/8" x 12 3/4"
 - 9. See Manufacturer's Specifications: http://pro.milgard.com/_doc/products/specifications/doc/specifications-thermally-improved-aluminum-window.doc
- B. Window Types: The following types, as indicated on Drawings:
 - 1. Awning.
 - 2. Horizontal sliding.
 - 3. Fixed.
- C. Performance Requirements: AAMA/WDMA/CSA 101/I.S.2/A440.
 - 1. Performance Class: 1120 Series: R20; 921 Series: HC45
 - 2. Performance Grade: N/A
 - 3. Condensation-Resistance Factor: 45 per AAMA 1503.
 - 4. Thermal Transmittance: Whole-window U-factor not more than 0.39 at 24-km/h wind velocity and winter temperatures per NFRC 100.
 - 5. Solar Heat-Gain Coefficient: Whole-window SHGC not more than 0.40, per NFRC 200.
- D. Construction: Provide units with a concealed, thermal break.
- E. Provide gear-type rotary operators with folding handles for awning and sliding windows.
- F. Provide nylon sash rollers for sliding windows.
- G. Glaze units with clear, low-e coated sealed insulating glass, complying with Division 08 Section "Glazing."
- H. Finish: Class II, clear anodic finish; AA-M12C22A31; complying with AAMA 611

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set units level, plumb, and true to line, without warp or rack of frames and panels. Provide proper support and anchor securely in place.

- B. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
- C. Adjust operating panels, screens, and hardware to provide a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
- D. Clean aluminum surfaces and glass immediately after installing windows. Remove nonpermanent labels from glass surfaces.

END OF SECTION 085113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Allowances: Provide hardware under Hardware Allowance in Division 01 Section "Price and Payment Procedures."
- B. Submittals: Hardware schedule.

PART 2 - PRODUCTS

2.1 HARDWARE

- A. Manufacturers:
 - 1. Hoppe
 - a. <http://www.us.hoppe.com/index.aspx>
 - 2. Hafele
 - a. <http://www.hafele.com/us/index.htm>
 - 3. KN Crowder Manufacturing
 - a. <http://www.kncrowder.com/>
 - 4. Baldwin Hardware
 - a. <http://www.knobsandhardware.com/products/view.aspx?sku=1240027>
- B. Hinges:
 - 1. Stainless-steel hinges with stainless-steel pins for exterior.
 - 2. Nonremovable hinge pins for exterior and public interior exposure.
 - 3. Ball-bearing hinges for doors with closers and entry doors.
 - 4. 3 hinges for aluminum doors.
- C. Locksets and Latchsets:
 - 1. BHMA A156.2, Series 4000, Grade 1 for bored locks and latches.
 - 2. BHMA A156.3, Grade 1 for exit devices.
 - 3. BHMA A156.5, Grade 1 for auxiliary locks.
 - 4. BHMA A156.12, Series 5000, Grade 1 for interconnected locks and latches.
 - 5. BHMA A156.13, Series 1000, Grade 1 for mortise locks and latches.
 - 6. Lever Handles on locksets and latchsets, Frankfurt Aluminum 117L.2246
 - 7. Provide trim on exit devices matching locksets.
- D. Edge pull for pocket doors
 - 1. Solid Brass Edge Pull, Satin Nickel
- E. Key locks to Owner's new master-key system.
 - 1. Cylinders with six-pin tumblers and removable cores.
 - 2. Provide construction keying.
 - 3. Provide key control system, including cabinet.
- F. Closers:
 - 1. Mount closers on interior side (room side) of door opening. Provide regular-arm, parallel-arm, or top-jamb-mounted closers as necessary.
- G. Provide wall stops or floor stops for doors without closers.

- H. Tracks:
 - 1. C-300 Extruded aluminum Track, For Single & Bi-Parting, Bi-Passing, Pocket or Face Mounted Doors
<http://www.kncrowder.com/slidingdoor/c300.html>
- I. Provide hardware finishes as follows:
 - 1. Hinges: Matching finish of lockset/latchset.
 - 2. Locksets, Latchsets, and Exit Devices: Satin chrome plated.
 - 3. Closers: Matching finish of lockset/latchset.
 - 4. Other Hardware: Matching finish of lockset/latchset.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount hardware in locations recommended by the Door and Hardware Institute unless otherwise indicated.

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3.
- B. Reflective-Coated Glass: ASTM C 1376, coated by vacuum deposition (sputter-coating process).
See Manufacturer's Specifications:
<http://www.cardinalcorp.com/data/pdf/loe3-366.pdf>
- C. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.

See manufacturer's specifications:
http://www.southwall.com/southwall/download/user/resource/HMTotal_Performance_Glazing.pdf@Heat%20Mirror%20Total%20Performance%20Glazing

2.2 LAMINATED-GLASS TYPES

- A. Glass Type 1: Low-e-coated, reflective-coated, laminated, tinted glass, HeatMirror88 film, with one ply of fully tempered float glass with inner ply Class 1 (clear).
 - 1. Thickness of Each Glass Ply: 3.0 mm.
 - 2. Low-E Coating: Sputtered on third surface.
 - 3. Krypton-filled
 - 4. Visible Light Transmittance: 66% percent minimum.
 - 5. Solar Heat Gain Coefficient: .34 maximum.
- B. Glass Type 2: Cardinal LoE³-366 Low-e-coated, laminated glass with one ply of clear fully tempered float glass.
 - 1. Thickness of Each Glass Ply: 3.0 mm.
 - 2. Low-E Coating: Sputtered on third surface.
 - 3. Krypton-filled
 - 4. Visible Light Transmittance: 66% percent minimum.
 - 5. Solar Heat Gain Coefficient: .27 maximum.

2.3 GLAZING SEALANTS

- A. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
- B. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are contained in GANA's "Glazing Manual."
- B. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- C. Remove nonpermanent labels, and clean surfaces immediately after installation.

END OF SECTION 088000

SECTION 089000 - LOUVERS AND VENTS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Provide louvers complying with performance requirements indicated as demonstrated by testing according to AMCA 500-L.
- B. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Aluminum Extrusions: ASTM B 221M, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B 209M, Alloy 3003 or 5005.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, Z275 zinc coating.
- D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- E. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel.

2.2 LOUVERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product(s) [indicated on Drawings] [named in subparagraph(s) below] or comparable product by one of the following:
 - 1. <Insert, in separate subparagraphs, manufacturer's name>.
- B. [Horizontal] [Vertical], Extruded-Aluminum, Storm-Resistant Louvers:
 - 1. [Available]Products:
 - a. <Insert manufacturer's name; product name or designation>.
 - 2. Louver Depth: [100 mm] [125 mm] [150 mm] [175 mm] [200 mm] [225 mm] <Insert dimension>.
 - 3. Aluminum Thickness: 1.5 mm for blades and 2.0 mm for frames.
 - 4. Free Area: Not less than [0.46 sq. m] [0.56 sq. m] [0.65 sq. m] <Insert quantity> for 1.2-m- wide by 1.2-m- high louver.
 - 5. Air Performance: Not more than 25-Pa static pressure drop at [3.0-m/s] [3.6-m/s] [4.1-m/s] <Insert value> free-area [exhaust] [intake] velocity.
 - 6. Wind-Driven Rain Performance: Not less than [99] [95] [80] <Insert number> percent effectiveness when subjected to a rain fall rate of [75 mm per hour and a wind speed of 13 m/s] [200 mm per hour and a wind speed of 22.4 m/s] <Insert rainfall rate and wind speed> at a core area intake velocity of [1.5 m/s] [2.0 m/s] [2.5 m/s] <Insert value>.
- C. Horizontal, Extruded-Aluminum, Drainable-Blade Louvers:
 - 1. [Available]Products:
 - a. <Insert manufacturer's name; product name or designation>.
 - 2. Louver Depth: [100 mm] [150 mm] <Insert dimension>.
 - 3. Aluminum Thickness: 1.5 mm for blades and 2.0 mm for frames.
 - 4. Free Area: Not less than [0.65 sq. m] [0.74 sq. m] <Insert quantity> for 1.2-m- wide by 1.2-m- high louver.
 - 5. Point of Beginning Water Penetration: Not less than [4.6 m/s] [4.8 m/s] [5.1 m/s] [5.3 m/s] [5.6 m/s] <Insert value>.

6. Air Performance: Not more than [25-Pa] <Insert value> static pressure drop at [3.6-m/s] [3.8-m/s] [4.1-m/s] [4.3-m/s] <Insert value> free-area [exhaust] [intake] velocity.
- D. Horizontal, Extruded-Aluminum, Nondrainable-Blade Louvers [with] [without] Center Baffle:
1. [Available]Products:
 - a. <Insert manufacturer's name; product name or designation>.
 2. Louver Depth: [50 mm] [100 mm] [150 mm] <Insert dimension>.
 3. Aluminum Thickness: 2.0 mm for blades and frames.
 4. Free Area: Not less than [0.70 sq. m] [0.74 sq. m] <Insert quantity> for 1.2-m- wide by 1.2-m- high louver.
 5. Point of Beginning Water Penetration: Not less than [3.6 m/s] [3.8 m/s] [4.1 m/s] [4.3 m/s] <Insert value>.
 6. Air Performance: Not more than [25-Pa] <Insert value> static pressure drop at [3.3-m/s] [3.6-m/s] [3.8-m/s] <Insert value> free-area [exhaust] [intake] velocity.
- E. Horizontal, Formed-Metal, Drainable-Blade Louvers:
1. [Available]Products:
 - a. <Insert manufacturer's name; product name or designation>.
 2. Louver Depth: [100 mm] [150 mm] <Insert dimension>.
 3. Metal and Thickness: [Galvanized steel, 1.3 mm] [Stainless steel, 1.3 mm].
 4. Free Area: Not less than [0.65 sq. m] [0.74 sq. m] <Insert quantity> for 1.2-m- wide by 1.2-m- high louver.
 5. Point of Beginning Water Penetration: Not less than [4.1 m/s] [4.3 m/s] [4.6 m/s] [4.8 m/s] <Insert value>.
 6. Air Performance: Not more than [25-Pa] <Insert value> static pressure drop at [3.6-m/s] [3.8-m/s] [4.1-m/s] [4.3-m/s] <Insert value> free-area [exhaust] [intake] velocity.
- F. Horizontal, Formed-Metal, Nondrainable-Blade Louvers [with] [without] Center Baffle:
1. [Available]Products:
 - a. <Insert manufacturer's name; product name or designation>.
 2. Metal and Thickness: [Galvanized steel, 1.3 mm] [Stainless steel, 1.3 mm].
 3. Free Area: Not less than [0.60 sq. m] [0.65 sq. m] [0.70 sq. m] [0.74 sq. m] <Insert quantity> for 1.2-m- wide by 1.2-m- high louver.
 4. Point of Beginning Water Penetration: Not less than [2.8 m/s] [3.0 m/s] [3.3 m/s] [3.6 m/s] <Insert value>.
 5. Air Performance: Not more than [25-Pa] <Insert value> static pressure drop at [2.8-m/s] [3.0-m/s] [3.3-m/s] [3.0-m/s] <Insert value> free-area [exhaust] [intake] velocity.

2.3 LOUVER SCREENS

- A. Provide screen at interior face of each exterior louver. Fabricate screen frames from same kind and form of metal as indicated for louver to which screens are attached.
1. Screening: [Aluminum] [Galvanized-steel] [Stainless-steel], 12.7-mm- square mesh.
 2. Screening: Flattened, expanded aluminum, 19 by 1.27 mm thick.

2.4 LOUVER FINISHES

- A. Aluminum Louvers: Conversion-coated and factory-primed finish, AA-C12C42R1x.
- B. Aluminum Louvers: Clear anodic finish, AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
- C. Aluminum Louvers: Color anodic finish, AAMA 611, [AA-M12C22A42/A44, Class I, 0.018 mm] [AA-M12C22A32/A34, Class II, 0.010 mm] or thicker.
1. Color: [Champagne] [Dark bronze] [Black] <Insert color>.
- D. Aluminum Louvers: Baked-enamel or powder-coat finish, AAMA 2603 except with a minimum dry film thickness of 0.04 mm.

- E. Aluminum Louvers: High-performance organic coating; AA-C12C42R1x; [two-coat fluoropolymer system complying with AAMA 2604] [three-coat fluoropolymer system complying with AAMA 2605], with finish coats containing at least 70 percent PVDF resin by weight.
- F. Galvanized-Steel Louvers: Two-coat baked-enamel or powder-coat finish over cleaned and conversion-coated metal, with a minimum dry film thickness of 0.05 mm.
- G. Stainless-Steel Louvers: [No. 4] [No. 6] finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install louvers level, plumb, and at indicated alignment with adjacent work.
- B. Provide perimeter reveals of uniform width for sealants and joint fillers, as indicated.
- C. Use concealed anchorages where possible.
- D. Build wall vents (brick vents) into masonry.
- E. Protect metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

END OF SECTION 089000

SECTION 092900 - GYPSUM BOARD**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

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

2.2 PANEL PRODUCTS

- A. Provide in maximum lengths available to minimize end-to-end butt joints.
- B. Interior Gypsum Board: ASTM C 1396/C 1396M, 5/8" thickness, with tapered edges. ASTM E119, 1 Hour fire-rating (Type X), Sag Resistant.

See Serious Materials EcoRock Specifications

http://www.seriousmaterials.com/ecorock_dsheets.pdf

- B. Interior Gypsum Board: ASTM C 1396/C 1396M, 5/8" thickness, with tapered edges. ASTM E119, 1 Hour fire-rating (Type X), Sag Resistant.

See Serious Materials ThermaRock Specifications

www.seriousmaterials.com/TRockXI_dsheets.pdf

- C. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M or ASTM C 1396/C 1396M, 5/8" thickness. 1 Hour fire-rating (Type X).

See Serious Materials QuietRock Specifications

http://www.quietsolution.com/QS_Manual_Spec_QuietRock__DAP_528.doc

- D. Glass-Mat, Water-Resistant Gypsum Backing Board: ASTM C 1178/c1178M, of

See G-P Gypsum; Dens Shield Tile Guard, Fiberglass-Mat Faced Gypsum Backing Board, 1/4"

<http://www.gp.com/BUILD/DocumentViewer.aspx?repository=BP&elementid=7064>

2.3 ACCESSORIES

- A. Trim Accessories: ASTM C 1047, formed from galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet. For exterior trim, use accessories formed from hot-dip galvanized-steel sheet, plastic, or rolled zinc.

1. Provide cornerbead at outside corners unless otherwise indicated.

2. Provide LC-bead (J-bead) at exposed panel edges.
 3. Provide control joints where indicated.
- B. Aluminum Accessories: Extruded-aluminum reglet indicated with Class II, clear anodic finish; AA-C12C22A31
- C. Joint-Treatment Materials: ASTM C 475/C 475M.
1. Joint Tape: Paper unless otherwise recommended by panel manufacturer.
 2. Joint Compounds: Drying-type, ready-mixed, all-purpose compounds.
 3. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound Cementitious Backer Unit
- Joint-Treatment Materials: Products recommended by cementitious backer unit manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gypsum board to comply with ASTM C 840.
1. Isolate gypsum board assemblies from abutting structural and masonry work. Provide edge trim and acoustical sealant.
 2. Single-Layer Fastening Methods: Fasten gypsum panels to supports with screws.
 3. Multilayer Fastening Methods: Fasten base layers and face layer separately to supports with screws.
- B. Install cementitious backer units to comply with ANSI A108.11.
- C. Fire-Resistance-Rated Assemblies: Comply with requirements of listed assemblies.
- D. Finishing Gypsum Board: ASTM C 840.
1. At concealed areas, unless a higher level of finish is required for fire-resistance-rated assemblies, provide Level 1 finish: Embed tape at joints.
 2. At substrates for tile, provide Level 2 finish: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges.
 3. Unless otherwise indicated, provide Level 4 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges.
 4. Where indicated, provide Level 5 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges. Apply skim coat to entire surface.
- E. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.
- F. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- G. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.

END OF SECTION 092900

SECTION 093100 - THIN-SET TILING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product data.
- B. Do not set stone when air or material temperature is below 10 deg C.

PART 2 - PRODUCTS

2.1 GLASS

- 1. Bendheim Backpainted Tempered Glass
 - a. Colors
 - 1) MAND-469, Kitchen
 - 2) MAND-437, Bathroom
- http://www.americanslate.com/documents/AMS_DataSheet_Flooring-Frostbitten.pdf

2.2 MORTAR AND GROUT

- A. Glass-Mat, Water-Resistant Gypsum Backing Board: ASTM C 1178/c1178M, of

See G-P Gypsum; Dens Shield Tile Guard, Fiberglass-Mat Faced Gypsum Backing Board, 1/4" <http://www.gp.com/BUILD/DocumentViewer.aspx?repository=BP&elementid=7064>
- B. Mortar for Stone Paving and Flooring: ASTM C 270, Proportion Specification, Type N for interior use.
 - 1. Thin-set Mortar:
 - a. Products:
 - 1) Durabond D-5 Premium Thin-Set Mortar
 - 2. Low-Alkali Cement: For limestone and marble, use white portland cement with not more than 0.60 percent total alkali per ASTM C 114.
 - 3. For pointing mortar, use colored cement or cement-lime mix of color selected.

2.3 ACCESSORIES

- A. Sealant: Clear silicone sealant.
 - 1. Products
 - a. Tremco Tremsil200
See Manufacturer's Specifications:
<http://www.tremcosealants.com/filesshare/pds/TREMSIL2.PDF>
- B. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.
 - 1. Products:
 - 2. Laticrete 190 Grout Sealer & Tile Protector
See Manufacturer's Specifications:
http://www.laticrete.com.au/pdf/product_data_shts/datashts/LATICRETE_190.pdf

2.4 STONE FABRICATION

- A. Fabricate stone in sizes and shapes to comply with requirements indicated.
 - 1. Pattern: Rectilinear pattern of 4 in - 8 in units, laid in brickwork pattern.

- B. Cut stone to produce uniform joints 1/4 in. wide.
- C. Pattern Arrangement: Fabricate and arrange stone units with veining as indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Do necessary field cutting as stone is set. Cut lines straight and true and finish field-cut edges to match shop-cut edges.
- C. Field-cut stone as necessary to fit at obstructions. Produce neat joints of size specified or indicated.

3.2 INSTALLING STONE

- A. Saturate concrete with clean water several hours before placing setting bed. Remove surface water before placing setting bed.
- B. Apply mortar bed bond coat to damp concrete and broom to provide an even coating. Limit area of bond coat to avoid its drying out. Do not exceed 1.5-mm thickness for bond coat.
- C. Spread, tamp, and screed setting bed to uniform thickness at elevations required for accurate setting of stone. Mix and place only as much mortar setting bed as can be covered with stone before initial set.
- D. Place stone before initial set of cement occurs. Immediately before placing stone on setting bed, apply 1.5-mm- thick, bond coat to back of each stone.
- E. Tamp and beat stone to obtain full contact with setting bed. Set each unit in a single operation before initial set of mortar; do not return to areas already set and readjust stone.
- F. Rake out joints to depth required to receive pointing mortar as units are set.
- G. Set thresholds in thin-set, latex-portland cement mortar to comply with ANSI A108.5 at locations where mortar bed would otherwise be exposed above adjacent floor.
- H. Point joints after setting. Tool joints flat, uniform, and smooth, without visible voids.
- I. Grout stone joints to comply with ANSI A108.10. Tool joints uniformly and smoothly with plastic tool.

3.3 CLEANING

- A. Clean stone flooring as work progresses. Remove mortar fins and smears before tooling joints.
- B. Clean stone flooring after setting and grouting are complete and apply sealer to cleaned stone flooring.

END OF SECTION 093100

SECTION 096340 - STONE FLOORING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product data.
- B. Do not set stone when air or material temperature is below 10 deg C.

PART 2 - PRODUCTS

2.1 STONE

- A. Slate: ASTM C 629.
 - 1. Classification: II Interior.
 - 2. Dark Grey
 - 3. Finish: Honed.
 - 4. American Slate Company
http://www.americanslate.com/documents/AMS_DataSheet_Flooring-Frostbitten.pdf

2.2 MORTAR AND GROUT

- A. Mortar for Stone Paving and Flooring: ASTM C 270, Proportion Specification, Type N for interior use.
 - 1. Thin-set Mortar:
 - a. Products:
 - 1) Durabond D-5 Premium Thin-Set Mortar
 - 2. Low-Alkali Cement: For limestone and marble, use white portland cement with not more than 0.60 percent total alkali per ASTM C 114.
 - 3. For pointing mortar, use colored cement or cement-lime mix of color selected.
- B. Grout: Standard cement grout complying with ANSI A118.6
 - 1. Products:
 - a. Durabond Fortified Tile Grout (Sanded)
 - 2. Use unsanded grout for joints 3 mm and narrower.
 - 3. Use sanded grout for joints 3 mm and wider.

2.3 ACCESSORIES

- A. Sealant: Clear silicone sealant.
 - 1. Products
 - a. Tremco Tremsil200
See Manufacturer's Specifications:
<http://www.tremcosealants.com/files/pds/TREMSIL2.PDF>
- B. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.
 - 1. Products:
 - 2. Laticrete 190 Grout Sealer & Tile Protector
See Manufacturer's Specifications:
http://www.laticrete.com.au/pdf/product_data_shots/datashts/LATICRETE_190.pdf

2.4 STONE FABRICATION

- A. Fabricate stone in sizes and shapes to comply with requirements indicated.
 - 1. Pattern: Rectilinear pattern of 4 in – 8 in units, laid in brickwork pattern.
- B. Cut stone to produce uniform joints 1/4 in. wide.
- C. Pattern Arrangement: Fabricate and arrange stone units with veining as indicated on Drawings.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Do necessary field cutting as stone is set. Cut lines straight and true and finish field-cut edges to match shop-cut edges.
- C. Field-cut stone as necessary to fit at obstructions. Produce neat joints of size specified or indicated.

3.2 INSTALLING STONE

- A. Saturate concrete with clean water several hours before placing setting bed. Remove surface water before placing setting bed.
- B. Apply mortar bed bond coat to damp concrete and broom to provide an even coating. Limit area of bond coat to avoid its drying out. Do not exceed 1.5-mm thickness for bond coat.
- C. Spread, tamp, and screed setting bed to uniform thickness at elevations required for accurate setting of stone. Mix and place only as much mortar setting bed as can be covered with stone before initial set.
- D. Place stone before initial set of cement occurs. Immediately before placing stone on setting bed, apply 1.5-mm- thick, bond coat to back of each stone.
- E. Tamp and beat stone to obtain full contact with setting bed. Set each unit in a single operation before initial set of mortar; do not return to areas already set and readjust stone.
- F. Rake out joints to depth required to receive pointing mortar as units are set.
- G. Set thresholds in thin-set, latex-portland cement mortar to comply with ANSI A108.5 at locations where mortar bed would otherwise be exposed above adjacent floor.
- H. Point joints after setting. Tool joints flat, uniform, and smooth, without visible voids.
- I. Grout stone joints to comply with ANSI A108.10. Tool joints uniformly and smoothly with plastic tool.

3.3 CLEANING

- A. Clean stone flooring as work progresses. Remove mortar fins and smears before tooling joints.
- B. Clean stone flooring after setting and grouting are complete and apply sealer to cleaned stone flooring.

END OF SECTION 096340

SECTION 096400 - WOOD FLOORING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Hardwood Flooring: Comply with NOFMA grading rules for species, grade, and cut.
 - 1. Certification: Provide flooring that carries NOFMA grade stamp on each bundle or piece.

PART 2 - PRODUCTS

2.1 FACTORY-FINISHED WOOD FLOORING

- A. Engineered-Wood Strip Flooring: HPVA EF.
 - 1. Products:
 - a. Wood Anchor, Pre-Finished Floor

http://www.woodanchor.com/cim/3101C7_2T14T11T37.dhtm
 - 2. Species: Elm.
 - 3. Thickness: 3/4 inch.
 - 4. Construction: 1/4 inch solid elm top .
 - 5. Width: 5 inches.
 - 6. Length: Manufacturer's standard.
 - 7. Edges: Square
 - 8. Finish: UV urethane

2.2 ACCESSORY MATERIALS

- A. Vapor Retarder: ASTM D 4397, polyethylene sheet not less than 0.15 mm thick.
- B. Asphalt-Saturated Felt: ASTM D 4869, Type II.
- C. Wood Flooring Adhesive: Mastic recommended by flooring and adhesive manufacturers for application indicated.
- D. Fasteners: As recommended by manufacturer, but not less than that recommended in NWFA's "Installation Guidelines: Wood Flooring."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with flooring manufacturer's written installation instructions, but not less than applicable recommendations in NWFA's "Installation Guidelines: Wood Flooring."
- B. Provide expansion space at walls and other obstructions and terminations of flooring of not less than 3/4 inches.
- C. Radiant Flooring: Wood flooring should be nailed directly into radiant flooring system, per manufacturers recommendation.

END OF SECTION 096400

SECTION 099100 - PAINTING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals:
 - 1. Product Data.
 - 2. Samples.

PART 2 - PRODUCTS

2.1 PAINT

- A. Products:
 - 1. Benjamin Moore Natura Zero VOC Paint
See Manufacturer's Specifications:
http://benjaminmoore.com/bmpsweb/DownloadBinary?fileName=TDS_513_en_US.pdf&nodeId=BEA%20Repository/574011&propertyId=BEA%20Repository/574011/data_sheet_file_en_US
 - 2. Benjamin Moore AURA® Exterior Paint Low Lustre Finish 634
See Manufacturer's Specifications:
http://www.benjaminmoore.com/bmpsweb/DownloadBinary?fileName=012309+634+TDS+US+OK.pdf&nodeId=BEA+Repository%2F498013&propertyId=BEA+Repository%2F498013%2Fdata_sheet_file_en_US
- B. MPI Standards: Provide materials that comply with MPI standards indicated and listed in its "MPI Approved Products List."
- C. Material Compatibility: Provide materials that are compatible with one another and with substrates.
 - 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. Nonflat Paints, Coatings:
 - a. Eggshell, 0 g/L.
 - b. Semi-gloss, 0 g/L.
 - 2. Primers, Sealers, and Undercoaters:
 - a. Primer sealer, 0 g/L.
- E. Exterior Paints
 - 1. Non-Flat Paints, Coatings:
 - a. Low Luster, 44 g/L
- F. Colors: As selected.
 - 1. Cotton Balls, #2145-70

PART 3 - EXECUTION

3.1 PREPARATION

- A. Comply with recommendations in MPI's "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, lighting fixtures, and similar items that are not to be painted. Mask items that cannot be removed. Reinstall items in each area after painting is complete.

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

3.2 APPLICATION

- A. Comply with recommendations in MPI's "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Paint exposed surfaces, unless otherwise indicated.
 - 1. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.
 - 2. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint the back side of access panels.
 - 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.

END OF SECTION 099100

SECTION 101423 - PANEL SIGNAGE

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
 - 1. Submit full-size rubbings for metal plaques.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Sheet: ASTM B 209M, alloy and temper recommended by aluminum producer and finisher, with not less than the strength and durability of 5005-H15.

2.2 SIGNS

- A. Dimensional Characters: Cutout aluminum plate
 - 1. Brushed Aluminum.
 - 2. Direct to aluminum substrate printing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate signs where indicated or directed by Architect. Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.

END OF SECTION 101423

SECTION 102816 - TOILET, BATH, AND LAUNDRY ACCESSORIES**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 MATERIAL STANDARDS REQUIREMENTS**

- A. Stainless Steel: ASTM A 666, Type 304, No. 4 finish (satin), 0.8-mm minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B 19, ASTM B 16M, or ASTM B 30.
- C. Aluminum: ASTM B 221M, Alloy 6063-T6 or 6463-T6.
- D. Sheet Steel: ASTM A 1008/A 1008M, 0.9-mm minimum nominal thickness.
- E. Galvanized-Steel Sheet: ASTM A 653/A 653M, Z180.
- F. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- G. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.
- H. Tempered Glass: ASTM C 1048, Kind FT (fully tempered).
- I. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- J. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- K. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.2 TOILET AND BATH ACCESSORIES

- A. Waste Receptacle:
1. Basis-of-Design Product: Crate and Barrel: Lacquer Bath Accessories
 2. Type: Freestanding.
 3. Dimensions: 8"W X 10"D X 12"H
 4. Material and Finish: Engineered wood, high gloss white lacquer finish.
 5. See manufacturer's specifications:
<http://www.crateandbarrel.com/family.aspx?c=1640&f=32341>
- B. Liquid-Soap Dispenser:
1. Basis-of-Design Product: CB2: Resin Bath Accessories
 2. Mounting: Freestanding.
 3. Materials: White polyresin
 4. Stainless-Steel Soap Valve: Designed for dispensing soap in liquid form.
 5. Dimensions: 3"W X 2"D X 7.25"H
 6. See manufacturer's specifications:
<http://www.cb2.com/family.aspx?c=477&f=4862>
- C. Soap Dish
1. Stainless steel,
 2. 3/4 inch high and 4.25 inches in diameter
 3. See manufacturer's specifications:
<http://www.cb2.com/family.aspx?c=477&f=2825>

- D. Mirror:
1. Material: Polished edge, float premium float glass .
 2. Size: 2 ft 7 in. x 3'.
- E. Shower Glass Bracket
1. Basis-of-Design Product: CR Lawrence; # NDC4NC, CRL Chrome No-Drill Fixed Panel Glass Clamp
 2. Material and Finish: Solid brass with satin chrome finish
 3. Glass Thickness: 3/8"
 4. See manufacturer's specifications for details:
Product:
http://www.crlaurence.com/ProductPages/N/NDC4CH_70341.html?Origin=Catalog: http://webcache.crlaurence.com/f/1512/45196/7d/dci.download.akamai.com/35985/cr_laurence/adv/cataloglibrary/catalogs/SD10/STANDALONE/index3.html#88
- F. Medicine Cabinet
1. Basis-of-Design Product: NuTone Illusion Recessed Medicine Cabinet Model 629X
 2. Mounting: Recessed.
 3. Size: 15" x 36" x 3-3/4.
 4. Door: Framed mirror door concealing storage cabinet equipped with continuous hinge and spring-buffered, rod-type stop and magnetic door catch.
 5. Shelves: Three, adjustable.
<http://www.homedepot.com/webapp/wcs/stores/servlet/ProductDisplay?storeId=10051&langId=-1&catalogId=10053&productId=100607937&N=10000003+90021+527198>
- G. Toothbrush and Razor Cup:
1. Basis-of-Design Product: CB2: Resin Bath Accessories
 2. Material and Finish: White polyresin.
 3. Dimensions: 3"W X 2"D X 4.75"H
 4. See manufacturer's specifications:
<http://www.cb2.com/family.aspx?c=477&f=4862>
- H. Towel Bar:
1. Basis-of-Design Product: Kohler, K-11588-CP
 2. Description: 1 inch square tube with circular end brackets.
 3. Mounting: Flanges with concealed fasteners.
 4. Length: 3 feet 6 inches.
 5. Material and Finish: Stainless steel, No. 4 finish satin
 6. http://www.us.kohler.com/onlinecatalog/detail.jsp?from=thumb&frm=&module=Accessory+Collection+-+Bath&item=12922202&prod_num=11588§ion=2&category=19&resultPage=0--729168768

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Built-in Appliances: Securely anchor to supporting cabinetry or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.
- B. Freestanding Appliances: Place in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- C. Verify that accessories required have been furnished and installed.
- D. Shower Glass Bracket Installation -Silicone must be used for reinforcement along the entire edge of the glass where clamps are used. It is the responsibility of the installer to determine if adequate structural backing support is being used.
- E. 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.
- F. 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 102816

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS

- A. Portable Fire Extinguishers: NFPA 10, listed and labeled for the type, rating, and classification of extinguisher.
1. Products:
 - a. Majestic fire; Dry Chemical BC
 - b. Stored Pressure Fire Extinguisher:
 - c. Product ID# 22676B, BC 10 lb w/wall hook.
 - d. See manufacturer's detail:
 - i. <http://www.majesticfire.com/AMEREX-AX457portable.html>
 1. Stored-Pressure Water Type: UL-rated 2-A, 9.5-L nominal capacity, in stainless-steel container; with pressure-indicating gage.
 2. Stored-Pressure Antifreeze Type: UL-rated 2-A, 9.5-L nominal capacity, in stainless-steel container; with pressure-indicating gage.
 3. Multipurpose Dry-Chemical Type: UL-rated 3A-40 B:C (flammable liquids and electrical equipment) 2.27 kg nominal capacity, in enameled-steel container.
- B. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for fire extinguishers indicated, with plated or baked-enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install mounting brackets in locations indicated at 1372 mm above finished floor to top of fire extinguisher.
- B. Install fire extinguishers in cabinets where indicated.

END OF SECTION 104416

SECTION 112813 – COMPUTERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data

PART 2 - PRODUCTS

- A. LAPTOP
1. Apple 17-inch Macbook Pro
 - a. Display: 17-inch (diagonal) high-resolution LED-backlit glossy widescreen display, 1920-by-1200 resolution
 - b. Battery and Power: Built-in 95-watt-hour lithium-polymer battery
 - c. Wireless: Built-in AirPort Extreme Wi-Fi (based on IEEE 802.11n draft specification); built-in Bluetooth 2.1 + EDR (Enhanced Data Rate) module
 - d. Processor and Memory: 2.66GHz Intel Core 2 Duo processor; 4GB (two 2GB SO-DIMMs) of 1066MHz DDR3 SDRAM
 - e. Meets ENERGY STAR requirements; EPEAT Gold rating
 - f. <http://www.apple.com/macbookpro/specs.html>
- B. DESKTOP
1. Apple TV
 - a. Intel Processor
 - b. 40GB Hard Disk
 - c. HDMI, Component, Optical Audio, and Analog AV video connections.
 - d. USB, Ethernet, Wifi Data connection
 - e. Built in IR-Receiver
 - f. <http://www.apple.com/appletv/specs.html>
- C. HANDHELD
1. Apple iPod Touch
 - a. Display: 3.5-inch (diagonal) widescreen Multi-Touch display
 - b. Wireless: Wi-Fi (802.11b/g)
 - c. Battery Life: Up to 36 hours of music playback; up to 6 hours of video playback
 - d. <http://www.apple.com/ipodtouch/specs.html>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with product installation manual and related NEC codes

END OF SECTION 112813

SECTION 113100 - RESIDENTIAL APPLIANCES**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Allowances: See Division 01 Section "Price and Payment Procedures" for appliance allowances.
- B. Submittals: Product Data.
- C. Regulatory Requirements: Comply with provisions of the following product certifications:
 - 1. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 2. UL and NEMA: Provide electrical components required as part of residential appliances that are listed and labeled by UL and that comply with applicable NEMA standards.
 - 3. ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.
 - 4. NAECA: Provide residential appliances that comply with NAECA standards.
- D. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
- E. Energy Ratings: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

PART 2 - PRODUCTS**2.1 RESIDENTIAL APPLIANCES**

- A. Electric Induction Cooktop: 30in., built-in cooktop with four burner elements.
 - 1. Product:
 - a. Wolf; CT30IU
 - 2. Color: Black Ceramic Glass
 - 3. Easy-to-clean black ceramic glass surface is resistant to scratching, staining, impact and heat
 - 4. Induction elements heat cookware, not the glass, for a cooler, safer cooking surface
 - 5. Four high-efficiency induction elements deliver power and control
 - 6. Maximum element power: (2) 1800 W with 3000 W boost and (2) 1200W
 - 7. True Simmer setting on two elements
 - 8. Melt setting on two elements
 - 9. Cookware sensing—elements will not be energized without an induction-compatible pan on the cooktop surface
 - 10. Hi-Power mode boosts power on 1800W elements by diverting power from adjacent element
 - 11. Temperature limiter to ensure that safe operating temperature of ceramic glass is never exceeded
 - 12. Illuminated touch controls with graduated control lighting and adjustable sound frequency and volume
 - 13. Hot-surface indicator light in control panel
 - 14. Lock mode—cooktop will be locked so that no elements can be turned on
 - 15. Universal OFF turns all elements off
 - 16. Countdown timer with 1 to 99 minute range
 - 17. http://www.wolfappliance.com/resources/products/downloads/Planning_CT30IU.pdf
- B. Electric Wall Convection Oven: Built-in, single, electric, self-cleaning wall oven with broiler unit.
 - 1. Product:
 - a. Bosch; HBL3450UC
 - 2. Color: Stainless Steel
 - 3. 4.7 cubic feet
 - 4. 6-way rack adjustability
 - 5. Expansive viewing window and bright halogen lighting system
 - 6. 12 different heating modes including several convection modes, more traditional modes such as bake and roast, and special modes such as pizza, pie or proof
 - 7. The large amber colored display makes helpful information visible at just a glance. This easy to use display allows you to control the set temperature and see the programmed timer function.
 - 8. Our built-in ovens' ECOCLEAN™ 2-hour self-clean cycle, the industry's best, makes the kitchen a safer place and delivers improved energy efficiency by running for the shortest period of time possible
 - 9. Bosch's heavy-duty rack supports can hold even the heaviest dishes while allowing the racks to glide far more smoothly than traditional ribbed oven cavities. They also make it easy to change rack positions or mount telescopic racks. Made with the highest standards, the porcelain rack supports stay in the oven during self-cleaning, eliminating the need for difficult removal.
 - 10. The glass control panel and retractable dials make the oven not only easy to use, but also easy to clean. The glass

11. surface is also resistant to scratching
 12. A recessed top heating element and a fully concealed bottom heating element allow for greater interior capacity, unprecedented safety when removing dishes, and extremely easy cleaning.
 13. http://www.boschappliances.com/products/specs_dimensions_popup.aspx?product_id=644
- C. Exhaust Hood: 30 in., retractable-downdraft exhaust hood with 3-speed automatic fan. Wall-mounted fan and light switch must be used for accessible installations.
1. Product:
 - a. Wolf: DD30I
 2. Fan Control: Counter-mounted switch, with separate light switch.
 3. Width: 30 in., Height: 9-1/16 in., Depth: 2-3/8 in.
 4. Classic, platinum and carbon stainless steel finishes available on control module and top cover
 5. Remote-mounted control module
 6. Internal, in-line and remote blower options
 7. Three-speed blower control
 8. Filter clean timer lets you know when the filter needs cleaning
 9. Delay-off feature automatically turns unit off after five minutes, chimney remains up
 10. Stainless steel filter cover with dishwasher safe aluminum mesh filter
 11. LED indicators
 12. Downdraft control kit, available as a sales accessory—includes control module, top cover, mounting brackets, RJ45 connector and mounting hardware
 13. <http://www.wolfappliance.com/resources/products/downloads/DD30.pdf>
- D. Refrigerator/Freezer: Freestanding, manual-defrost, two-door refrigerator with bottom-mounted freezer.
1. Product:
 - a. Vestfrost: Eco-Fridge/ConServ Refrigeration
 2. Fresh Food Compartment Volume: 7.1 cu.ft..
 3. Freezer Compartment Volume: 3.4 cu.ft.
 4. Shelf Area: Adjustable glass shelves, 2.8 sq. ft
 5. Height: 79.2"; Width: 23.6"; Depth (excluding handle): 23.4"
 6. Freezing capacity (24 hours): 39.5 lbs.
 7. Compressor (refrigerator): surge 14.5A; run, 1.0A
 8. Compressor (freezer): surge, 16A, run, 1.5A
 9. Power Consumption (24 hours): at 68°F, .70 Kwh; at 77°F, .90 Kwh; at 90°F, 1.5 Kwh
 10. Standard Voltage: 120V, 60 HZ
 11. Cord Length: 6'4"
 12. Built-in condenser for lower energy consumption
 13. CFC-free refrigerant and foam
 14. Separate compressor for fridge and freezer
 15. Left OR right hand door opening (easy to change with no special tools or expertise).
 16. Attractive European styling
 17. <http://www.conservrefrigerators.com/conserv.html>
- E. Dishwasher: Built-in, under the counter, automatic dishwasher, wash cycles with hot-air and heat-off drying cycles and half load option, stainless-steel tub and door liner, and platinum nylon-coated sliding dish racks.
1. Product
 - a. Bosch; SHE68M05UC
 2. Color: Stainless Steel
 3. Width: 24 in., Height: 35 in., Depth: 22-7/16in.
 4. Extra-large interior space, allowing you to fit 14 place settings rather than the industry standard of 12.
 5. RACKMATIC® allows you to raise or lower the premium upper rack at the touch of a lever (even when full), giving you up to 14" of space on the bottom or 10" on top. The top rack is also removable to accommodate larger items
 6. Stainless steel construction retains heat better than plastic tubs, helping to dry dishes faster and more efficiently
 7. An advanced sensor system determines the soil level in the wash water and automatically deletes fresh water fills if they're not needed, saving you time and money while cutting energy usage by up to 20%. This cutting-edge feature adjusts water temperature and cycle length for optimal efficiency, allowing you to reduce energy usage by up to 25% with just the push of a button. Combine it with a cycle for the ultimate in performance and efficiency.
 8. ENERGY STAR® qualified
 9. By using two small pumps to individually wash and drain instead of a single large one, vibration and noise are dramatically reduced.
 10. With a nineteen or twenty-four hour timer, Bosch dishwashers work on your schedule. Program them to start once guests leave or after you've drifted off to sleep. Wait until you're out of the house, or run it in off-peak evening hours for even greater savings on your energy bill.
 11. Bosch specially engineered PERFECTDOOR to stay in a fixed position when it is open more than 10 degrees. This increases safety by eliminating the possibility of the door dropping open or springing closed suddenly.
 12. Because our Flow Through Water Heater is not located in the tub and has no exposed heating element, it prevents plastic items on the bottom rack from melting. It has the added benefit of protecting you from accidental burns during unloading.
 13. http://www.boschappliances.com/products/specs_dimensions_popup.aspx?product_id=694

- F. Clothes Washer: Freestanding, front-loading, automatic clothes washer with 4.2 cu. ft. capacity NeveRust Stainless Steel interior and 9 wash cycles including the ability to adjust temperature levels, spin speeds, water levels.
1. Product
 - a. LG; WM2301HW
 2. Width: 27 in., Height: 38-11/16 in., Depth: 29-3/4 in.
 3. Direct Drive Motor for the Ultimate in Durability and Reliability (10 Year Warranty)
 4. 10° TilTub™ for Easy Reach into the Rear of the Drum
 5. 1200 RPM Powerful Spin for Efficient Water Extraction
 6. SenseClean™ System for Intelligent Fabric Care
 7. 9 Washing Programs
 8. 5 Temperature Levels
 9. Delay Wash (up to 19 hours)
 10. Upfront Electronic Control Panel with Dual LED Display and Dial-A-Cycle™
 11. Large Chrome Rimmed Door with Glass
 12. Stackable with Matching Dryer
 13. Optional Matching Drawer Pedestal
 14. LG Anti-Vibration System
 15. LoDecibel™ Quiet Operation
 16. Highly Energy and Water Efficient
 17. <http://www.lge.com/us/appliances/washers/LG-WM2301HW.jsp#features>
- G. Electric Clothes Dryer: Freestanding, front-loading clothes dryer, 7.3 cu. ft. capacity with aluminized alloy steel interior.
1. Product
 - a. LG; DLE2301W
 2. Width: 27 in., Height: 38-11/16 in., Depth: 30 in.
 3. Sensor dry with precise temperature control with variable heater
 4. 9 Drying Programs
 5. 5 Temperature Levels
 6. Upfront Electronic Control Panel with Dual LED Display and Dial-A-Cycle™
 7. Large Chrome Rimmed Door with Glass
 8. LoDecibel™ Quiet Operation
 9. <http://www.lge.com/us/appliances/dryers/LG-electric-dryer-DLE2301W.jsp>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Built-in Appliances: Securely anchor to supporting cabinetry or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.
- B. Freestanding Appliances: Place in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- C. Test each item of residential appliances to verify proper operation. Make necessary adjustments.
- D. Verify that accessories required have been furnished and installed.

END OF SECTION 113100

SECTION 11400 - FOOD SERVICE EQUIPMENT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Allowances: See Division 01 Section "Price and Payment Procedures" for appliance allowances.
- B. Submittals: Product Data.

PART 2 - PRODUCTS

- A. Cutlery: 14-piece knife block set
 1. Crate and Barrel: OXO Professional 14-Piece Knife Block Set
 2. 14-Piece Knife Set includes: 3.5" paring knife, 4" santoku knife, 5" serrated knife, 8" chef's knife, 8" slicing knife, 8" bread knife, six 4.25" steak knives, sharpening steel and wood block.
 3. Stainless Steel Blades
 4. Santoprene and polypropylene handles for good grip and comfort
 5. Wood knife block
 6. Tapered blades allow for easy gliding through foods.
 7. <http://www.crateandbarrel.com/family.aspx?c=580&f=31705>
- B. Cookware Set:
 1. Rachel Ray: Porcelain Enamel Non-Stick 10-Piece Cookware Set
 2. Ten-piece cookware set includes: 1 \emptyset quart covered saucepan, 3-quart covered sauté pan, 8" open French skillet, 10" **open French skillet and 6-quart covered stockpot.**
 3. Color: Green
 4. Durable and long lasting enamel.
 5. Aluminum construction ensures quick, even heating.
 6. Handles: Stainless steel and silicone
 7. Easy, non-scratch cleaning.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. none

END OF SECTION 114000

SECTION 114200 - FOOD PREPARATION EQUIPMENT**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 SUGGESTED PRODUCTS**

- A. Cutting Board: 16in. x 12in.
1. Crate and Barrel: Non-slip cutting board
 2. Color: Bamboo
 3. <http://www.crateandbarrel.com/family.aspx?c=660&f=32328>
- B. Hand Towel: 16in.x28in.
1. CB2: Bamboo Bath Towels
 2. Color: White
 3. <http://www.cb2.com/family.aspx?c=475&f=2839>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. None needed

END OF SECTION 114200

SECTION 121200 - WALL DECORATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Allowances: See Division 01 Section "Price and Payment Procedures" for art allowances.
- B. Submittals: Product Descriptions.

PART 2 - PRODUCTS

2.1 PRINTS

- A. Ring Around, 2008
 - 1. Original Artwork, 4' x 4'
 - 2. Artist: Keith Magruder
 - 3. Found wood, Copper leaf, Natural patina
- B. Black Face, 2008
 - 1. Original Artwork 4' x 4'
 - 2. Artist: Keith Magruder
 - 3. Found wood, Shoe polish
- C. Four Kids, 2008
 - 1. Original Artwork, 4' x 4'
 - 2. Artist: Keith Magruder
 - 3. Found wood, Matte medium, Paper
- D. Bread, 2007
 - 1. Original Artwork, 12" x 22"
 - 2. Artist: Keith Magruder
 - 3. Found wood, Gold leaf, Matte medium, Ink

2.2 FRAMES

- A. Photo Frames: Free-floating photos, 11.5" X11.5"
 - 1. CB2; Float Frames
 - 2. Color: Stainless steel frame with clear glass
 - 3. <http://www.cb2.com/family.aspx?c=593&f=4883&q=350382&fromLocation=Search&DIMID=400001&SearchPage=1>
- B. Photo Frames: Free-floating photos, 7" X 9"
 - 1. CB2; Float Frames
 - 2. Color: Stainless steel frame with clear glass
 - 3. <http://www.cb2.com/family.aspx?c=593&f=4883&q=350382&fromLocation=Search&DIMID=400001&SearchPage=1>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hung per architectural plan
- B. Install panels level and aligned at top and bottom, vertical and plumb, with faces flush.

END OF SECTION 121200

SECTION 122113 - HORIZONTAL LOUVER BLINDS**PART 1 - GENERAL****1.1 RELATED SECTIONS:**

- A. Submittals: Product Data and Samples.
- B. Product Standard: Unless otherwise indicated, comply with WCMA A 100.1.
- C. Section 16000 Electrical
- D. Aluminum or steel blind pockets integrated into the window wall.
- E. Electrical control components to enable control functions as specified in this section

1.2 SUMMARY:

- A. Provide electrically operated external specialty venetian blind system with related specified hardware to complete the installation to the following locations:
- B. These motorized louver blinds will be used to cover all of the approximately south facing glazing on the house.
- C. Specialty venetian blinds shall be mounted in a custom metal pocket.

1.3 QUALITY ASSURANCE:

- A. All bidders submitting bids on the work of this section shall meet or exceed the quality of materials, components and assemblies herein. Bidders who do not comply with these specifications shall refrain from submitting a bid
- B. Alternate bids, alternate products shall be submitted to the Design Consultant ten (10) days prior to tender closing. Alternate bids can only be submitted as an alternate to the specified base bid product
- C. Manufacturer shall have a minimum of fifteen (15) years experience in the manufacture of the specified shading system. All work specified under this section shall be supplied by one subcontractor
- D. All work specified under this section shall be supplied and installed entirely by one subcontractor using his own resources
- E. Specialty venetian blinds to be installed by a firm with a minimum of ten (10) years' experience, specializing in the installation of shading systems
- F. Conform to applicable Building Codes, relevant local codes and all other standards noted
- G. Install one complete sample with accessories on site. Review the installation before proceeding with the remainder of the work. Adjust sample installation, as required, to gain acceptance. Accepted work may form part of the final installation

1.4 SUBMITTALS AND TEST REPORTS:

- A. Submit fully detailed drawings prepared in AutoCAD 2000 version format showing all components, finishes and other construction conditions, installation, controls and all applicable dimensions according to Section 01300 - Submittals
- B. Submit duplicate samples of the key components of the specified specialty venetian blind system with the specified finish. Minimum size 12" (300mm) for review
- C. Submit duplicate samples of the specified sections of head rail, bottom rail, brackets / attachment methods and side guide wires / channels for review
 - 1. Electric venetian blind motors and all electronic control equipment supplied by this section shall comply with CSA/UR and ULC/UL standards. Copies of compliance available for submission upon request.
 - 2. Submit duplicate copies of operating and maintenance instructions including the name, address and other contact details of local service company

1.5 INSPECTION / PREPARATION

- A. Verify that the structure necessary to carry the specialty venetian blind assembly is a proper installation and secure
- B. Verify that the electrical and control wiring is completed (refer to Division 16)
- C. Notify general contractor in writing of any deficiencies in the work of other trades that would affect the window treatment system
- D. Make accurate measurements at the site before fabrication. Check layout of glazing framing sections, spans and loading capabilities

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Do not deliver to site until areas to receive the specialty venetian blinds are completely finished
- B. Deliver materials in original protective wrappers or containers, with manufacturer's labels and sealed intact
- C. Handle and store materials in accordance with the manufacturer's recommendations, protecting materials and finishes from damage or soiling

PART 2 - PRODUCTS**2.1 HARDWARE**

- A. Lifting tape and ladder tape
 1. Lifting tape to be manufactured from Trevira and tear resistant up to 110daN. Tape to be 10mm (3/8") wide.
 2. Ladder tape to be manufactured from Trevira with cross webs that are positively attached to the slats (which are specially punched) to ensure no movement.
- B. Side guides
 1. Perlon side guides 3- 4mm diameter perlon cables with a tensile strength of 320daN.
 2. Perlon cables to be held by an extruded aluminum housing or a special clamping bolt, or
- C. Electric Venetian blind motors
 1. Venetian blind motor located inside the extruded aluminum head rail. Motor to provide raise / lower and tilt function. Venetian blind motor shall be equipped with a disconnect plug at motor lead
 2. Venetian blind motor shall be an asynchronous unit, start and run, single phase type (110V 60 Hz or 230V 50 Hz), thermally protected, with a torque rating between 6 and 12 Nm as appropriate and with integral capacitor.
 3. Venetian blind motor shall incorporate output shafts to allow the motor to be located in the center of the head rail with drive shafts extended in both directions.
 4. Motor speed shall range from 20 to 35 RPM and draw 0.45 to 1.1 amp as selected by the manufacturer for proper system operation. Motor lead shall be plenum rated quality.
 5. Venetian blind motor shall be equipped with externally located limit switches which allow exact control of the raised and lowered Venetian blind position, together with a safety cut off switch in case the upper limit fails.
 6. Include all components for proper unit operation

2.2 ACCESSORIES

- A. Aluminum Head Box / Pelmet:
 1. Pelmet to be custom manufactured from aluminum sheet to protect the venetian blind in the raised position. Height of the pelmet to be determined by reference to the type of louver the drop of the blind. Minimum internal depth of the pelmet to be as follows for 150mm (6") wide flexible crowned louvers: 200mm (7 7/8")

2.3 MATERIALS

- A. Material quality and coatings:
 1. All extruded aluminum components shall be extruded from 6063T6 quality aluminum
 2. All aluminum components shall have a clear anodized finish according to AAM12C22A31
 3. Unexposed aluminum unless otherwise specified: mill finish

PART 3 - BASIC CONTROL FUNCTIONS AND OPTIONS**3.1 SELF-TRIGGERING CONTROLS**

- A. Wind sensors on the roof will raise the external blinds if the wind speed is over 38 mph.

3.2 MANUALLY-TRIGGERED CONTROLS

- A. Manual Switches will raise or lower each set of blinds individually

3.3 INSTALLATION

- A. Install work using skilled tradesman and install in strict accordance with manufacturer's recommendations.
- B. All items installed, plumbed, squared and rigidly anchored maintaining uniform clearances and accurate alignment measurements
- C. The specialty venetian blind system shall be premeasured and manufactured offsite.

END OF SECTION 122113

SECTION 123530 - RESIDENTIAL CASEWORK

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 CASEWORK

- A. Comply with KCMA A161.1
- B. Comply with KCMA A161.2 for plastic-laminate countertops.
- C. Cabinets:
 - 1. Products:
 - a. Manufacturer: Plyboo
 - 1) Product: 3/4" PlybooStrand plywood
 - 2) Havana; 48" X 72", 3 Ply
 - 3) See Manufacturer's Specifications:

http://www.plyboo.com/images/plyboo/downloads/s&f_Plyboo_bamboo-plywood-spec-5.01.09.doc
 - 2. Face Style: Flush overlay.
 - 3. Cabinet Style: Frameless.
 - 4. Door and Drawer Fronts: White, glossy, High Density Polyethylene (HDPE)
 - 5. Face Frame Finish: Plastic laminate.
 - 6. Exposed Cabinet End Finish: Plastic laminate.
 - 7. Hinges: Stanley hardware 2" cabinet hinge.
 - 8. Drawer Guides: Touch release drawer slides.
- D. Quartz Countertops and Splashes:
 - 1. Products:
 - a. See specifications #123640 for details.
- E. Countertop Configuration:
 - 1. Front Style: Self-edge
 - 2. End Splash: Square edge

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cabinets with no variations in flushness of adjoining surfaces by using concealed shims. Where casework abuts other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match casework face.
- B. Install cabinets without distortion so doors and drawers fit openings properly and are aligned.
- C. Install level and plumb to a tolerance of 3.2 mm in 2.4 m.

- D. Fasten each cabinet to adjacent unit and to structural members of wall construction. Fasten wall cabinets through back, near top and bottom, at ends and not less than 600 mm o.c.
 - 1. Use No. 10 wafer-head screws sized for 25-mm penetration into wood framing, blocking, or hanging strips.
 - 2. Use toggle bolts through metal backing behind gypsum board.
- E. Fasten plastic-laminate countertops by screwing through corner blocks in base units into underside of countertop. Spline and glue joints in countertops and use concealed mechanical clamps.
 - 1. Provide cutouts for sinks and lavatories, including holes for faucets and accessories.
 - 2. Seal edges of cutouts by saturating with varnish.
- F. Fasten solid-surface countertops by screwing through corner blocks in base units into underside of countertop. Align adjacent surfaces. Form seams 3.2 mm wide and adhere with manufacturer's recommended joint adhesive in color to match countertop. Dress joints smooth, remove surface scratches, and clean entire surface.
 - 1. Seal edges of cutouts by saturating with varnish.

END OF SECTION 123530

SECTION 123661 – QUARTZ SURFACING COUNTERTOPS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Product Data:
 - 1. Quartz Surfacing : Submit manufacturer's product data, [sample warranty form,] and fabrication and installation instruction
 - 2. Accessories: Submit manufacturer's product data and installation instructions.
- B. Submittals: 300mm thick.
- C. Verify dimensions of quartz surfaces by field measurements and indicate on Shop Drawings.

PART 2 - PRODUCTS**2.1 QUARTZ**

- A. Standards Required
 - 1. ISO 14001 and 9001 Certification:
 - 2. ASTM C616 standard specification for quartz dimension stone
 - 3. ANSI/NSF Standard 51 – Food Equipment Materials
- B. Interior Honed Quartz :
 - 1. # 2740, Rosemary
 - 2. Finish: Honed.
 - 3. 93% Quartz
 - 4. CAESARSTONE Quartz Surfaces
 - 5. See Manufacturer's Specifications:
http://www.caesarstoneus.com/downloads/pdf/CS_TDM_23.pdf

2.2 SETTING MATERIALS

- A. Water-Cleanable Epoxy Adhesive: ANSI A118.3.
 - 1. Products:
 - a. Latapoxy 310 Stone Adhesive
See Manufacturer's Specifications:
<http://www.laticrete.com/Portals/0/datasheets/LDS6790.pdf>
- B. Sealant: Clear silicone sealant.
 - 1. Products
 - a. Tremco Tremsil200
See Manufacturer's Specifications:
<http://www.tremcosealants.com/files/pds/TREMSIL2.PDF>
- C. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.
 - 1. Products:
 - a. Laticrete 190 Grout Sealer & Tile Protector
See Manufacturer's Specifications:
http://www.laticrete.com.au/pdf/product_data_shfts/datashts/LATICRETE_190.pdf

2.3 COUNTERTOP FABRICATION

- A. Comply with recommendations in MIA's "Dimensional Stone - Design Manual IV."
 - 1. Thickness: 3cm
 - 2. Edge Detail: Square Bevel
- B. Splashes: 20-mm nominal thickness.

1. Height: 4'9" from top of kitchen counter to the datum line.
 - a. Back-painted tempered glass
 2. Top-Edge Detail: Straight square.
 3. Window in wall adjacent to sink.
- C. Fabricate molded edges with machines having abrasive shaping wheels made to reverse contour of edge profile. Form corners of molded edges as indicated with outside corners slightly eased.
- D. Seams: Fabricate countertops without seams.
- E. Cutouts and Holes:
1. Undercounter Fixtures: Make cutouts for undercounter fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Edge Detail: Vertical, slightly eased at top and bottom surfaces and projecting 5 mm into fixture opening.
 2. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

PART 3 - EXECUTION

3.1 INSTALLING COUNTERTOPS

- A. Install countertops by adhering to supports with water-cleanable epoxy adhesive.
- B. Space seams with 1.5-mm gap for filling with sealant. Use temporary shims to ensure uniform spacing and use clamps to eliminate lipping.
- C. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts while cutting.
- D. Install backsplash and end splashes by adhering to wall with water-cleanable epoxy adhesive. Leave 1.5-mm gap between countertop and splash for filling with sealant. Use temporary shims to ensure uniform spacing.
- E. Grout seams to comply with ANSI A108.10. Tool grout uniformly and smoothly with plastic tool.
- F. Apply sealant to seams and to gap between countertops and splashes.

3.2 CLEANING

- A. Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.
- B. Clean stone countertops not less than six days after completion of sealant installation, using clean water and soft rags. Do not use materials or methods that could damage stone.
- C. Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions.

END OF SECTION 123661

SECTION 124200 - TABLE ACCESSORIES**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Allowances: See Division 01 Section "Price and Payment Procedures" for appliance allowances.
- B. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 SUGGESTED PRODUCTS**

- A. Silverware:
 - 1. Heath Ceramics: David Mellor Café Design
 - 2. David Mellor Design operates on the simple principle that well-designed equipment can improve your life.
 - 3. Color: Stainless Steel
 - 4. 4-Piece Set
 - 5. <http://www.heathceramics.com/go/heath/homeware/store/index.cfm?catID=24>
- B. Shallow Salad Bowl:
 - 1. Heath Ceramics: Shallow Salad Bowl
 - 2. Color: Persimmon/ French Grey Combo
 - 3. 13" diameter
 - 4. 2.5qt. capacity
 - 5. Dishwasher, microwave, and oven safe.
 - 6. Ideal for salads, pastas or main dishes.
 - 7. <http://www.heathceramics.com/go/heath/tableware/store/?catID=37>
- C. Glassware:
 - 1. CB2: Marta Barware
 - 2. Stylish and micro-thin
 - 3. 4.75 in. tall
 - 4. 18 oz. capacity
 - 5. <http://www.cb2.com/family.aspx?c=236&f=1249>
- D. Dining Plates:
 - 1. Heath Ceramics: Dinner Plate
 - 2. Color: French Grey Glaze
 - 3. 10.75 in. diameter
 - 4. Rimless design
 - 5. Dishwasher, microwave, and oven safe.
 - 6. <http://www.heathceramics.com/go/heath/tableware/store/index.cfm?catID=7>
 - 7. http://www.bedbathandbeyond.com/product.asp?order_num=-1&SKU=14889922&RN=398&KSKU=112591
- E. Cookware Set: 10-pieces
 - 1. Color: Green
 - 2. http://www.bedbathandbeyond.com/product.asp?order_num=-1&SKU=14889922&RN=398&KSKU=112591
- F. Kitchen Placemat: 17in.x11.5in.
 - 1. CB2: Mosaic Recycled Placemat
 - 2. Color: Coffee/Cream with fun bits of bright carton color
 - 3. 100% recycled mats are actually juice boxes shredded, compressed, and re-freshed.
 - 4. Water- and moisture-resistant; won't crack, splinter or chip.
 - 5. Clean with wet cloth
 - 6. <http://www.cb2.com/family.aspx?c=238&f=4387>
- G. Cutlery: 14-piece knife block set
 - 1. Crate and Barrel
 - 2. <http://www.crateandbarrel.com/family.aspx?c=580&f=31705>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. None needed

END OF SECTION 124200

SECTION 124400 - BATH FURNISHINGS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Allowances: See Division 01 Section "Price and Payment Procedures" for furnishing allowances.
- B. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 BATH LINENS**

- A. Bathmats:
 - 1. CB2: Circus Rugs
 - 2. Color: White
 - 3. Dimensions: 23.5in.x35.5in.
 - 4. 100% hand-woven, soft, and absorbent cotton.
 - 5. Machine wash.
 - 6. <http://www.cb2.com/family.aspx?c=475&f=4721>
- B. Bath Towels: 30in.x60in., bamboo
 - 1. CB2: Bamboo Bath Towels
 - 2. 65% bamboo and 35% combed Egyptian cotton
 - 3. Wide end hem border
 - 4. Color: White
 - 5. Dimensions: 30in.x60in.
 - 6. Machine wash warm, tumble-dry low
 - 7. <http://www.cb2.com/family.aspx?c=475&f=2839>
- C. Hand Towel: 16in.x28in.
 - 1. CB2: Bamboo Hand Towel
 - 2. 65% bamboo and 35% combed Egyptian cotton
 - 3. Wide end hem border
 - 4. Color: White
 - 5. Dimensions: 30in.x60in.
 - 6. Machine wash warm, tumble-dry low
 - 7. <http://www.cb2.com/family.aspx?c=475&f=2839>
- D. Washcloth: 12in.x12in.
 - 1. CB2: Bamboo Washcloth
 - 2. 65% bamboo and 35% combed Egyptian cotton
 - 3. Wide end hem border
 - 4. Color: White
 - 5. Dimensions: 12in.x12in.
 - 6. Machine wash warm, tumble-dry low
 - 7. <http://www.cb2.com/family.aspx?c=475&f=2839>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. none.

END OF SECTION 124400

SECTION 124500 - BEDROOM FURNISHINGS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Allowances: See Division 01 Section "Price and Payment Procedures" for furnishing allowances.
- B. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 BED LINENS**

- A. Comforter: Royal Velvet Down Alternative Comforter, 100% Cotton, 250 Thread Count
 - 1. Bed, Bath & Beyond: Royal Velvet Down Alternative Comforter
 - 2. Full/Queen Size
 - 3. 100% Cotton
 - 4. 250 Thread Count
 - 5. Filled with a down-like polyester that mimics the loft and comfort of down.
 - 6. Dimensions: 86" W x 86" L
 - 7. Dry clean.
 - 8. http://www.bedbathandbeyond.com/product.asp?order_num=-1&SKU=112132&RN=817
- B. Duvet Cover: Full/Queen Duvet Cover
 - 1. CB2: Sardinia Bed Linens
 - 2. Color: Solid Crème
 - 3. Eco-Friendly bamboo rayon and natural linen weave
 - 4. Herringbone weave adds texture to solid color.
 - 5. Machine wash.
 - 6. <http://www.cb2.com/family.aspx?c=422&f=5224&q=sardinia+bed+linens&fromLocation=Search&DIMID=400001&SearchPage=1>
- C. Shams: Set of two Standard Shams
 - 1. CB2: Sardinia Bed Linens
 - 2. Color: Solid Crème
 - 3. Eco-Friendly bamboo rayon and natural linen weave
 - 4. Herringbone weave adds texture to solid color.
 - 5. Machine wash.
 - 6. <http://www.cb2.com/family.aspx?c=422&f=5224&q=sardinia+bed+linens&fromLocation=Search&DIMID=400001&SearchPage=1>
- D. Throw Blanket: 48 in. x 76 in.
 - 1. CB2: Logan Throw
 - 2. Acrylic/wool weave
 - 3. Color: White and grey grid pattern
 - 4. 8 in. outer fringe.
 - 5. Dry clean.
 - 6. <http://www.cb2.com/family.aspx?c=595&f=5221&q=logan+throw&fromLocation=Search&DIMID=400001&SearchPage=1>
- E. Sheets: Full size sheet set
 - 1. CB2: Percale Sheet Sets
 - 2. Color: white
 - 3. 300 thread count
 - 4. 100% Cotton
 - 5. Double-needle stitching
 - 6. Machine wash.
 - 7. <http://www.cb2.com/family.aspx?c=428&f=3297>
- F. Pillow Cases: Set of two, standard size
 - 1. CB2: Percale Sheet Sets

2. Color: white
3. 300 thread count
4. 100% Cotton
5. Double-needle stitching
6. Machine wash.
7. <http://www.cb2.com/family.aspx?c=428&f=3297>

2.2 PILLOWS

- A. Pillows: Allergy Luxe Down Alternative Pillow, 300 thread count
 1. Bed, Bath & Beyond: Allergy Luxe Down Alternative Pillow
 2. Dimensions: Jumbo size 20" x 28"
 3. 300 thread count
 4. 80% polyester/20% cotton
 5. Filled with a premium down alternative fiber.
 6. Machine wash
 7. http://www.bedbathandbeyond.com/product.asp?order_num=-1&SKU=110451&RN=34&

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Place in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- B. Verify that accessories required have been furnished and installed.

END OF SECTION 124500

SECTION 124600 - FURNISHING ACCESSORIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Allowances: See Division 01 Section "Price and Payment Procedures" for waste receptacle allowances.
- B. Submittals: Product Data.-

PART 2 - PRODUCTS

2.1 FURNISHING ACCESSORIES

- A. Living Room Throw Pillows: 16" square
 1. Living Room Throw Pillows: 16" square
 2. CB2; Grid Pillow
 3. Color: cement color, mapped with contrast white stitching.
 4. Hidden zipper closure.
 5. Feather-down insert.
 6. Machine Wash
 7. <http://www.cb2.com/family.aspx?c=595&f=5072>

2.2 WASTE RECEPTACLES

- A. Kitchen Trash Can and Recycle Can: 7 gallons, 25.5in. H x 13in. W x 11.5in. D
 1. Bed Bath & Beyond: Polder Under-the-Counter Trash Can
 2. Color: Stainless Steel finish
 3. 7 gallon capacity
 4. Dimensions: 25.5in. H x 13in. W x 11.5in. D
 5. Rubber base
 6. Rubber band securely holds trash bags in place.
 7. http://www.bedbathandbeyond.com/product.asp?order_num=-1&SKU=16050075&RN=1020
- B. Bedroom Wastebasket: 8"W x 10"D x 12"H
 1. Color: High-Gloss White Lacquer
 2. Dimensions: 8"W x 10"D x 12"H
 3. Engineered wood.
 4. Clean with a damp cloth.
 5. <http://www.crateandbarrel.com/family.aspx?c=1640&f=32341>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. none.

END OF SECTION 124600- FURNISHING ACCESSORIES

SECTION 125800 - RESIDENTIAL FURNITURE**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Allowances: See Division 01 Section "Price and Payment Procedures" for furnishing allowances.
- B. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 RESIDENTIAL CHAIRS**

- A. Living Room Residential Chair
 1. B&B Italia; Metropolitan Chair ME84
 2. Dimensions: 33 in. W x 28 in. H x 32 in. D
 3. Internal Frame: Tubulars and Steel Profiles
 4. Seat Cushion: shaped polyurethane, polyester fiber
 5. Cover: Available in fabric or leather
 6. http://www.bebitalia.it/#/BEBITALIA/SOFASANDARMCHAIRS/METROPOLITAN/TECHNICALSHEET_1_1829_24_1
- B. Bedroom Desk Chair
 1. Eames; Management Chair
 2. Dimensions: H 31-34" D 23" W 23"
 3. Lightweight, corrosion-resistant and die-cast aluminum frame.
 4. Black, Cygnus mesh covering that is a self-contouring, flexible material, which provides even weight distribution and long-term comfort.
 5. Five-point base
 6. Swivel capabilities
 7. <http://www.dwr.com/product/product-groups/classics-from-herman-miller/eames-aluminum-management-chair-mesh.do>

2.2 DINING CHAIRS

- A. Stools: 18.75 in. W x 16 in. D x 18 in. H
 1. CB2; Axel Stool
 2. Color: Midnight black leather
 3. Dimensions: 18.75 in. W x 16 in. D x 18 in. H
 4. Solid Beachwood frame with black leather straps
 5. Fixed legs
 6. Wipe clean with a soft cloth
 7. <http://www.cb2.com/family.aspx?c=106&f=3853>

2.3 COFFEE TABLES

- A. Bench: 17.5 in. H x 57.5 in. W x 18 in. D
 1. Giulio Lazzotti; Giulio Bench
 2. Black molded plywood
 3. <http://www.dwr.com/product/furniture/living/coffee-tables/giulio-bench.do?sortBy=ourPicks>

2.4 BEDS

- A. Mattress: 54" x 75", 4 lb. of high density memory foam, in compliance with federal fire safety standards, entirely recyclable material, natural green tea imbedded in memory foam, cover made with 100% organic cotton.
 1. Keetsa; Cloud Mattress
 2. Limited VOC's
 3. <http://shop.keetsa.com/products/the-keetsa-cloud>

2.5 Dining Tables**A. Madison Extension Dining Table**

1. 61.5" Width x 38" Depth x 30" Tall
2. Expandable 20" Leaf
3. Quarter-sawn ash veneer with solid wood legs
4. <http://www.crateandbarrel.com/family.aspx?c=884&f=6854&q=TABLE&fromLocation=Search&DIMID=400001&SearchPage=1>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Place in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- B. Verify that accessories required have been furnished and installed.

END OF SECTION 125800

SECTION 129300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

- A. Seating and Tables:
1. Products:
 - a. Patio Chair: H 36.75" W 29" D 37.5", Post-consumer or post-commercial high-density polyethylene; stainless steel fasteners.
 - i. Adirondack Chair
 - ii. 100% recycled polyethylene
 - iii. Color: Red
 - iv. <http://www.dwr.com/product/outdoor/adirondack+collection/adirondack-3-slat.do>
 - b. Patio Ottoman: H 21" W 12.5" D 18", Post-consumer or post-commercial high-density polyethylene; stainless steel fasteners.
 - i. Adirondack Ottoman
 - ii. 100% recycled polyethylene
 - iii. Color: Red
 - iv. <http://www.dwr.com/product/outdoor/adirondack+collection/adirondack-ottoman.do>
 - c. Fire Pit: 30in. dia x 16in. H
 - i. CB2: Sparky Fire Pit
 - ii. Color: Sheet steel
 - iii. <http://www.cb2.com/family.aspx?c=830&f=5333&q=sparky+fire+pit&fromLocation=Search&DIMID=400001&SearchPage=1>
 - d. Urban C Table
 - i. Ø" steel rod and sheet steel constructed
 - ii. Finish Color: Carbon
- B. Bicycle Racks:
1. Products:
 - a. Manufacturer's name: Creative Pipe
 - b. Product name: Lighting bolt LR; series LR-P-4-SM-G
 - c. 89.5"L X 27.5"H X 25"W
 - d. http://www.creativepipe.com/lighting_bolt_lr
 2. Bicycle Rack Construction: Hot dipped galvanized finish
 3. Style: Single-side parking.
 4. Installation Method: Freestanding or permanent surface mount

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Anchor site furnishings securely, positioned at locations and elevations indicated.
- B. Post Setting: Set cast-in support posts in concrete footing.
- C. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete and fill annular space between post and concrete with grout.
- D. Pipe Sleeves: Use steel pipe sleeves anchored into concrete for installing posts. After posts have been inserted, fill annular space between post and sleeve with grout.

END OF SECTION 129300

SECTION 135300 - METEOROLOGICAL INSTRUMENTATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PRODUCT INFORMATION

- A. WEATHER STATION
1. Compatibility: Modbus TCP RS 485 communications
 2. Description: Roof or tripod mounted small weather station capable of solar radiance, wind direction and speed, temperature and relative humidity, and barometric pressure readings.
 3. Operation: Continuous operation and data capture when connected with appropriate data logger.
 4. Wind Direction Range 0 - 360 degrees
 5. Wind Speed Range 0 - 100 MPH
 6. Temperature Range -58 to 122 C
 7. Humidity Range 0- 100% Relative Humidity
 8. Pyranometer Range 0 - 1000 Watts per square meter Operating temperature -40 to 131 F
 9. Specific Product Specification http://www.obvius.com/pdfs/A89WS_Datasheet.pdf

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with Product Manual

END OF SECTION 135300

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 HANGERS AND SUPPORTS**

- A. Hanger and Pipe Attachments: Factory fabricated with galvanized coatings; nonmetallic plastic bend support for PEX tubing.

Uponor Plastic Bend Support A5250500

Tube Talon 1/2", 5/8", 3/4", 1"

PEX Wall Support Bracket 1/2" and 3/4"

- B. Cleanouts
ABS Cleanout Fitting, 2" Genova Products 81619
www.hardwarestore.com

- C. WATER METER
1. Turbine type, Class II, AWWA C701. Pulse Output.
 2. Minimum Flow .15 GPM, Maximum Flow 20 GPM
 3. Maximum Pressure 150 psig.
 4. Pressure drop at continuous flow rate 2.9 psid
 5. Temperature Range 32 to 190°F
 6. Specific product specification <http://www.omega.com/Green/pdf/FTB4600.pdf>

- D. WATER METER CONNECTIONS
1. Sharkbite Connection system used
http://www.mobilehomedepotmi.com/parts_pages/fittings_sharkbite.html

PART 3 - EXECUTION**3.1 GENERAL PIPING INSTALLATIONS**

- A. Install piping free of sags and bends.
- B. Install fittings for changes in direction and branch connections.
- C. Install sleeves for pipes passing through walls and concrete floor and roof slabs.
- D. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.
- E. Comply with requirements in Division 07 Section "Penetration Firestopping" for sealing pipe penetrations in fire-rated construction.
- F. Install unions at final connection to each piece of equipment.

3.2 GENERAL EQUIPMENT INSTALLATIONS

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

3.3 BASES, SUPPORTS, AND ANCHORAGES

- A. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 100 mm larger in both directions than supported unit.
 - 2. Install dowel rods on 450-mm centers around the full perimeter of the base to connect concrete base to concrete floor.
 - 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.4 HANGERS AND SUPPORTS

- A. Comply with MSS SP-69 and MSS SP-89. Install building attachments within concrete or to structural steel.
- B. Install hangers and supports to allow controlled thermal and seismic movement of piping systems.
- C. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- D. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Pipe Hangers (MSS Type 5): For suspension of pipes, DN 15 to DN 100, to allow off-center closure for hanger installation before pipe erection.
 - 2. (MSS Type 10): For suspension of non-insulated stationary pipes, DN 15 to DN 50.
- E. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, DN 20 to DN 500.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, DN 20 to DN 500, if longer ends are required for riser clamps.

3.5 GENERAL METERS AND GAUGES INSTALLATIONS

- A. General: Comply with the PHCC National Standard Plumbing Code and manufacturers' recommendations.

END OF SECTION 220500

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data and Shop Drawings
- B. 1.2 RELATED WORK
- C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

PART 2 - PRODUCTS

- A. WATER METER
 - 1. Turbine type, Class II, AWWA C701. Pulse Output.
 - 2. Minimum Flow .15 GPM, Maximum Flow 20 GPM
 - 3. Maximum Pressure 150 psig.
 - 4. Pressure drop at continuous flow rate 2.9 psid
 - 5. Temperature Range 32 to 190°F
 - 6. Specific product specification <http://www.omega.com/Green/pdf/FTB4600.pdf>

PART 3 - EXECUTION

- A. General: Comply with the PHCC National Standard Plumbing Code and manufacturers' recommendations.

END OF SECTION 220519

SECTION 221113 – FACILITY WATER DISTRIBUTION PIPING

PART 1 - SECTION REQUIREMENTS

1.1 Submittals: Product Data

- 1.2 This section applies to the non-radiant portion of hydronic piping systems for radiant heating, and cooling of a building.

PART 2 - PRODUCTS

2.1 Copper Piping for Hydronic Use

- A. Sizes: 1/2 “, 3/4 “, 1”, 1 1/4 “
1. Piping is to be connected with soldered or NPT fittings.
 2. All piping is TYPE L
 3. Fittings with diameter \leq 1.5 Wrought copper or cast bronze ANSI B16.22 & B16.18
- B. PVC Plastic, ABS, DWV Pipe and Fittings: ASTM D 2665, Schedule 40, plain ends with PVC socket-type, DWV pipe fittings.
1. 2”X10’ DWV CC ABS PIPE Genova Products
 2. ABS Coupling, 2” Genova Products 80120
 3. Sanitary Street ABS Elbow, 2” Genova Products 82926
 4. ABS Sanitary Tee, 2” Genova Products 81120
 5. ABS 2” Vent Cap Genova Products
 6. ABS 2” Wye Genova Products 81020
 7. ABS 2” Pipe x 10’ pipe Genova Products

PART 3 - EXECUTION

3.1 Copper Pipe Installation

- A. All water and glycol systems with operating temperatures of 40°F to 210°F: Install Type L, drawn copper tubing with wrought copper fittings and solder joints for 1.5” and smaller, above ground, within building
- B. Install air vents at high points in the system, heat transfer coils, and elsewhere as required for system air venting.

2.2 ABS Pipe Installation

- A. Comply with requirements in Division 22 Section “Common Work Results for Plumbing” for basic piping installation requirements.
- B. Install wall penetration system at each pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 22 Section “Common Work Results for Plumbing” for wall penetration systems.
- C. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- D. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- E. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
- F. Building Sanitary Drain: 2 percent downward in direction of flow for piping DN 80 and smaller; 1 percent downward in direction of flow for piping DN 100 and larger.

- G. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
- H. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- I. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- J. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- L. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
- M. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure unless otherwise indicated.
- N. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pipe hanger and support devices.

END OF SECTION 221113

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Comply with NSF 14 for plastic, potable domestic water piping and components.
- B. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. PEX Tube and Fittings: ASTM F 877, SDR 9 PEX tubing and ASTM F 1807, metal insert-type fittings with copper or stainless-steel crimp rings.
 - 1. Manifold: ASTM F 877 plastic or corrosion-resistant-metal assembly, with a plastic or corrosion-resistant-metal valve for each outlet.
 - 2. Piping: Wirsbo AQUAPEX Tubing. 1/2", 3/4", 1".

http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Plumbing/Specifications/Uponor_Plbg_Spec_ProPEX_RH%20Revisions.aspx?sc_lang=en

Complies with:

ASTM F876 Standard Specification for Cross-linked Polyethylene (PEX) Tubing

ASTM F877 Standard Specification for Cross-linked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems

International Plumbing Code (IPC)
 - 3. Rings: ProPEX Ring 1/2", 3/4", 1"

http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Plumbing/AQUAPEX%20Tubing/8ProPEX%20%20Ring.aspx?sc_lang=en
 - 4. Tees: ProPEX® Engineered Plastic (EP) Tee
1" x 3/4" x 3/4", 3/4" x 1/2" x 1/2", 3/4" x 3/4" x 3/4"
 - 5. Multi-Port Tee: ANSI/NSF 14- and 61-certified ProPEX EP Multi-Port Tee 3 outlet, 4 outlet.

http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/EP%20Fittings/011%20EP%20Branch%20Multi%20port%20Tee.aspx?sc_lang=en
 - 6. EP Plug: Ends PEX tubing lines
<http://www.pexsupply.com/ProPEX-EP-Plugs-536000>
- B. Special-Duty Valves:
 - 1. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
 - 2. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.
 - 3. Union Ball Valves: MSS SP-122, with full-port ball, socket or threaded detachable end connectors, and pressure rating not less than 860 kPa at 23 deg C.

ProPEX® Lead-free (LF) Brass Ball Valve full port 1/2" x 1/2"

http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Plumbing/LF%20Fittings/LF4817575_4827575_LF4821010_ProPEX%20LF%20Brass%20Ball%20Valve_01%2020%202009.aspx?sc_lang=en

ProPEX Angle Stop Valve D " Q4905038
ProPEX EP In-line Valve, 3/4" PEX x 3/4" PEX Q4837575

- C. Transition Fittings: Manufactured piping coupling or specified piping system fitting. Same size as pipes to be joined and pressure rating at least equal to pipes to be joined. IAPMO 3558; ANSI/NSF 14- and 61-certified; HUD MR 1269; ICC ESR 1099.

1. ProPEX® EP Coupling 1/2"x 3/4"

Specially made for Wirsbo AQUAPEX tubing, can also be used in Radiant applications.
http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/EP%20Fittings/58%20ProPEX%20%20EP%20Coupling.aspx?sc_lang=en

2. ProPEX® Lead-free (LF) Brass Male Threaded Adapter 1/2" x 1/2", 3/4"x3/4", 1"x1"

Connects PEX tubing to NPT thread.
http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Plumbing/LF%20Fittings/LF452xxxx_ProPEX%20LF%20Brass%20Male%20Threaded%20Adapter_01%2020%202009.aspx?sc_lang=en

3. ProPEX® to MIP Lead-free (LF) Brass Ball Valve D " x D "

Makes Connections between AQUAPEX tubing. Do not dismantle.

http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Plumbing/LF%20Fittings/LF4817575_4827575_LF4821010_ProPEX%20LF%20Brass%20Ball%20Valve_01%2020%202009.aspx?sc_lang=en

4. ProPEX® Lead-free (LF) Brass Female Threaded Adapter. Use with ProPEX ring for connection.

http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Plumbing/LF%20Fittings/LF457xxxx_ProPEX%20LF%20Brass%20Female%20Threaded%20Adapter_01%2020%202009.aspx?sc_lang=en

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install Wirsbo AQUAPEX tubing in accordance with the tubing manufacturer's recommendations and as indicated in the installation handbook.
- B. Do not install PEX tubing within 6 inches [152 mm] of gas appliance vents or within 12 inches [305 mm] of any recessed light fixtures.
- C. Do not solder within 18 inches [457 mm] of PEX tubing in the same waterline. Make sweat connections prior to making PEX connections.
- D. Do not expose PEX tubing to direct sunlight for more than 30 days.
- E. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer.
- F. Protect PEX tubing with sleeves where abrasion may occur.
- G. Use strike protectors where PEX tubing penetrates a stud or joist and has the potential for being struck with a screw or nail.

- H. Use tubing manufacturer-supplied bend supports where bends are less than six times the outside tubing diameter.
- I. Minimum horizontal supports are installed not less than 32 inches between hangers in accordance with model plumbing codes and the installation handbook.

3.2 INSPECTING AND CLEANING

- A. Inspect and test piping systems as follows:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
- B. Clean and disinfect potable domestic water piping by filling system with water/chlorine solution with at least 50 mg/L of chlorine. Isolate with valves and allow to stand for 24 hours. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

3.3 PIPING SCHEDULE

- A. Aboveground Distribution Piping: PEX Piping.

3.4 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball or gate valves for piping DN 50 and smaller.
 - 2. Throttling Duty: Use bronze ball or globe valves for piping DN 50 and smaller. Use cast-iron butterfly valves with flanged ends for piping DN 65 and larger.
 - 3. Drain Duty: Hose-end drain valves.
- B. Install gate valves close to main on each branch and riser serving two or more plumbing fixtures or equipment connections and where indicated.
- C. Install gate or ball valves on inlet to each plumbing equipment item, on each supply to each plumbing fixture not having stops on supplies, and elsewhere as indicated.
- D. Ball, butterfly, and check valves may be used in matching piping materials.
- E. Install drain valve at base of each riser, at low points of horizontal runs, and where required to drain water distribution piping system.
- F. Install swing check valve on discharge side of each pump and elsewhere as indicated.
- G. Install ball valves in each hot-water circulating loop and discharge side of each pump.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013.
- B. Clothes Washer Outlet Boxes: Brass box and face plate with combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
Uponor ProPEX® Lead-free (LF) Washing Machine Outlet Box
http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Plumbing/LF%20Supply%20Boxes/LF5930500%20ProPEX%20LF%20Washer%20Outlet%20Box_01%2020%202009.aspx?sc_lang=en
- C. Water Filters: Inline with stainless steel screen. Screws onto ½-inch male pump inlet.
Shurflo Inline Filter 40-0088
<http://www.realgoods.com/product/water-heating-pumping/water+pumping/accessories/shurflo+inline+filter.do>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install Water Filter by screwing onto 1/2 inch pump inlet.
- B. Follow installation practices outlined in 221116

END OF SECTION 221119

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

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

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PUMPS

- A. In-Line, Sealless Diaphragm Pumps: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps. Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal; rated for 860-kPa minimum working pressure and minimum continuous water temperature of 107 deg C.
 - 1. Available Products:
 - a. SHURflo; 2088 Series Diaphragm Pump.
 - 1) Automatic Demand Pump (115 VAC).
 - 2) In-line filter.
<http://www.shurflo.com/pdf/industry/general/911/911-2088-594-154.pdf>
 - b. FLOJET; Domestic Booster Pump.
 - 1) Body material: Polypropylene.
 - 2) Sealed motor with run dry capability.
 - 3) 1 gal pressure pump.
<http://www.grainger.com/Grainger/items/4YD37>
 - c. Uponor D'MAND Hot Water Demand Delivery System Model 100.
 - 1) 1/25 HP.
 - 2) Integral check valves.
http://www.uponor-usa.com/-/media/Files/Product%20Documents/DMand%20Cutsheet.aspx?sc_lang=en

2.2 MOTORS

- A. NEMA MG 1, "Standard for Motors and Generators." Include NEMA listing and labeling.
- B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- C. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.3 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot water recirculation pump.
 - 1. Available Products:
 - a. Metlund D'MAND HardWired Motion Sensor V-102.
 - 1) Type: Water-immersion temperature sensor, for installation in piping.
 - 2) Settings: Motion starts pump, if necessary. Stop pump at 100 deg F (37.78 deg C).
 - 3) Part of Uponor D'MAND Hot Water Demand Delivery System Model 100.
http://www.uponor-usa.com/-/media/Files/Product%20Documents/DMand%20Cutsheet.aspx?sc_lang=en

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Support pumps and piping so weight of piping is not supported by pump volute.
- D. Install electrical connections for power, controls, and devices.
- E. Suspend in-line pumps independent from piping. Use continuous-thread hanger rods and vibration isolation hangers. Fabricate brackets or supports as required for pumps.
- F. Install vertical in-line pumps on concrete bases.
- G. Connect piping with valves that are at least the same size as piping connecting to pumps.
- H. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- I. Install shutoff valve and strainer on suction side of pumps.
- J. Install nonslam check valve and throttling valve on discharge side of pumps.
- K. Install thermostats in hot-water return piping.
- L. Install pressure gages on suction and discharge of each pump. Install at integral pressure gage tapings where provided.

END OF SECTION 221123

SECTION 221200 - FACILITY POTABLE-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 POTABLE-WATER STORAGE TANKS

- A. Polyethylene Potable-Water Storage Tanks: One single-chamber, molded, HDPE or PE construction; fabricated for potable-water storage tank application.
 - 1. Capacity: 750 gal.
 - 2. See <http://www.ryanherco.com/> for fabricator

2.2 SIPHONS

- A. Automatic Siphons: Manufactured siphon assembly of molded HDPE trap, pipe, and bell, with PVC vent piping and stainless-steel bolts.
 - 1. Unit Size: min. 4 inches diameter.

2.3 DISTRIBUTION PIPES AND FITTINGS

- A. PEX Pipes and Fittings: Refer to 221116 specs.

2.4 CLEANOUTS

- A. Cleanouts: ASME A112.36.2M, with round, flanged, cast-iron housing; and secured, scoriated, medium-duty loading class, cast-iron cover. Include cast-iron ferrule and countersunk brass cleanout plug.

PART 3 - EXECUTION

3.1 FACILITY POTABLE-WATER STORAGE TANK INSTALLATION

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

END OF SECTION 221200

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Minimum Pressure Requirement for Soil, Waste, and Vent: 30 kPa.
- B. Comply with NSF 14, "Plastic Piping Components and Related Materials," for plastic piping components.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

- A. PVC Plastic, ABS, DWV Pipe and Fittings: ASTM D 2665, Schedule 40, plain ends with PVC socket-type, DWV pipe fittings.
 - 1. ABS P-Trap, 2" Genova Products 88520
 - 2. Aluminum Vent Flashing
 - 3. 2" diameter 10' ABS Pipe, reference 221113
- B. See <http://www.hardwarestore.com/> for supplier

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping installation requirements.
- B. Install wall penetration system at each pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for wall penetration systems.
- C. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- D. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping DN 80 and smaller; 1 percent downward in direction of flow for piping DN 100 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- E. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- F. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- G. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- H. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

- I. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure unless otherwise indicated.
- J. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pipe hanger and support devices.

3.2 PIPE SCHEDULE

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

END OF SECTION 221316

SECTION 221353 - FACILITY SEPTIC TANKS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 SEPTIC TANKS

- A. Polyethylene Septic Tanks: One single-chamber, molded, HDPE or PE construction; fabricated for septic tank application.
 - 1. Capacity: 500 gal.
 - 2. See <http://www.ryanherco.com/> for fabricator
- B. Polyethylene Greywater Tank: Single Chamber.
 - 1. Capacity: 120 gal.
 - 2. See <http://www.ryanherco.com/> for fabricator

2.2 SIPHONS

- A. Automatic Siphons: Manufactured siphon assembly of molded HDPE trap, pipe, and bell, with PVC vent piping and stainless-steel bolts.
 - 1. Unit Size: min. 4 inches diameter.

2.3 DISTRIBUTION PIPES AND FITTINGS

- A. ABS Sewer Pipe and Fittings: ASTM D 2751, SDR 35, for solvent-cement or elastomeric gasket joints.
 - 1. Solvent Cement: ASTM D 2235.
 - 2. Gaskets: ASTM F 477, elastomeric seal.

PART 3 - EXECUTION

3.1 SEPTIC TANK INSTALLATION

- A. Install septic tanks level.
- B. Install polyethylene septic tanks according to guidelines.
- C. Fill septic tank with water.

END OF SECTION 221353

SECTION 223226 - DOMESTIC-WATER MULTIMEDIA SAND FILTER**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data

PART 2 - PRODUCTS**2.1 PEA GRAVEL**

- A. Composition: Medium sized rock aggregate
- B. Supplier: U-Save Rockery, San Jose CA 95112
1. <http://www.usaverockerysanjose.com/>

2.2 SAND

- A. Composition: Fine sized soil aggregate
- B. Supplier: U-Save Rockery, San Jose CA 95112
1. <http://www.usaverockerysanjose.com/>

2.3 LOAM

- A. Composition: Soil mixture of approximately two parts top soil and three parts sand. It has higher water content than sand but lower than clay soil.
- B. Supplier: U-Save Rockery, San Jose CA 95112
1. <http://www.usaverockerysanjose.com/>

2.4 BIO-MATRIX

- A. Composition: Fine, mulch like material derived from sphagnum peat moss
1. Absorbs PCBs, oil based paints, inks and dyes, vegetable oils, blood, and animal fats without leaching.
 2. Specific gravity of 0.904
 3. Non-toxic, 100% organic industrial absorbent that is economically efficient, non-abrasive, and in is already biodegraded in its natural state. The inherent capillary action of the activate peat provides a powerful wicking action and encapsulates oils, solvents, heavy metals, pesticides, herbicides and all other organic chemicals on contact.
 4. Suppresses vapors and absorbs hydrocarbons on land or water in wet or dry conditions.
 5. Is an ideal host for microbial degradation/bio-remediation of contaminated land. It also contains HAC, a natural organic catalyst that accelerates the process of microbial degradation, bringing the soil back to its original condition in a fraction of the usual time.
- B. Supplier: Bio-Matrix USA
1. <http://www.biomatrixusa.com/images/biomatrix%20brochure.pdf>
 2. www.biomatrixusa.com

2.5 BAMBOO PLYWOOD

- A. Construction Grade Bamboo Plywood
 - 1. Supplier: Calibamboo
 - a. Available at www.calibamboo.com/bambooplywood.html
 - b. 1-888-788-CALI
 - 2. Size: 4ft x 8ft
 - 3. Thickness: 5/8 in
 - 4. Color: woven
 - 5. Price: \$39/board

2.6 GEOTEXTILE

- A. Nonwoven needle punched polypropylene fabric
 - 1. Flow Rate: 150gal/min/sf
 - 2. Tensile Strength: 90lbs
 - 3. Puncture Strength: 60lbs
 - 4. Mullen Burst: 185psi
 - 5. Elongation at break: 50%
- B. Supplier: US Fabrics
 - 1. Available at <http://www.usfabricsinc.com/media/products/US90NW.pdf>

2.7 PLANTS

- A. Bamboo: *Sasamorpha borealis*
 - 1. Small sized, cold hardy bamboo shrubbery.
 - 2. Maximum height: 6ft.
 - 3. Diameter: 0.3in
 - 4. Hardiness: -10 degree Fahrenheit
 - 5. USDA zone 6-9
- B. Supplier: Bamboo Garden
 - 1. Available at <http://www.bamboogarden.com/price.htm#Sasamorpha%20borealis>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Assemble bamboo plywood to form a 6x5x3ft planter box following the guidelines of the supplier.
- B. Planter Box Design
 - 1. For a solely gravity fed system build the planter box on a slight grade so that filtered water will flow to the collecting end with the outlet pipe.
- C. Lay the geotextile across the bottom of the planter box so that it covers the entire bottom and has a 1in lip up the sides of the box.
- D. Layer the soils:
 - 1. Pour in an 8in layer of pea gravel and distribute evenly.
 - 2. Pour in a 12in layer of sand.
 - 3. Pour in a 1 in layer of bio-matrix
 - 4. Pour in a 7in layer of loam.
 - 5. Pour in 3in of pea gravel.
- E. Connect the inlet piping to the system by laying the piping over the top layer of gravel.
- F. Surround the piping with geotextile if necessary.

- G. Pour the remaining 5in of pea gravel over the piping.
- H. Plant the bamboo into the gravel in a zig-zag pattern across the planter box such that there are plants in opposite facing corners.
- I. Run gray water through the system.

END OF SECTION 223226

SECTION 223529 - NONCIRCULATING, STORAGE DOMESTIC WATER HEAT EXCHANGERS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data

PART 2 - PRODUCTS**2.1 SUPERSTOR ULTRA SSU 80**

- A. 23Ø" in diameter and 72" in height – 80 gallon capacity
- B. Cupronickel heat exchanger, with 34 square feet of exchange surface
- C. Working pressure up to 150psi and test pressure up to 300psi.
- D. Connections:
 - 1. Domestic 1Ø" NPT male
 - 2. Boiler 1" NPT
- E. 316L stainless steel shell.
- F. Water-blown foam insulation at thickness of 2" with less than Ø deg F per hour heat loss. Insulation is CFC free.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install per manufacturer specifications

END OF SECTION 223529

SECTION 224100 - PLUMBING FIXTURES**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Submittals: Product Data for each type of plumbing fixture, including trim, fittings, accessories, appliances, appurtenances, equipment, and supports.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" for plumbing fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS**2.1 WATER CLOSET**

- A. Water Closet: Round front, siphon-jet type, wall-mounted.
 - 1. Basis-of-Design Product: Duravit; Starck 3.
 - 2. Material: Porcelain
 - 3. Dimensions: 14.6"W x 21.6"D x 17.4"H
 - 4. http://www.duravit.com/products/series/starck-3/toilets/toilet-wall-mounted--220109_toilets_93749_useo6q3rtg.html

2.2 SHOWER

- A. Showerhead:
 - 1. Basis-of-Design Product: Kohler: Stillness Multifunction Showerhead # K-968
 - 2. Materials and Finish: Polished chrome.
 - 3. Description: Includes showerhead, arm and flange.
 - 4. See manufacturer's specifications for details:
http://www.us.kohler.com/onlinecatalog/pdf/1039084_4.pdf
- B. Showerhead:
 - 1. Basis-of-Design Product: Kohler: WaterTile Rain Overhead Showering Panel # K8030
 - 2. Materials and Finish: Polished chrome.
 - 3. See manufacturer's specifications for details:
http://www.us.kohler.com/onlinecatalog/pdf/1057619_4.pdf
- C. Shower Drain: 78.4"W x 3.9"D x 3.9"H, installation height side outlet 3.9in., to be installed on floor below shower.
 - 1. Product: Waterworld Solutions, GT 2000 ZU
 - 2. Type: Residential
 - 3. Stainless Steel, including g Siphon.
- D. Bathroom Sink Faucet: Single-lever, antiscald-type faucet; maximum 0.16-L/s flow rate.
 - 1. Basis-of-Design Product: Kohler; Falling Water wall-mount lavatory faucet trim with 10 - Ø" spout, valve not included # K-T 197
 - 2. See manufacturer's specifications for details:
http://www.us.kohler.com/onlinecatalog/pdf/086501_4.pdf
 - 3. Include ball, gate, or globe valves on supplies if check stops are not included with faucet.
 - 4. Body Material: Solid brass
 - 5. Finish: Polished chrome
 - 6. Hand-held showers.
- E. Kitchen Sink Faucet: Single-lever, 360 degree swivel spout with 9" clearance, brass construction, ADA compliant lever handles, 2.2 gallon per minute flow rate.
 - 1. Basis-of-Design Product: Kohler; K-18865-CP

2. Finish: Polished chrome
 3. http://www.us.kohler.com/onlinecatalog/detail.jsp?prod_num=18865
- F. Mixing-Valve Faucet and Miscellaneous Fittings: Single-lever, antiscald-type faucet; maximum 0.16-L/s flow rate.
1. Shower Dial
 2. Basis-of-Design Product: Kohler; MasterShower Rite-Temp Hi-Flow valve trim, valve not included # K-T9492-7
 3. See manufacturer's specifications for details:
http://www.us.kohler.com/onlinecatalog/pdf/085723_4.pdf
 4. Include ball, gate, or globe valves on supplies if check stops are not included with faucet.
 5. Body Material: Metal
 6. Finish: Polished chrome
 7. Hand-held showers.

2.3 SINKS

- A. Ceramic Sink: Wall mounted type, 1" thick, ultra modern square white vessel sink, porcelain vitreous ceramic basin
1. Product: Modern Danish; PR- OC58
 2. <http://store.moderndanish.com/Items/pr-%20oc58%20square%20thick%20edges?caSKU=pr-%20oc58%20square%20thick%20edges&caTitle=Ultra%20Modern%20SQUARE%20White%20Vessel%20Sink%20Bathroom-%20Porcelain%20Vitreous%20Ceramic%20Basin%20Laboratory%20%20OC58>
- B. Kitchen Sink: Solid, 16-gauge Stainless-Steel Sink: Undercounter type, two compartments, 33" x 18" x 9-1/2", 9 in. basin depth.
1. Product: Kohler; Poise K-3159-H with SilentShield™ sound-absorption technology
 2. Finish: Stainless Steel with Mirror finish accents
 3. http://www.us.kohler.com/onlinecatalog/detail.jsp?prod_num=3159-H

2.3 WATER FILTRATION SYSTEM

- A. Aquifer Water Filtration System
1. Product Kohler; K-200
 2. Single-stage filtration system
 3. No spill filter cartridge, ⌀ turn quick change
 4. http://www.us.kohler.com/onlinecatalog/detail.jsp?prod_num=200

PART 3 - EXECUTION

3.1 INSTALLATIONS

- A. Install fitting insulation kits on fixtures for people with disabilities.
- B. Install fixtures with flanges and gasket seals.
- C. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- D. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- E. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- F. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- G. Fasten wall-mounted fittings to reinforcement built into walls.
- H. Fasten counter-mounting plumbing fixtures to casework.
- I. Secure supplies to supports or substrate within pipe space behind fixture.
- J. Set shower receptors and mop basins in leveling bed of cement grout.
- K. Install individual supply inlets, supply stops, supply risers, and tubular brass traps with cleanouts at fixture.

- L. Install water-supply stop valves in accessible locations.
- M. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes unless otherwise indicated.
- N. Install disposers in sink outlets. Install switch where indicated, or in wall adjacent to sink if location is not indicated.
- O. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.
- P. 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.
- Q. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.
- R. Install piping connections between plumbing fixtures and piping systems and plumbing equipment. Install insulation on supplies and drains of fixtures for people with disabilities.
- S. Ground equipment.

END OF SECTION 224100

SECTION 230500 - COMMON WORK RESULTS FOR HVAC**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. 23 05 19 - Meters and Gages
- B. 23 05 16 - Expansion Fittings and Loops

1.2 SECTION REQUIREMENTS

- A. Submittals: Product Data.

1.3 RELATED SECTIONS

- A. 230523 - General-Duty Valves for HVAC Piping
- B. 230593 - Testing, Adjusting, and Balancing for HVAC
- C. 230516 - Expansion Fittings and Loops for HVAC Piping

PART 2 - PRODUCTS**2.1 PRESSURE GAGES AND TEST PLUGS**

- A. Pressure Gages: Direct-mounting, indicating-dial type complying with ASME B40.100. Dry metal case, minimum 63-mm diameter with red pointer on white face, and plastic window. Minimum accuracy 3 percent of middle half of range. Range two times operating pressure.
- B. Commercial Grade Type C Gages.
 - 1. Max Operating Temperature at 1500°F
 - 2. Painted Steel Casing
 - 3. Bronze Bourdon
 - 4. Brass ♂ NPT Connection
 - 5. Range from vacuum to 600psi
 - 6. Accurate to 2%, or 3% within the first or last 10% of the range.
 - 7. Various Dimensions
- C. Manufacturer Info:
 - 1. Omega Engineering, Inc.
 - 2. Product data found at: <http://www.omega.com/Pressure/pdf/PGC.pdf>

2.2 EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

- A. Amtrol AX200-V Expansion Tanks to control system pressure.
 - 1. ASME Pressure Vessel
 - 2. Uses a Butyl/EPDM diaphragm for air retention.
 - 3. Separates system water from air cushion
 - 4. Maintenance free design.
 - 5. Steel tank containment.
 - 6. Precharged to 12 psig
 - 7. Working range from 125 psig maximum pressure and 240 deg. F maximum temperature.
- B. Manufacturer Info:
 - 1. Amtrol Hydronic Technologies
 - 2. Product data found at: <http://www.amtrol.com/pdf/extrolbrochure.pdf>

PART 3 - EXECUTION**3.1 GENERAL PIPING INSTALLATIONS**

- A. Install piping free of sags and bends.
- B. Install fittings for changes in direction and branch connections.
- C. Install sleeves for pipes passing through concrete walls, gypsum board partitions, and concrete floor and roof slabs.
- D. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.
- E. Comply with requirements in Division 07 Section "Penetration Firestopping" for sealing pipe penetrations in fire-rated construction.
- F. Install unions at final connection to each piece of equipment.
- G. Install dielectric unions and flanges to connect piping materials of dissimilar metals in gas piping.
- H. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.
- I. Follow manufacturer's recommended installation procedures for expansion fittings and loops for HVAC piping

3.2 GENERAL EQUIPMENT INSTALLATIONS

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

END OF SECTION 230500

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING**PART 1 - GENERAL****1.1 SUBMITTALS**

- A. Product Data.

1.2 RELATED SECTIONS

- A. 230500 – Common Work Results for HVAC
- B. 230593 – Testing, Adjusting, and Balancing for HVAC

PART 2 - PRODUCTS**2.1 GENERAL-DUTY VALVES**

- A. Valve Sizes: Same as upstream piping unless otherwise indicated.
- B. Valves in Insulated Piping: With 50-mm stem extensions.
- C. End Connections: Threads shall comply with ANSI B1.20.1. Flanges shall comply with ANSI B16.1 for cast-iron valves and with ANSI B16.24 for bronze valves. Solder-joint connections shall comply with ANSI B16.18.
- D. Two-Piece, Copper-Alloy Ball Valves: Forged-brass body with regular-port, chrome-plated bronze ball; PTFE or TFE seats; and 4140-kPa minimum CWP rating and blowout-proof stem.
 - 1. Manufactured by Nibco
 - 2. Manufacturer information available at manufacturer's product catalogue: <http://www.nibco.com/assets/TS508APV.pdf>
- E. Bronze, Swing Check Valves: Class 125, bronze body with bronze disc and seat.
 - 1. Manufactured by Nibco
 - 2. Manufacturer information available at manufacturer's product catalogue: <http://www.nibco.com/assets/TS413BI.pdf>
- F. Pressure Temperature Relief Valve: Fully automatic relief protection meeting ANSI Z21.22 certification and is A.S.M.E. rated and certified.
 - 1. Provides temperature relief at 210 deg F and pressure relief at a range from 75 to 150 psi.
 - 2. Manufactured by Watts
 - 3. Manufacturer information available at manufacturer's product catalogue: <http://www.watts.com/pdf/ES-10L-100XL.pdf>
- G. Hose Bibbs: operates up to 180 def F and 125 lbs CWP to 100 deg F
 - 1. Manufactured by Nibco
 - 2. Manufacturer information available at manufacturer's product catalogue: <http://www.nibco.com/assets/465661PV.pdf>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Use gate and ball valves for shutoff duty; globe and ball for throttling duty.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves for each fixture and item of equipment.
- D. Install three-valve bypass around each pressure-reducing valve using throttling-type valves.
- E. Install valves in horizontal piping with stem at or above center of pipe.
- F. Install valves in a position to allow full stem movement.
- G. Install check valves for proper direction of flow in horizontal position with hinge pin level.

3.2 MAINTENANCE

- A. Operate lever once each year at minimum for temperature and pressure relief valve to ensure clear waterways.
- B. Caution to avoid hot water at discharge when performing maintenance operations.

END OF SECTION 230523

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

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

PART 2 - PRODUCTS

2.1 RELIEF VENT SYSTEMS

- A. Automatic air vents for air elimination and control operating up to 250 psi maximum system condition with a maximum venting pressure of 150 psi at system temperature of 240 deg F.
- B. Manufactured by Taco Systems. Product data sheet available at: <http://www.taco-hvac.com/uploads/FileLibrary/100-7.1.pdf>

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine the approved submittals for HVAC systems and equipment.
- C. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- D. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- E. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- F. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- G. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of dampers and valves for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at indicated values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to indicated values.

- H. Report deficiencies discovered before and during performance of test and balance procedures.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

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

3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

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

3.4 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

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

3.5 TOLERANCES

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

END OF SECTION 230593

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Quality Assurance: Labeled with maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to ASTM E 84.
- C. Comply with
 - 1. ASTM C 534 Type 1 (Tubing), Grade 1
 - 2. ASTM D 1056-00-2C1
 - 3. New York City MEA 186-86-M Vol. IV
 - 4. USDA Requirements
 - 5. ASTM E 84 1-1/2" 25/50-tested
 - 6. UL 723 and NFPA 255
 - 7. CAN/ULC S102-03
 - 8. FMRC 2006 Approval Guide
 - 9. Chapter 14 Pipe Insulation
 - 10. NFPA No. 101 Class A Rating

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials.
 - 1. FlexTherm® 1" Insulation
 - a. Operating Temperature Range -72°F to 220°F
 - b. Water Vapor Permeability Dry Cup. Perm-In <0.06 ASTM E 96
 - c. Water Absorption % <0.20 by volume
 - d. Thermal Conductivity (K)
 - 1) 90° F (32° C) Mean Temp .270 (.039) ASTM C 177/C 518
 - 2) 75° F (24° C) Mean Temp .265 (.038) ASTM C 177/C 518
 - 3) 50° F (10° C) Mean Temp .260 (.037)
 - e. For more information see: http://www.nomacoinsulation.com/files/NI-0020-PS_FlexTherm_White.pdf

PART 3 - EXECUTION

3.1 INSULATION INSTALLATION

- A. Flexible Elastomeric Insulation Installation:
 - 1. Seal longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - 2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of pipe insulation. Secure insulation materials and seal seams with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

END OF SECTION 230700

SECTION 230800 – COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Certified TAB reports, Uponor Climate Controls Network Programming Software and custom code.

1.2 GENERAL SYSTEM DESCRIPTION

- A. The HVAC and Hot Water systems for Refract house are an entirely custom engineered system. The Design Engineer should be present for testing, balancing, and commissioning. All controls algorithms are custom, and are outlined in this document but open to change. Commissioning shall not be the end of system optimization. All balancing, flow rates, and operation code will be tweaked during final stages of prototype development and will only be final once this stage is complete. The house that goes to competition will be fully optimized, and this operation scheme will be the true plan that will be used in any marketed production houses; there is no substitute for field optimization of these types of mechanical systems.

1.3 QUALITY ASSURANCE

- A. Commissioning Firm:
 - 1. Shall be approved by Design Engineer.

PART 2 - PRODUCTS

- A. UPONOR COMMISSIONING SOFTWARE
 - 1. Shall be the primary interface for initial system setup, as well as all data monitoring and operational modification. Consult trained Uponor professionals and documentation to ensure product is applied properly.

PART 3 - EXECUTION

3.1 EXAMINATION AND GENERAL PROCEDURES

- A. Tests and Performance Checks
 - a. All systems shall be inspected, tested, run, balanced and checked according to direct discretion of the Design Engineer. This document shall only detail the intended Sequence of Operation. See Construction Documents for drawings and schedules
- B. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- C. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE 111 and in this Section.
- D. See General Procedures Sections 3.3 – 3.5, and Tolerance Section 3.6

3.2 SEQUENCE OF OPERATIONS

- A. All pump and temperature and valve names reference the Construction Documents.
- B. SOLAR THERMAL OPERATION
 - 1. The solar thermal glycol loop is circulated through the collector array by variable speed pump P.COLL. The pump engages when the panel temperature (T.COLL) is 2F greater than the storage tank temperature (T.TANK), and disengages when it falls below the storage tank temperature. When the top of the thermal storage tank (T.TANK) is below 150F, water from the middle of the tank is sent to the collectors (ZC-13 is open, ZC-14 is closed). When the top of the tank is greater than 150F, water is drawn from the bottom of the tank instead (ZC-14 is open, ZC-13 is closed).

- C. REVERSIBLE HEAT PUMP BACKUP (RHP IN HEATING MODE)
1. The top of the thermal storage tank is always maintained above the minimum temperature required to provide hot water and space heating (125F) by either the solar thermal array or the backup system, the RHP in heating mode. If this temperature (T.TANK) ever falls below 125F, the RHP is engaged in heating mode, its circulator (P.RHP) is engaged, zone valves switch the RHP loop to operate on the storage tank (DV-1 and ZC-1 open), and the RHP heats the storage tank. The heating continues until the tank reaches 130F. Whenever the RHP is not heating the tank, DV-1 and ZC-1 are closed.
- D. DOMESTIC HOT WATER OPERATION
1. The domestic hot water tank (T.DHW) is maintained above 115F at all times by engaging the DHW loop pump (P.DHW) whenever the DHW tank temperature falls to 115F and disengaging it when the tank reaches 120F.
- E. DOMESTIC HOT WATER PREHEAT FUNCTION
1. Rejected heat from the chiller first runs through an indirect fire DHW preheat tank before going to the cooling tower. Whenever the domestic preheat tank (T.PREHEAT) is less than 5F below the reject temperature (T.REJ. OUT) ZC-2 opens to bypass the tank and reduce head losses.
- F. HEATING MODE OPERATION
1. Each of the hot HVAC demands has its own circulator (P.FCUI.HOT and P.RAD) that draws directly from the thermal storage tank, so whenever there is a call for these their respective circulators operate (see Air Side and Radiant Sections)
- G. COOLING MODE OPERATION
1. The cooling mode of the HVAC system has one primary loop, circulated by P.COLD, and whenever there is a demand for cooling or dehumidification this loop runs. Whenever there is a cooling/dehumidification call and the buffer tank exit temperature (T.BUFF. OUT) is above 58F, the Absorption chiller operates with output set to 54F, and pumps P.CHILL, P.GEN, and P.REJ run.
 2. Whenever the chiller is unable to match the load the chiller exit temperature (T.CHILL) will rise, so whenever the chiller is running and this temperature is above 56F the RHP will engage in cooling mode. It will disengage when T.CHILL falls back below 55F. The RHP will also operate whenever there is a call for dehumidification or emergency cooling (see Zone Control section).
 3. Demand side equipment is piped in a secondary configuration from the primary loop. The FCU is energized by engaging its circulator (P.FCUI.COLD) and the radiant system operation is described in the Radiant section.
- H. AIR SIDE COMPONENT OPERATION
1. The FCU engages whenever there is a call for dehumidification, or for certain zone heating or cooling conditions (see Zone control section), usually at LOW fan speed. Under normal conditions, the ERV is also engaged simultaneously, running at HIGH speed. There are two conditions when ERV will not run: when free cooling is possible (economizer type function), or when the temperature and humidity difference is small enough that the ERV benefit is outweighed by its electrical consumption.
 2. In the first case, the free cooling function operates as follows: if a) there is a call for cooling, b) the outside temperature (OT1) is more than 5F cooler than the zone calling for cooling, and c) outside absolute humidity (OHI) is lower than the dehumidification setpoint (69 gr/lb), then an economizer-type function is enabled: the ERV disengages and mechanical dampers MD1 and MD2 switch to bypass it, and the FCU engages at MED speed. In the event of a low power cooling call (see climate control section) the coils are not energized (P.FCUI.COLD does not run), and cool air is passed directly from outside into the space; in the event of a high power cooling call, the coils are energized, further cooling the natural ventilation air.
 3. In the second case, the ERV energy saving function operates as follows: anytime the FCU runs (either to condition or ventilate), if the outside/inside difference in temperature is below 15degF and the outside absolute humidity (OHI) is below 90grains/lb, the ERV will be bypassed in order to reduce the electrical consumption of the system.
 4. Any time the FCU is called to operate in ventilation mode and there is also zone call, the coils are energized (either by P.FCUI.HOT or P.FCUI.COLD) to condition the ventilation air.
- I. RADIANT SYSTEM
1. Both floor and ceiling manifolds operate from a single six-zone manifold, circulated by a P.RAD, which operates to maintain a 5F deltaT in cooling and a 10F deltaT in heating. The mixing valve (MV-1) operates to achieve a desired radiant inlet temperature (T_rad) by mixing supply and return flows - in this setup, it is the radiant pump which actually draws flow from the primary loops, at a rate dependent on the position of the mixing valve. Depending on which mode the panels are operating in - heating or cooling - the appropriate zone control valves on the supply side of the pump (ZC-3 and ZC-5 for heating and ZC-4 and ZC-6 for cooling) are opened. On the demand side of the pump, each radiant zone has zone control valves on the return manifold (ZC-7 through ZC-12) to select which zones are energized.
- J. CLIMATE CONTROL SYSTEM (GENERAL)
1. Three zone monitors (temp and humidity) are employed to monitor each of the three zones (in house modules A-C). The HVAC equipment has one zone for air heating/cooling and dehumidification, and three zones for radiant heating/cooling (each w/ floor and ceiling panels). The contest requires house 15m average temps (at any chosen location) to be within 72-76F during all measurement periods. Thus zone controls are set to maintain all zones between 73.5F and 74.5F under normal circumstances (using "low power" calls), and to increase the system power if the house falls outside 72.5F -75.5F (using "high power" calls). If any zone rises above 76.5F then an "emergency cooling" call is issued.
 2. Relative humidity is maintained below 52% (contest requires 1h average RH to be within 40-55%) by issuing a call for dehumidification if humidity in any zone rises above this.

3. CO₂/VOC sensors are also employed in all three zones, and call for demand controlled ventilation when required (in addition to the minimum fresh air rate – see Ventilation section)
- K. CLIMATE CONTROL SYSTEM (COOLING)
 1. If a zone call is “low power” with no need for dehumidification, both the floor and ceiling radiant panels are energized in that zone with inlet temperature equal to the highest dewpoint of any zone (or the cold water supply, whichever is higher).
 2. If the call is “high power”, the FCU engages in addition to the radiant surfaces.
 3. If the call is “emergency cooling” then the RHP is engaged in addition to the chiller.
 4. If there is a call for dehumidification, the FCU engages with its circulator, and the RHP is engaged to provide very cold water to the coils.
 5. If zones have conflicting calls for heating and cooling, preference is given to Zone 2 (module B), and conflicting calls are cancelled.
- L. CLIMATE CONTROL SYSTEM (HEATING)
 1. If the call is normal power, the floor radiant panels are energized with 110F inlet temperature water.
 2. If the call is high power, the FCU and its hot circulator are activated, and both the floor and ceiling surfaces run at 110F
- M. CLIMATE CONTROL SYSTEM (BLOWN AIR)
 1. The FCU is set to engage at least 6 minutes out of every hour to provide the effective minimum ventilation rate of 20 CFM. If any zone requires greater ventilation based on its CO₂ sensor, the FCU operates to keep the CO₂/VOC levels acceptable.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish.
- B. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare schematic diagrams of systems’ “as-built” duct layouts.
- B. For variable-air-volume systems, develop a plan to simulate diversity.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Verify that motor starters are equipped with properly sized thermal protection.
- E. Check for airflow blockages.
- F. Check condensate drains for proper connections and functioning.
- G. Check for proper sealing of air-handling unit components.
- H. Check for proper sealing of air duct system.

3.5 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data; number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate.
- B. Prepare schematic diagrams of systems’ “as-built” piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Set system controls so automatic valves are wide open to heat exchangers.
5. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

3.6 TOLERANCES

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

END OF SECTION 230800

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY:

- A. Provide regulations and information for constructing a digitally controlled HVAC system.
- B. This includes instrumentation, controllers, devices to supply power to the controllers, controller containment devices, and controllable valves.

PART 2 - PRODUCTS

2.1 230913 Instrumentation and Control Devices for HVAC

- A. Thermostats
 - 1. Flush Mount Thermostat with Horizontal Display
 - a. Width 4.50" Height 2.25" Depth .50"
 - b. Ambient Temperature between 14°F to 160°F for storage, operating temperature between 32°F and 105°F.
 - c. Operates between 10% and 90% relative humidity.
 - d. Screw-terminal block connections
 - e. Class II wiring standards
 - f. 3.5V DC power from DZCM directly. Do not power externally
 - g. For Radiant Heating and Cooling applications
 - h. Controls heating, cooling and ventilation control
 - i. For more information see : http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9010530_TSTAT_HorizontalFlush.aspx?sc_lang=en
 - 2. Flush Mount Thermostat Temperature Sensor
 - a. Power: 3.5VDC powered from the DZCM. Caution: Do not connect external power to thermostat.
 - b. Operating Conditions: 32°F to 105°F (0°C to 41°C)
 - c. 10% to 90% humidity (non-condensing)
 - d. Connections: Connections are push pin terminals
 - e. LCD Display: No display
 - f. For more information see: http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9010540_Wall%20Sensor.aspx?sc_lang=en

2.2 230913.23 Temperature Sensors

- A. Temperature Sensors
 - 1. Temperature Sensor General Requirements
 - a. Type: 10k J-curve
 - b. Tolerance: (+/- 0.54°F) (+/- 0.3°C)
 - c. Ambient Conditions: 32°F to 105°F (0° to 41°C)
 - d. 10% to 90% humidity (non-condensing)
 - e. Class II wiring standards
 - 2. Supply and Return Pipes Sensors
 - a. Connections: RJ45 Cat5e connections.
 - b. Physical Dimensions
 - 1) Height 1.5"
 - 2) Width 3"
 - c. For more information See http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9013001_dualSensor.aspx?sc_lang=en
 - 3. Domestic Hot Water (DHW) Tank Sensors
 - a. Connections: RJ45 Cat5e connections.
 - b. Physical Dimensions
 - 1) Height 1.5"
 - 2) Width 3"
 - c. For more information See http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9012002_DHWsensor.aspx?sc_lang=en
 - 4. Outdoor Air Sensors
 - a. Connections: RJ45 Cat5e or Screw Terminal connections.

- b. Physical dimensions:
 - 1) Lead Length 17.5"
 - 2) Length 3"
 - 3) Width 1.5"
 - c. For more information see: http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9012005_Outdoor%20Air%20Sensor%2010k.aspx?sc_lang=en
 - 5. Slab Sensors
 - 1) Screw Terminal connections.
 - 2) Physical dimensions:
 - a) Lead Length 120"
 - b) Length 1"
 - c) Diameter .37"
 - 3) For more information see: http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9010599_tstatSslab.aspx?sc_lang=en

2.3 Direct-Digital Control for HVAC

- A. System Controllers
 - 1. System Controller General Requirements
 - a. Power Input 24V AC
 - b. Storage Temperature: 14°F to 160° F (-10°C to 70°C)
 - c. Operating Conditions:
 - 1) Temperature: 32°F to 105°F (0°C to 41°C)
 - 2) Humidity 10% to 90% (non-condensing)
 - 3)
 - 2. Router Main Control (RTR)
 - a. Communication: 1 Ethernet port for connection to the Internet and/or the Uponor Configuration Tool (UCT) and/or the Touch Panel Interface (TPI)
 - b. 5 Cat5e subnet ports for the Digital Zone Control Modules (DZCMs)
 - c. 1 Molex plug for power and subnet for interconnect cable
 - d. Control Application: Provides communication link from all controllers. Sends all functional commands to field modules.
 - e. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9011000_RTR.aspx?sc_lang=en
 - 3. Primary Equipment Control (PEC)
 - a. Physical Dimensions
 - 1) Length 8"
 - 2) Width 7"
 - 3) Depth 1.5"
 - b. 5 configurable outputs for boiler/GSHP control
 - 1) 1 chiller output
 - 2) 1 heat/cool output
 - 3) 1 primary pump output
 - 4) 1 domestic pump output
 - 5) 1 recirculation pump output
 - c. Output Ratings: 0 – 10VDC, 2mA maximum
 - d. Inputs:
 - 1) Outdoor air temperature
 - 2) Primary supply and return temperature
 - 3) 1 domestic tank sensor
 - 4) 1 recirculation sensor
 - 5) 1 pressure sensor
 - 6) 2 buffer tank hot/cool sensor
 - e. Input Type: 10k NTC resistive
 - f. Connection: Interconnect cable
 - g. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9012000_PEC.aspx?sc_lang=en
 - 4. Supply Water Temperature (SWT) Control
 - a. Physical Dimensions
 - 1) Length 8"
 - 2) Width 7"
 - 3) Depth 1.5"
 - b. Input Rating: 10k, NTC resistive
 - c. Output Rating: 0 to 10 VDC, 20 mA maximum supply current
 - d. Outputs with LEDs:
 - 1) 5 Mix Water Channel configurable outputs
 - 2) 5 Secondary Pump Outputs
 - e. Inputs:
 - 1) 5 Supply and Return sensors per channel
 - 2) 4 Snow-melt zones
 - 3) Slab Sensor
 - 4) Snow and Ice Sensor Detector

- f. Manual-override switch
 - g. Communication: connection through the interconnect cable
 - h. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9013000_SWT.aspx?sc_lang=en
- 5. Digital Zone Control Module (DZCM)
 - a. Physical Dimensions
 - 1) Length 8"
 - 2) Width 4.5"
 - 3) Depth 1.5"
 - b. Output: 3.5VDC to power Climate Cōntrol™ Network System Manifold Valve Actuators (A9010501)
 - c. Inputs: 10 Uponor Network thermostats
 - d. Communication: Via a Cat5e patch cable with RJ45 connectors
 - e. Power Draw: 50 VA maximum for each DZCM
 - f. Fuse: 4 Amps, 125V, GMA
 - g. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9011500_DZCM.aspx?sc_lang=en
- 6. Furnace and Air Conditioning (FAC) Control
 - a. Physical Dimensions
 - 1) Length 8"
 - 2) Width 4.5"
 - 3) Depth 1.5"
 - b. Outputs with LED indications: 5 On/Off outputs configurable for dry or wet contacts.
 - c. Inputs: Two 10k thermistor sensors
 - d. Communication: Connection provided through a Cat5e patch cable with RJ45 connectors
 - e. Power Draw: 5 VA maximum per FAC control unit
 - f. Output: 24VAC, 10 VA wet or 24 VA dry connected to air handler equipment, relay coils or other approved hardware
 - g. Fuse: 4 Amps, 125V, GMA
 - h. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9011100_FAC.aspx?sc_lang=en
- 7. Heat-recovery Ventilator (HRV) Control
 - a. Physical Dimensions
 - 1) Length 8"
 - 2) Width 4.5"
 - 3) Depth 1.5"
 - b. Input Power: provided by dedicated transformer or through the Cat5e cable
 - c. Outputs with LED indications: 3 On/Off outputs
 - d. Inputs: 2 Configurable input points
 - e. Communication: Via a Cat5e patch cable with RJ45 connectors.
 - f. Power Draw: 4 VA maximum for each HRV control unit without attached VOC/CO2 sensor
 - g. Output: 24VAC, 24 VA
 - h. Fuse: 4 Amps, 125V, GMA
 - i. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9011200_HRV.aspx?sc_lang=en
- 8. Zone Valve and Damper (ZVD) Control
 - a. Physical Dimensions
 - 1) Length 8"
 - 2) Width 4.5"
 - 3) Depth 1.5"
 - b. Outputs with LED indications: 8 On/Off (opened or closed) outputs
 - c. Inputs: 8 Configurable inputs
 - d. Connection: Communication connection made through a Cat5e patch cable with RJ45 connectors
 - e. Power Draw: 5 VA maximum per ZVD control unit
 - f. Output: 24VAC 10 VA wet or 24 VA dry to be connected to air handler equipment, relay coils or other approved hardware
 - g. Fuse: 4 Amps, 125V, GMA
 - h. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9011400_ZoneValveD.aspx?sc_lang=en
- 9. Generic Input and Output (GIO) Control
 - a. Physical Dimensions
 - 1) Length 8"
 - 2) Width 4.5"
 - 3) Depth 1.5"
 - b. Outputs with LED indications: 8 On/Off configurable outputs
 - c. Inputs: Configurable inputs (8)
 - d. Communication: Via a Cat5e patch cable with RJ45 connectors
 - e. Power Draw: 7 VA maximum for each unit with dry contact outputs; 89 VA maximum for each unit with wet-contact outputs
 - f. Output: 24VAC, 10 VA wet or 24 VA dry
 - g. Fuse: 4 Amps, 125V, GMA
 - h. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9011600_GIO.aspx?sc_lang=en
- 10. Boiler Relay
 - a. Physical Dimensions
 - 1) Length 1.5"
 - 2) Width 3"
 - 3) Depth 2.5"

- b. Power: 10VDC at 10mA
 - c. Control: Modulating control
 - d. Enclosure: Mounts on a standard Ø" electrical knockout.
 - e. Connections: RJ45 connectors
 - f. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9012020_BoilerMod.aspx?sc_lang=en
 - 11. Pump Relay,
 - a. Physical Dimensions
 - 1) Length 1.5"
 - 2) Width 3"
 - 3) Depth 2.5"
 - b. Power: 10VDC at 10mA
 - c. Pump Relay 3 amp at 120VAC
 - d. Enclosure: Mounts on a standard Ø" electrical knockout
 - e. Connections: 2 RJ45 connectors
 - f. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9013030_Pump%20Relay.aspx?sc_lang=en
- B. Controllable Valves 230913.33
- 1. Two and Three Way Actuated Ball Valves
 - a. Valve Specifications
 - 1) Service chilled or hot water, 50% glycol
 - 2) Flow characteristic: Two-way on/off, Three-way on/off, diverting
 - 3) Sizes 1/2", 3/4" and 1"
 - 4) Type of end fitting female, NPT
 - 5) Materials:
 - a) Body forged brass
 - b) Stem stainless steel
 - c) Seals EPDM
 - 6) Pressure rating 300 psi
 - 7) Media temp. range 32°F to 212°F [0°C to 100°C]
 - 8) Close off pressure 20 – 75 psi
 - 9) Leakage Class III 0.1%
 - 10) Cv rating 1.0 – 8.
 - 11) For more information see http://www.belimo.us/bellib/Zone_Valves/ZoneValves.pdf
 - b. Actuator Specifications
 - 1) Control On/off
 - 2) Nominal voltage 24 VAC 50/60 Hz 3 10% or 120 VAC 50/60 Hz 3 10%
 - 3) Power Consumption 6.5 W
 - 4) Transformer Sizing 7VA (Class 2 power source)
 - 5) Electrical Connection Wire lead length, 120V 6" 24V 18"
 - 6) Position Indication Integrated into lever (NC only)
 - 7) Running Time Motor: 20-40 seconds Spring: 5 seconds
 - 8) Humidity 5 to 95% non-condensing
 - 9) Ambient Temperature 32°F to 104°F (0°C to + 40°C)
 - 10) Storage Temperature -40°F to 176°F (-40°C to +80°C)
 - 11) Housing Rating UL94-5V(B)
 - 12) Agency Listing CE, cULus
 - 13) Noise Level max. 35 db (A)
 - 14) Quality Standard ISO 9001
 - 15) Built-in Auxiliary Switch 1 x SPST, 5A resistive (5A inductive) @ 24 VAC 1 x SPST, 5A
 - 2. Three-way Modulating Valve with Control
 - a. Leakage:
 - 1) 0% for valve control path (ports A to B)
 - 2) < 2.0% for valve control path (ports B to AB) of full-rated Cv (valve with no disc)
 - b. Flow Characteristics: "A" port equals percent; "B" port is modified for constant common flow
 - c. Media Temperature: 0°F to 212°F (-18°C to 100°C)
 - d. End Fittings: National Pipe Thread (NPT)
 - e. Maximum Differential Pressure: 20 psi (typical applications)
 - f. Service: Chilled or hot water; glycol up to 60%
 - g. Actuator Power: 24VAC (+/- 20%); 24VDC (+/- 10%); Class 2 power-rated at 3VA
 - h. Power Consumption: 1.5W (holding 0.4W)
 - i. Control: 2 to 10VDC
 - j. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A901302x_3Way_ModValve.aspx?sc_lang=en
 - 3. 2 Wire Thermal Actuators for Valve Manifolds
 - a. Physical Dimensions
 - 1) Length 2.51"
 - 2) Width 1.58"
 - 3) Depth 1.58"
 - b. Operating Voltage: 24 VAC nominal
 - c. Operating Range: 22 V to 28 V
 - d. Maximum Close-off Pressure: 17 psi
 - e. Time to Open/Close: 3 to 5 minutes

- f. Operating Current: 0.23 A (230mA)
 - g. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Brass%20Manifolds/A3030523_Two%20wire%20Thermal%20Actuator_TrueFLOW_04%2024%2009.aspx?sc_lang=en
- C. Controllable Actuators 230913.43
 - 1. Direct Coupled Actuators
 - a. Power Supply 24 VAC 3 20% 50/60 Hz or 24 VDC 3 10%
 - b. Power Consumption 1.5 W (0.4 W)
 - c. Transformer Sizing 3 VA (Class 2 power source)
 - d. Electrical Connection 3 ft, 18 GA plenum rated cable 1/2" conduit connector
 - e. Overload Protection electronic throughout 0 to 95° rotation
 - f. Operating Range Y 2 to 10 VDC, 4 to 20 mA
 - g. Input Impedance 100 k ff (0.1 mA), 500 ff
 - h. Feedback Output U 2 to 10 VDC (max 0.5 mA)
 - i. Angle of Rotation max. 95°, adjust. with mechanical stop
 - j. Torque 45 in-lb
 - k. Direction of Rotation reversible with switch
 - l. Actuator will move:
 - 1) =CCW with decreasing control signal (10 to 2V)
 - 2) =CW with decreasing control signal (10 to 2V)
 - m. Manual Override external push button
 - n. Running Time 95 seconds, constant independent of load
 - o. Humidity 5 to 95% RH non condensing (EN 60730-1)
 - p. Ambient Temperature -22°F to 122°F [-30°C to 50°C]
 - q. Storage Temperature -40°F to 176°F [-40°C to 80°C]
 - r. Housing NEMA 2, IP54, UL enclosure type 2
 - s. Agency Listings
 - 1) cULus acc. to UL 60730-1A/-2-14,
 - 2) CAN/CSA E60730-1:02,
 - 3) CE acc. to 2004/108/EEC and 2006/95/EC
 - t. Weight 1.7 lbs [0.5 Kg]
 - u.
- D. Power Conditioners
 - 1. Transformers
 - a. Physical Dimensions
 - 1) Length 4"
 - 2) Width 4"
 - 3) Depth 1.88"
 - b. Primary: White - Black, 120 V, 60 Hz, 0.55 A
 - c. Secondary: 24VAC, 50 VA
 - d. For more information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/217%20Transformer.aspx?sc_lang=en
- E. Controller Storage Cabinets
 - 1. Climate CÐntrol™ Network System Control Cabinet
 - a. Physical Dimensions
 - 1) Length 36.8"
 - 2) Width 14.5"
 - 3) Depth 2"
 - b. Material: 18 GA (.048) Steel.
 - c. Finish: Powder-coated white inside and outside
 - d. Outside Door: Hinged
 - e. Inside Door: Hinged, with screw lock
 - f. For More information see http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Controls/A9010000_03_CCN%20Control%20Cabinet.aspx?sc_lang=en

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All installations are to comply with manufacturer directions.
- B. Install control wiring concealed, except in mechanical rooms, and according to requirements specified in Division 26 Sections.

END OF SECTION 230900

SECTION 232123 - HYDRONIC PUMPS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data. Include certified pump-performance curves, furnished specialties, motor horsepower and electrical characteristics.
- B. Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS**2.1 HYDRONIC PUMPS**

- A. Close-Coupled, In-Line Centrifugal Pumps: Factory-assembled and -tested, overhung impeller, designed for installation with pump and motor shafts mounted horizontally or vertically. Rated for 860-kPa minimum working pressure and minimum continuous water temperature of 107 deg C.
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded connections.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
- B. Available Products:
 - 1. Grundfos ALPHA
 - 2. Permanent Magnet in Line Centrifugal Pump. Operating range of 0 – 21 GPM flow rate, head of 0 – 19 feet, max working pressure at 150 psi and temperature range from 36 – 230 deg F. Power supplied by a 115V motor. Operates at .65A and between 5 – 45 W power consumption.
 - 3. Product data and information can be found at manufacturer's website: [http://www.us.grundfos.com/Web/Download.nsf/Pages/E2FE899F7214E6CE88257574005B41C2/\\$File/L-AL-TL-001.pdf](http://www.us.grundfos.com/Web/Download.nsf/Pages/E2FE899F7214E6CE88257574005B41C2/$File/L-AL-TL-001.pdf)

2.2 MOTORS

- A. NEMA MG 1, "Standard for Motors and Generators." Include NEMA listing and labeling.
- B. Less than 373 W: Built-in thermal-overload protection.
- C. 373 to 2238 W: Permanently lubricated ball bearings.
- D. 3.73 kW and Larger: Grease-lubricated ball bearings.
- E. Motor shall be non-overloading within full range of pump performance.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install pumps with access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- B. Support pumps and piping so weight of piping is not supported by pump volute.
- C. Install electrical connections for power, controls, and devices.

- D. Suspend in-line pumps independent from piping. Use continuous-thread hanger rods and vibration isolation hangers. Fabricate brackets or supports as required for pumps.
- E. Install vertical in-line pumps on concrete bases.
- F. Connect piping with valves that are at least the same size as piping connecting to pumps.
- G. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- H. Install shutoff valve and strainer on suction side of pumps.
- I. Install nonslam check valve and throttling valve on discharge side of pumps.

END OF SECTION 232123

SECTION 233113 – PRE-INSULATED FABRIC DUCT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with UL 181 for ducts and closures.

PART 2 - PRODUCT

2.1 FLEXIBLE AIR DUCTS

- A. CPE Core which is mechanically locked together by a corrosive resistant galvanized steel helix.
- B. Wrapped with thick fiberglass insulation and covered by a scrim foil mylar sleeve.
- C. Contains vapor barrier.
- D. Acoustically insulated
- E. Available R-values: R-4.0, R-6.0, R-8.0. Use R-8.0 for all applications unless space constraints forbid doing so.
- F. Fittings. Use appropriate fittings to connect flexible ducts to equipment and registers. See custom metal ductwork section in this document.

2.2 MANUFACTURERS

- A. Flexmaster
 1. Similar products from NovaFlex, Getech Co., etc.
 2. Link to manufacturer's specs: <http://www.flexmasterusa.com/LinkClick.aspx?fileticket=nRpsUgTqOpo%3d&tabid=67>

2.3 CUSTOM SHEET METAL DUCTWORK

- A. Ductwork for Mechanical Room Air Distribution Equipment, as well as distribution and adaptor boxes for registers is to be determined in field by a professional Mechanical Engineering firm. Ductwork shall consist nominally of 10" and 8" circular ducting, insulated in field to at least R-8.0 for exposed ductwork and R-6.0 for non-exposed ducting.
- B. Fittings and all associated materials and construction to be determined in field by installer. Care should be taken to ensure constructing ducting runs of the minimal static pressure, with minimum loss, and maximum insulation.
- C. Consult design Engineer for all questions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Outdoor, Supply-Air Ducts: Seal Class A.
 2. Outdoor, Exhaust Ducts: Seal Class C.
 3. Outdoor, Return-Air Ducts: Seal Class C.
 4. Unconditioned Space, Supply-Air Ducts in Pressure Classes 500 Pa and Lower: Seal Class B.
 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 500 Pa: Seal Class A.
 6. Unconditioned Space, Exhaust Ducts: Seal Class C.
 7. Unconditioned Space, Return-Air Ducts: Seal Class B.
 8. Conditioned Space, Supply-Air Ducts in Pressure Classes 500 Pa and Lower: Seal Class C.
 9. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 500 Pa: Seal Class B.
 10. Conditioned Space, Exhaust Ducts: Seal Class B.
 11. Conditioned Space, Return-Air Ducts: Seal Class C.
- C. Conceal ducts from view in finished and occupied spaces.
- D. Avoid passing through electrical equipment spaces and enclosures.
- E. Support ducts to comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Hangers and Supports."
- F. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- G. Install fusible links in fire dampers.
- H. Clean new duct system(s) before testing, adjusting, and balancing.

3.2 TESTING, ADJUSTING, AND BALANCING

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

END OF SECTION 233113

SECTION 233313 - DAMPERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with UL 181 for ducts and closures.

1.2 MANUFACTURERS

- A. Titus

PART 2 - PRODUCT

2.1 Retrofit VAV Terminals

- A. Digitally controlled VAV to shut off flow in round duct runs.
- B. Actuator: Belimo LMB24-SR, see 23.09.13.43 (in 23.09.00)
- C. Model: DECV-8"
- D. Link to manufacturer's specs:
<http://www.flexmasterusa.com/LinkClick.aspx?fileticket=nRpsUgTqOpo%3d&tabid=67>

2.2 Fittings. Use appropriate fittings to connect flexible ducts to equipment and registers. See custom metal ductwork section in this document.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Outdoor, Supply-Air Ducts: Seal Class A.
 - 2. Outdoor, Exhaust Ducts: Seal Class C.
 - 3. Outdoor, Return-Air Ducts: Seal Class C.
 - 4. Unconditioned Space, Supply-Air Ducts in Pressure Classes 500 Pa and Lower: Seal Class B.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 500 Pa: Seal Class A.
 - 6. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 7. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 8. Conditioned Space, Supply-Air Ducts in Pressure Classes 500 Pa and Lower: Seal Class C.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 500 Pa: Seal Class B.
 - 10. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 11. Conditioned Space, Return-Air Ducts: Seal Class C.
- C. Conceal ducts from view in finished and occupied spaces.
- D. Avoid passing through electrical equipment spaces and enclosures.

- E. Support ducts to comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Hangers and Supports."
- F. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- G. Install fusible links in fire dampers.
- H. Clean new duct system(s) before testing, adjusting, and balancing.

3.2 TESTING, ADJUSTING, AND BALANCING

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

END OF SECTION 233313

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

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

PART 2 - PRODUCTS**2.1 OUTLETS AND INLETS**

- A. Diffusers:
1. Titus Products:
 - a. Titus CT-480
 2. Material: Aluminum
 3. Finish: #26 White. Baked anodic acrylic paint. Must pass ASTM Corrosive Environments Salt Spray Test, 250-hour ASTM D870 Water Immersion Test, and ASTM D2784 Reverse Impact Cracking Test w/ a 50-inch pound force applied.
 4. Mounting: Heavy duty mounting frames with removable core for access. Core supports located no more than 6 inches apart.
 5. Link to manufacturer's specs:
 - a. <http://www.titus-hvac.com/ecatalog/getfile2.aspx?fileid=810>
- B. Wall Grilles:
1. Titus Products:
 - a. Titus- Aeroblade Grille 56FL
 2. Material: Aluminum.
 3. Finish: #26 White. Baked anodic acrylic paint. Must pass ASTM Corrosive Environments Salt Spray Test, 250-hour ASTM D870 Water Immersion Test, and ASTM D2784 Reverse Impact Cracking Test w/ a 50-inch pound force applied.
 4. Mounting: Screw holes shall be countersunk for a neat appearance.
 5. Link to manufacturers specs:
 - a. [Http://www.titus-hvac.com/ecatalog/getfile2.aspx?fileid=976](http://www.titus-hvac.com/ecatalog/getfile2.aspx?fileid=976)
- C. Gravity Vents:
1. Greenheck Products:
 - a. GRSR-10
 2. Material: Aluminum.
 3. Airflow 250-700CFM
 4. Link to manufacturers specs:
 - a. <http://www.greenheck.com/media/pdf/catalogs/GRSAugust2008.pdf>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install diffusers, registers, and grilles level and plumb.

- B. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 235613 - HEATING SOLAR FLAT-PLATE COLLECTORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. All collector data and specifications per ASHRAE standard testing conditions.

PART 2 - PRODUCTS

2.1 HEATING SOLAR FLAT-PLATE COLLECTORS

- A. Description: Manufacturer fabricated and tested Flat-Plate type solar thermal collectors.
 - 1. Basis-of-Design Product: SchucoSol DG collectors manufactured by Schuco or comparable product by one of the following:
 - a. Heliodyne, Inc.
- B. Characteristics and Capacities:
 - 1. Heat Transfer Medium: Water or Water/Glycol.
 - 2. Maximum Pressure and Temperature Rating: 120degC and 1000 kPa
 - 3. Flow Rate: 2.5 L/min to 5 L/min
 - 4. Maximum Pressure Drop: 350 kPa
 - 5. Maximum Efficiency (ASHRAE): 0.790
 - 6. Heat loss coefficient (ASHRAE): 3.90 W/m²K
 - 7. Water Capacity: 2.0 L
- C. Manufacturer Data Link
 - 1. <http://www.scu-cca-solar.org/submittals/SchucoDG.pdf>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Collectors are Roof-Mounted.
- B. Use only Schuco Rails and Mounting Hardware, or equivalent approved substitute.
- C. Pressure/Temperature Relief Valves must be installed and drained properly.
- D. Use "equal length" method of plumbing parallel collector strings

END OF SECTION 235613

SECTION 236413 - INDIRECT-FIRED ABSORPTION WATER CHILLER

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Indirect-Fired Absorption Water Chiller. Sonnenklima Suninverse 10kW

2.2 INDIRECT-FIRED ABSORPTION CHILLER

- A. Description: Factory-assembled and run-tested water chiller complete with controls
- B. Refrigeration:
 - 1. Refrigerant: Water.
 - 2. Refrigerant Circuit: Closed cycle refrigeration with Water as refrigerant, Lithium Bromide as desiccant salt. Evaporator coil chills water, absorber and condenser coils reject heat, and generator uses heat input to separate refrigerant and desiccant and close the thermal cycle.
- C. Controls: Manufacturer's standard microprocessor-based chiller controls; unit mounted, and factory wired with a single-point power connection and mounted control circuit. Controls include modulation of the wet-cooling-tower fan speed per manufacturer control algorithm.
- D. Water Chiller Characteristics and Capacities:
 - 1. Capacity: 10 kW
 - 2. Full-Load Efficiency:
 - a. COP: based on circuit temperatures and cooling tower operation. At full capacity 0.78 COP.
 - 3. Design Evaporator Fluid Flow Rate: 1.3 m³/hr.
 - 4. Minimum Evaporator Fluid Flow Rate: 1.3 m³/hr.
 - 5. Evaporator Entering-Fluid Temperature: 12° C
 - 6. Evaporator Leaving-Fluid Temperature: 6° C
 - 7. Evaporator Fluid Pressure Drop: 350 mbar.
 - 8. Condenser Entering-Water Temperature: 27-35° C
 - 9. Chiller Power Input: 10kW.
 - 10. Chiller Electrical Characteristics: 230 V 1 ph, 50 hz
- E. Product Data Sheet
 - 1. <http://www.scu-cca-solar.org/submittals/SunInverseCHILLERandCOOLINGTOWER.pdf>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow manufacturer's installation instructions

END OF SECTION 236413

SECTION 236513 - OPEN-CIRCUIT FORCED DRAFT COOLING TOWER**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Open-circuit Forced Draft Cooling Tower. Sonnenklima wct23kW

2.2 OPEN CIRCUIT FORCED DRAFT COOLING TOWER

- A. Description: Factory-assembled and run-tested cooling tower
- B. Fluid:
 - 1. Refrigerant: Water.
- C. Controls: Manufacturer's standard microprocessor-based chiller controls; unit mounted, and factory wired with a single-point power connection and mounted control circuit. Controls are handled by Absorption Chiller, Sonnenklima SunInverse10kW, see specification 236413.
- D. Characteristics and Capacities:
 - 1. Capacity: 23 kW
 - 2. Flow Rate: 2.6 m³/hr.
 - 3. Design temperatures: 35C in, 27C out at 30C outdoor temperature.
 - 4. Nozzle Pressure Drop: 0.43 bar
 - 5. Sump volume: 70L
 - 6. Power consumption: 370W
 - 7. Physical Dimensions: 1.85m x 1.0m x 0.61m, 150kg
- E. Product Data Sheet
 - 1. <http://www.scu-cca-solar.org/submittals/SunInverseCHILLERandCOOLINGTOWER.pdf>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Follow manufacturer's installation instructions

END OF SECTION 236513

SECTION 237113 – PRESSURIZED WATER THERMAL STORAGE TANKS**1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data

PART 2 - PRODUCTS**2.1 CUSTOM THERMAL STORAGE TANK**

- A. Tank is to be an ASME Grade Pressure Vessel custom fabricated as specified in shop drawings by Design Engineer. General specifications follow.
- B. Manufacturer: Niles Steel Tank
- C. Specifications:
 - 1. Diameter: 36"
 - 2. Size: 360gal
 - 3. Material: Plain Steel
 - 4. Liner: None
 - 5. Ports: 2" NPT fittings for inlets and outlets, 8" NPT fittings for thermal immersion probes, and 4" NPT fill fitting located at the center top of the tank. Locations specified on shop drawings.
 - 6. Insulation: Blown, multi-coat, closed-cell insulation to R-20.0 minimum.
 - 7. Jacket: none
- D. Link to manufacturer data sheet: <http://www.nilesst.com/PDFSpecs/nst002.pdf>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install per manufacturer specifications.

END OF SECTION 237113

SECTION 237116 – CHILLED WATER THERMAL STORAGE**1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data

PART 2 - PRODUCTS**2.1 CHILLED WATER THERMAL STORAGE TANK**

- A. Tank is to be an ASME Grade Pressure Vessel
- B. Manufacturer: Niles Steel Tank
- C. Specifications:
 - 1. Diameter: 24"
 - 2. Size: 130gal
 - 3. Configuration: Horizontal
 - 4. Material: Plain Steel
 - 5. Liner: None
 - 6. Ports: 2" NPT fittings for inlets and outlets, sparge tube fitted on inlet.
 - 7. Jacket: none
- D. Link to manufacturer data sheet: <http://www.nilesst.com/PDFSpecs/nst002.pdf>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install per manufacturer specifications.

END OF SECTION 223529

SECTION 237223 - FAN COIL UNITS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data

1.2 QUALITY ASSURANCE

- A. The energy recovery ventilator shall be certified by the Home Ventilating Institute (HVI) under CSA 439. Both a heating and an air conditioning test must be run to demonstrate year round energy recovery.
- B. Unit shall be listed under UL 1812, Standard for Ducted Air to Air Heat Exchangers.
- C. The energy recovery core shall meet NFPA 90A and 90B requirements for flame spread, not to exceed 25, and smoke generation, not to exceed 50, through an on going testing and verification program using UL Standard 723.
- D. The RenewAire core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten years from the date of purchase. Balance of Unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two years from the date of purchase.

PART 2 - PRODUCTS**2.1 FACTORY-ASSEMBLED UNITS**

- A. Basis-of-Design Product: RenewAire EV200 Energy Recovery Ventilator
- B. Basic Unit Controls:
1. Control voltage transformer.
- C. Capacities and Characteristics:
1. Fan:
 - a. Airflow: 100-200CFM
 - b. External Static Pressure: 0.1inwg
 - c. Motor Horsepower: 1/5th
 2. Electrical Characteristics:
 - a. Volts: 120
 - b. Phase: Single
 - c. Hertz: 60
 - d. Full-Load Amperes: 1.5
- D. Heat Exchange Core
1. Type: Total Enthalpy (sensible and latent load)
 2. Exchange surface: Cross-plate enthalpy core
- E. Manufacturer Data Sheets
1. http://www.renewaire.com/_assets/files/installation/EV70_130_200_300Man_MAR08.pdf

PART 3 - EXECUTION**3.1 CONSTRUCTION**

- A. The energy recovery core shall be of static plate, cross-flow construction, with no moving parts.
- B. No condensate pan or drain shall be required.
- C. The unit shall be supplied with an internal 24 VAC transformer and relay.
- D. The unit shall have line cord for easy plug-in operation.
- E. A latched and hinged door shall provide access to blowers, energy recovery core, and filters.
- F. Cabinet walls and doors shall be insulated with 1" FSK high-density board insulation, with additional ½" foam insulation on access door for thermal and sound insulation.
- G. The energy exchange element and blowers shall be protected by a polyester filter in both exhaust air and fresh air streams.

3.2 INSTALLATION

- A. Per Manufacturer's Instructions

END OF SECTION 237223

SECTION 238143 - AIR-SOURCE HEAT PUMPS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with ASHRAE 15 and ASHRAE 90.1.
- D. Comply with safety requirements in UL 484 and UL 1995.
- E. Warranty: Submit a written warranty signed by manufacturer agreeing to repair or replace refrigeration components that fail within five years after Substantial Completion.

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. Factory-assembled and -tested, packaged air-source heat pumps complete with controls.
- B. Water Circuit: Refrigerant-to-water heat exchanger leak tested to 3102 kPa on refrigerant side and 2758 kPa on waterside. Factory mount heat exchanger on resilient rubber vibration isolators.
- C. Refrigerant Circuit Components: Sealed refrigerant circuit rated per ARI-ISO-13256. Service fittings on suction and liquid for charging and testing. Pilot-operated, sliding-type reversing valve with replaceable magnetic coil. ASTM B 743 copper refrigerant piping with wrought-copper fittings and brazed joints. Minimum 10-mm- thick, flexible elastomeric insulation on piping exposed to airflow through unit.
 - 1. Filter-Dryer: Factory installed to clean and dehydrate refrigerant circuit.
 - 2. Compressor: Installed on vibration isolators in an acoustically treated enclosure with anti-recycle timer; high- and low-pressure cutout, or loss of charge switch; and internal thermal-overload protection.
 - a. Freezestat stops compressor if water-loop temperature falls below 1.6 deg C.
 - b. Condensate overflow switch stops compressor with high condensate level in pan.
- D. Basic Unit Controls: Low- and high-voltage protection. Overcurrent protection for compressor and fan motor. Random time delay, three to ten seconds, starts on power-up. Control voltage transformer.
- E. Electrical Connection: Single electrical connection 120VAC

2.2 AIR-SOURCE HEAT PUMPS, 17.6 kW AND SMALLER

- A. Products:
 - 1. Multiaqua MAC-036 Reverse Cycle Chiller
- B. Water Circuit: Stainless-steel, brazed plate, refrigerant-to-water heat exchanger.
 - 1. Heat exchanger is integral to Reverse Cycle Chiller; no refrigerant is external to unit.
- C. Refrigerant Circuit: Charge with R-407c refrigerant. Hermetic scroll compressor. Thermal Expansion Valve refrigerant metering device.
- D. Capacities and Characteristics:
 - 1. Heating Capacity: 3 tons (36,000 BTU/hr)
 - 2. Cooling Capacity: 3 tons (36,000 BTU/hr)

3. Efficiency: 10.55 EER
 4. Power input: 3.3 kW
 5. Refrigerant: R-407c
 6. Water Flow Rate: 5.5-8.6 GPM
 7. Connections: 1.25in NPT copper
 8. Max Pressure: 50ftwg
- E. Manufacturer Data Sheet Link
1. http://www.multiaqua.com/pdf09/Multiaqua09_MAC_036,048,060.pdf

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install per manufacturer specifications
- B. Heat Pump installed and strapped to Mechanical Equipment Skid.
- C. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap.

END OF SECTION 238143

SECTION 238219 - FAN COIL UNITS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, including color charts for cabinet finishes.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED UNITS

- A. Basis-of-Design Product: Rittling FCHP with 04 size fan motor, 4-row cooling coil and 1-row heating coil
- B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- C. Main and Auxiliary Drain Pans: formed to slope from all directions to the drain connection as required by ASHRAE 62.
- D. Chassis: Galvanized steel where exposed to moisture.
- E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 2.5 mm, rated for a minimum working pressure of 1378 kPa and a maximum entering-water temperature of 104 deg C. Include manual air vent and drain valve.
- F. Basic Unit Controls:
 - 1. Control voltage transformer.
- G. Capacities and Characteristics:
 - 1. Fan:
 - a. Airflow: 200-300CFM
 - b. External Static Pressure: 0.1inwg
 - c. Motor Horsepower: 1/8th
 - 2. Cooling Capacity:
 - a. Total: 22,000 BTU/hr
 - b. Sensible: 11,000 BTU/hr
 - c. Entering-Air Dry-Bulb Temperature: 82 degF
 - d. Entering-Air Wet-Bulb Temperature: 72 degF
 - 3. Chilled-Water Coil:
 - a. Water Flow: 4 GPM
 - b. Water-Side Pressure Loss: 4ftwg
 - c. Entering-Water Temperature: 44degF
 - 4. Heating Capacity:
 - a. Output: 22,000 BTU/hr
 - b. Entering-Air Temperature: 60F
 - c. Air-Temperature Rise: 50F
 - 5. Hot-Water Heating Coil:

- a. Water Flow: 3 GPM
 - b. H Water-Side Pressure Loss: 0.2ftwg
 - c. Entering-Water Temperature: 120F
- 6. Electrical Characteristics:
 - a. Volts: 120
 - b. Phase: Sinle
 - c. Hertz: 60.
 - d. Full-Load Amperes: 0.85
- H. Manufacturer Data Sheets
 - 1. <http://www.rittling.com/literature/catalogs/FC%20Catalog%200908%20no%20CSA.pdf>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb and firmly anchored.
- B. Connect to supply and return piping with shutoff valve and union at each connection.
- C. Connect units to wiring systems and to ground.

END OF SECTION 238219

SECTION 238316 - RADIANT-HEATING HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

- A. PEX-AL-PEX: ASTM F 876. For service at 690 kPa and 82 deg C.
1. Fittings: Uponor ProPEX fittings. See 22 11.16.
- B. Aluminum: Plating between 2 pieces of PEX Plastic tubing.
- C. Dimensions: 1/2" ID.
- D. Product: Uponor Multi-layer Composite Tubing. Uponor, Inc. See Standard ASTM F1281.
1. Product Link: http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Tubing/D1140750%20D1251000_MLC%20%20PEX%20AL%20PEX%20%20Tubing_12%2002%202008.aspx?sc_lang=en

2.2 RADIANT HEATING SPECIALTIES

1. Floor and Ceiling Mounting Tracks: Warmboard Radiant Panels. See 06 16 23 for structural specifications.
- a. Type: 1-1/8" structural plywood subfloor with 5/8" tracks for radiant tubing. Aluminum sheet is bonded to surface for radial thermal conductivity.
- b. Link to manufacturer specs: http://www.warmboard.com/wp-content/uploads/2007/03/installguide_050109.pdf
2. Distribution Manifolds:
- a. Uponor TruFLOW Jr. 6-position Manifold with Balancing Valves and Isolation Valves
- 1) Material: UNS C3850 Brass
- 2) Manifold Size: 1.25" ID
- 3) Cv (with valve wide open): 1.9
- 4) Working Pressure: 150psi
- 5) Flow rate: 15gpm (max)
- 6) Link to data sheet
- a) http://www.uponor-usa.com/-/media/Files/Technical%20Documents/Specifications%20and%20Submittals/Radiant%20Heating/Brass%20Manifolds136%20TruFLOW%20Jr%20%20Assembly%20with%20Isolation%20and%20Balancing%20Valves%20One.w.aspx?sc_lang=en
- b. Actuators
- 1) Uponor Thermal Actuator for TruFLOW Manifold. See 23 09.13.33.

2.3 CONTROLS

- A. See Uponor Network Controls 23 09 13.23.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install piping downstream from manifolds without joints.

- B. Secure piping at center of turns or bends.
- C. Install Warmboard plates as wood subfloor with space between each plate for plate expansion.
- D. Install manifolds in accessible locations.
- E. Fill system with 0 – 20 percent of ethylene glycol-to-water solution.

END OF SECTION 238316

SECTION 251419 - INTEGRATED AUTOMATION TERMINAL CONTROL UNITS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes endpoint device control units.
- B. Related Sections include the following:
 - 1. Division 26 Section "Network Lighting Controls" for C-Bus network information.

1.2 DEFINITIONS

- A. Logic: Pascal based programming language.

1.3 SUBMITTALS

- A. Product Data: For endpoint control modules.
- B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this project.
 - 1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 2. Block Diagram: Show interconnections between components specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with 47 CFR, Subparts A and B, for Class A digital devices
- C. Comply with NFPA 70.

1.5 COORDINATION

- 1. Coordinate endpoint control devices that communicate with C-Bus or Ethernet networks.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Available Manufactures: Subject to compliance with requirements, manufactures offering products that may be incorporated into the Work include, but are not limited to the following:
- B. Manufactures: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D; Schneider Electric
 - 2. Global Chache

2.2 PRODUCTS

- A. Pascal Automation Controller http://www.squaredlightingcontrol.com/viewitem.cfm/p_id/80/cat_id/85/subcat_id/62/pt_id/2
 - 1. System Requirements: Endpoint control unit shall connect to the C-Bus network to send and receive commands from other C-Bus connected devices. Unit shall connect to one or two devices via RS-232 to send and receive control signals. Unit shall be programmed in Logic to translate C-Bus commands and information to the controlled devices understood format and forward this information over the RS-232 connection to the devices.

- Unit shall be programmed in Logic to translate information from connected devices and translate information to comply with the C-Bus protocol. Until shall send C-Bus compatible information to the C-Bus network.
- 2. Unit features indicators for Power, C-Bus connection, and RS-232 connection.
- 3. Unit is mountable in DIN Rail enclosure 4M wide.
- 4. Complies with and is listed UL 916.

B. GC-100 Network Adapter <http://www.globalcache.com/products/gc-index.html>

- 1. System Requirements: Endpoint control unit shall connect to Ethernet network to send and receive commands from other Ethernet devices on the network. Until shall connect to one or two devices via RS-232 to send and receive control signals. Unit shall pass commands from devices connected over the Ethernet network to the RS-232 connection of the attached device. Until shall forward information received from the RS-232 connection to devices connected over the Ethernet network.
- 2. Unit features 1 or 2 RS-232 9 Pin Serial Ports
- 3. FCC (Part 15, Class B)
- 4. UL Listed

2.3 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low Voltage Electrical Power Conductors and Cables"
- B. UPT Cable: 100 ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2 Category 5

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow Manufacture's instructions.

END OF SECTION 251419

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: II.
 - a. Component Importance Factor: 1.0
 - b. Component Response Modification Factor: 4.5.
 - c. Component Amplification Factor: 1.3.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 1.000G.
 - 4. Design Spectral Response Acceleration at 1.0 Second Period: .400G.
- B. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- 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. Comply with NFPA 70.

PART 2 - PRODUCTS**2.1 CONDUCTORS AND CABLES**

- A. Conductors:
 - 1. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
 - 2. Conductors, Larger Than No. 10 AWG: Stranded copper.
 - 3. Insulation: Thermoplastic, rated at 75 deg C minimum.
 - 4. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.
- B. Cable Type NM-B Cable: Comply with UL 719 with Type THHN/THWN conductors complying with UL 83.
- C. Cable Type SEU: Comply with UL 854 with Type THHN/THWN conductors complying with UL 83
- D. Cable Type UF-B: Comply with UL 493 with Type THHN/THWN conductors complying with UL 83.
- E. See Section 260519 for detail

2.2 GROUNDING MATERIALS

- A. Conductors: Solid for No. 8 AWG and smaller, and stranded for No. 6 AWG and larger unless otherwise indicated.
 - 1. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
 - 2. Bare, Solid-Copper Conductors: Comply with ASTM B 3.
 - 3. Bare, Stranded-Copper Conductors: Comply with ASTM B 8.
- B. Ground Rods: Copper-clad steel, sectional type; 16 by 2400 mm in diameter.
- C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts with

clamp-type pipe connectors sized for pipe.

2.3 ELECTRICAL IDENTIFICATION MATERIALS

- A. Conductor Identification Materials: Color-Coding Conductor Tape: Self-adhesive vinyl tape 25 to 50 mm wide.
- B. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 1.0-mm galvanized-steel backing; and with colors, legend, and size required for application.
- E. Equipment Identification Labels: Engraved, laminated acrylic or melamine label; punched or drilled for screw mounting. White letters on a dark-gray background; red letters for emergency systems.
- F. Fasteners: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.4 SUPPORT AND ANCHORAGE COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly, and provide finish suitable for the environment in which installed.
 - 1. Channel Dimensions: Selected for structural loading.
- B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and fittings.
- C. Mounting, Anchoring, and Attachment Components:
 - 1. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 2. Through Bolts: Structural type, hex head, high strength; complying with ASTM A 325.
 - 3. Toggle Bolts: All-steel springhead type.
 - 4. Hanger Rods: Threaded steel.

2.5 SEISMIC-RESTRAINT COMPONENTS

- A. Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least 2.5 times the maximum seismic forces to which they will be subjected.
- B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.

PART 3 - EXECUTION

3.1 GENERAL ELECTRICAL EQUIPMENT INSTALLATION REQUIREMENTS

- A. Install electrical equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
- B. Install electrical equipment to provide for ease of disconnecting the equipment with minimum interference to other installations.
- C. Install electrical equipment to allow right of way for piping and conduit installed at required slope.
- D. Install electrical equipment to ensure that connecting raceways, cables, wireways, cable trays, and busways are clear of obstructions and of the working and access space of other equipment.

- E. Install required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Comply with requirements in Division 08 Section "Access Doors and Frames."
- G. Install sleeve and sleeve seals of type and number required for sealing electrical service penetrations of exterior walls.
- H. Comply with NECA 1.

3.2 WIRING METHODS

- A. Service Entrance: Type THHN-THW, single conductors in conduit.
- B. Exposed Feeders, Branch Circuits, and Class 1 Control Circuits, Including in Crawlspace: Nonmetallic-sheathed cable, Type NM.
- C. Feeders and Branch Circuits Concealed in Ceilings, Walls, Partitions, and Crawlspace: Nonmetallic-sheathed cable, Type NM.

3.3 GROUNDING

- A. Underground Grounding Conductors: Install bare copper conductor, No. #6 AWG minimum. Bury at least 600 mm below grade.
- B. Pipe and Equipment Grounding Conductor Terminations: Bolted.
- C. Connections to Structural Steel: Bolted.
- D. Install grounding conductors routed along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- E. Install ground rods driven into ground until tops are 50 mm below finished floor or final grade unless otherwise indicated.
- F. Make connections without exposing steel or damaging coating if any.
- G. Install bonding straps and jumpers in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
- H. Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
- I. Bond to equipment mounted on vibration isolation hangers and supports so vibration is not transmitted to rigidly mounted equipment.
- J. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
- K. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
 - 1. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - 2. Perform tests by fall-of-potential method according to IEEE 81.
 - 3. Report measured ground resistances that exceed the following values:

- a. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
 - b. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 - c. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
 - d. 10 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.4 IDENTIFICATION

- A. Accessible Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive color coding tape-in bands.
1. Telecommunication System: Gray.
 2. Data Cables: Blue.
 3. C-Bus Cable: Black
- B. Power-Circuit Conductor Identification: For No. 3 AWG conductors and larger, at each location where observable, identify phase using color-coding conductor tape.
- C. Warning Labels for Enclosures for Power and Lighting: Comply with 29 CFR 1910.145; identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- D. Equipment Identification Labels:
1. Labeling Instructions:
 - a. Indoor Equipment: Adhesive film label with clear protective overlay or Self-adhesive, engraved, laminated acrylic or melamine label. Provide a single line of text with 13-mm- high letters on 38-mm- high label; where two lines of text are required, use labels 50 mm high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment.
 - c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.
 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Electrical switchgear and switchboards.
 - c. Transformers.
 - d. Motor-control centers.
 - e. Disconnect switches.
 - f. Enclosed circuit breakers.
 - g. Inverter
 - h. Motor starters.
 - i. Push-button stations.
 - j. Power transfer equipment.
 - k. Contactors.
 - l. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
- E. Verify identity of each item before installing identification products.
- F. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- G. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- H. Install system identification color banding for cables at 15-m maximum intervals in straight runs, and at 7.6-m maximum intervals in congested areas.
- I. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Ungrounded service feeder and branch-circuit conductors.
1. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.

2. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 150 mm from terminal points.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Fasten hangers and supports securely in place, with provisions for thermal and structural movement. Install with concealed fasteners unless otherwise indicated.
- B. Separate dissimilar metals and metal products from contact with wood or cementitious materials, by painting each metal surface in area of contact with a bituminous coating or by other permanent separation.
- C. Multiple Raceways or Cables: Install on trapeze-type supports fabricated with steel slotted channel.
- D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 90 kg.
- E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods, unless otherwise indicated or required by Code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. To Light Steel: Sheet metal screws.
 6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount on slotted-channel racks attached to substrate.
- F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.6 SEISMIC REQUIREMENTS

- A. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.
- B. Install bushing assemblies for anchor bolts for wall- and floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in substrate.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.
- D. Accommodation of Differential Seismic Motion: Make flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to electrical equipment that is anchored to a different structural element than the one supporting them as they approach equipment.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

SECTION 260519- WIRING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. THWN-2 Wiring AWG #8, #6, #10
 - 2. Brass Copper Wiring AWG #10
 - 3. Romex plastic insulated sheathed wire

1.2 RELATED SECTIONS

- A. Section 260500 - Common Work Results for Electrical

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Southwire

2.2 MATERIALS

- A. Vinylon PVC/Nylon Wires THWN -2 AWG 8, 6, 10
 - 1. Meets following requirements
 - a. UL 83: File No. E15119
 - b. UL 1063 (MTW): File No. E85964
 - c. AWM: File No. E11829
 - d. Canadian Standard C22.2 No. 75 and CSA Bulletin No. 1451
 - e. ASTM: B3, B8, B787
 - f. WC70/ICEA S-95-658
 - g. Federal Specification A-A- 59544
 - h. NFPA70: National Electrical Code®
 - 2. Product Data:
 - a. THWN-2 AWG #8
 - 1) No. of Strands: 19
 - 2) PVC Ins. Mils: 30
 - 3) Nylon Jkt. Mils: 5
 - 4) Approx O.D. Inches: 0.217 in.
 - 5) Allowable Ampacities (@ 90°C): 55 A
 - 6) Approx Net Wt (lbs/m ft): 63
 - b. THWN-2 AWG #6
 - 1) No. of Strands: 19
 - 2) PVC Ins. Mils: 30
 - 3) Nylon Jkt. Mils: 5
 - 4) Approx O.D. Inches: 0.253 in.
 - 5) Allowable Ampacities (@ 90°C): 75 A
 - 6) Approx Net Wt (lbs/m ft): 96
 - c. THWN-2 AWG #10
 - 1) No. of Strands: 19
 - 2) PVC Ins. Mils: 20
 - 3) Nylon Jkt. Mils: 4
 - 4) Approx O.D. Inches: 0.165 in.
 - 5) Allowable Ampacities (@ 90°C): 30 A
 - 6) Approx Net Wt (lbs/m ft): 39
 - 3. Specifications for Southwire modules can be found at manufacturer's website: http://74.125.155.132/search?q=cache:ww_e5rjpeNIJ:www.paigeelectric.com/specs/P7295D.pdf+Bare+Copper+AWG+size+10&cd=10&hl=en&ct=clnk&gl=us
- B. Brass Copper AWG 10
 - 1. Meets following requirements:

- a. ASTM B-3
 - b. UL-493
 - c. UL-493
 - d. UL-719
 2. Product Data
 - 1) No. of Strands: 19
 - 2) Approx O.D. Inches: .1019
 - 3) Approx Net Wt (lbs/m ft): 32
 3. Specifications for Southwire modules can be found at manufacturer's website: http://74.125.155.132/search?q=cache:wW_e5rjpeNIJ:www.paigeelectric.com/specs/P7295D.pdf+Bare+Copper+AWG+size+10&cd=10&hl=en&ct=clnk&gl=us
- C. Romex Simpull with SIM jacket
 1. Meets or exceeds UL Standard 83, UL Standard 719, Federal Specification A-A-59544, and requirements of the National Electrical Code.
 2. Product Data:
 - a. 2 Conductor
 - 1) Size (AWG): 10
 - 2) No. Conductors in Cable: 2
 - 3) No. Strands in Conductors: 1
 - 4) Insulation Thickness (mils): 24
 - 5) Size (AWG): 10
 - 6) No Strands: 1
 - 7) Approx. Cable Dimension (mils): 494 x 210
 - 8) Approx. Net Weight per 1000 (lbs): 126
 - 9) Allowable Ampacity: 30 A
 - 10) Voltage Rating: 600 V
 - 11) Standard Package: EH
 - b. 3 Conductor
 - 1) Size (AWG): 10
 - 2) No. Conductors in Cable: 3
 - 3) No. Strands in Conductors: 1
 - 4) Insulation Thickness (mils): 24
 - 5) Size (AWG): 10
 - 6) No Strands: 1
 - 7) Approx. Cable Dimension (mils): 422
 - 8) Approx. Net Weight per 1000 (lbs): 167
 - 9) Allowable Ampacity: 30 A
 - 10) Voltage Rating: 600 V
 - 11) Standard Package: BH
 3. Specifications for Southwire modules can be found at manufacturer's website: <http://www.electrolinksales.com/downloads/SIMPull.pdf>

PART 3 - EXECUTION

3.1 Installation

- A. Safety and Implementation
 1. THWN-2 Wiring AWG #8, #6, #10 and Brass Copper Wiring AWG #10
 - a. Cables may be used for underground feeder or branch-circuit wiring for installation above or below ground, including direct burial, and in wet or corrosive locations.
 - b. Cables may also be used for exposed or concealed interior wiring in wet, dry or corrosive locations and in cable trays.
 - c. Multiconductor cables are assembled flat parallel. For cables with ground, the ground wire is placed between two of the insulated conductors
 - d. Cables have polyvinyl chloride (PVC) insulation and a sunlight-resistant PVC overall jacket, and single conductor cables having a sunlight-resistant PVC insulation.
 2. Romex Wiring
 - a. Maybe be used for both exposed and concealed work in normal dry locations at temperatures not exceeding 90°C.
 - b. Primarily used in residential wiring as branch circuits for outlets, switches, and other loads.
 - c. May be run in air voids of masonry block or tile walls where such walls are not subject to excessive moisture or dampness.
 - d. Copper conductors are annealed copper.
 - e. Stranded conductors are compressed stranded.

END OF SECTION

SECTION 260533 - CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Southwire E in and E in Conduits

1.2 RELATED SECTIONS

- A. Section 260519 - WIRING

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Southwire

2.2 MATERIALS

- A. Southwire E in Conduit
 - 1. Meets following requirements
 - a. U.L. Standard No. 1569 and Article 334
 - b. UL Standard for Safety 360
 - c. Canadian Standards Association (CSA)
 - d. Listed NEC Articles 350 & 300
 - 2. Product Data:
 - a. Trade Size: E "
 - b. Feet Per Coil: 100
 - c. Feet Per Reel: 500-1000
 - d. Wight (lbs) Per 100 ft: 34.6
 - e. Overall Diameter (inches): 1.105
 - 3. Specifications for Southwire modules can be found at manufacturer's website: <http://www.southwire.com/Southwire/StaticFiles/PriceSheets/DF08.pdf>
- B. Southwire E in Conduit
 - 1. Meets following requirements
 - a. U.L. Standard No. 1569 and Article 334
 - b. UL Standard for Safety 360
 - c. Canadian Standards Association (CSA)
 - d. Listed NEC Articles 350 & 300
 - 2. Product Data:
 - a. Trade Size: E "
 - b. Feet Per Coil: 100
 - c. Feet Per Reel: 500-1000
 - d. Wight (lbs) Per 100 ft: 27.2
 - e. Overall Diameter (inches): .920
 - 3. Specifications for Southwire modules can be found at manufacturer's website: <http://www.southwire.com/Southwire/StaticFiles/PriceSheets/DF08.pdf>

PART 3 - EXECUTION

3.1 Installation

- A. Safety and Implementation

1. Flexible Steel Conduit
2. Coiled
3. Wires not included
4. Resists nail penetration
5. Galvanized steel
6. High-grade galvanized steel or aluminum alloy strip of uniform gauge for an excellent combination of strength and durability
7. Interlocking design formed from continuous metal strip for integrity and flexibility
8. Reduced wall conduits 40% lighter (steel) than heavy-gauge steel
9. Interior surface allows easy wire fishing
10. Galvanized steel for superior corrosion resistance
11. U.L. conduits with 2-hour (aluminum) and 3-hour (steel) through-penetration Fire Wall classification
12. Applications: residential, commercial, industrial, etc
13. Use in dry locations only

END OF SECTION

SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 DEVICES

- A. Branch Current Monitor comply with UL 508
 - 1. Current Inputs: Up to 42 channels using solid core CTs, frequency 50/60 Hz, voltages below 600 V phase to phase
 - 2. Measurement Resolution: 1280 Hz sampling, 1.2 second update rate
 - 3. Wire Compatibility: Accommodates up to #6 THHN insulated conductors
 - 4. Control Power: 120 VAC, line to neutral, 50/60 Hz
 - 5. Environmental Conditions: Operating temperature range: 0 to 60° C, <95% RH, non-condensing
 - 6. Compatibility: Modbus RS 485 communications
 - 7. Specific Product Specification: <http://www.powerlogic.com/literature/3020H00204R507.pdf>

2.2 CONDUCTORS AND CABLES

- A. Circuit Wiring: Less than #6 THHN insulated conductors
- B. Monitoring Communication: Three wire RS 485

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install branch current monitors according to product manual and by certified electrician

END OF SECTION 260913

SECTION 260923 - LIGHTING CONTROL DEVICES**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes all lighting control devices including occupancy sensors.
- B. Related Systems
 - 1. 26 09 43 - Network Lighting Controls

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Square D; Schneider Electric

2.2 DEVICES

- A. Line-Voltage Surge Protection: An integral part of the lighting control devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.
- B. Outdoor Photoelectric and Motion Sensors: C-Bus connected to operate C-Bus equipment. Complies with UL 916. <http://ecatalog.squared.com/pubs/Power Management/Lighting Control/Square D Clipsal Lighting Control Products/Sensors/1250HO0514.pdf>
 - 1. Light-Level Monitoring Range: 1 lx to full sunlight, with an adjustment for turn-on and turn-off levels within that range.
 - 2. Time Delay: 0-second minimum.
 - 3. Field of View: 110 degrees
 - 4. Contact Configuration: C-Bus connection, one terminal block.
- C. Indoor, Ceiling-Mounted Photoelectric and Motion Sensor: C-Bus connected to operate C-Bus equipment. Complies with UL 916. <http://ecatalog.squared.com/pubs/Power Management/Lighting Control/Square D Clipsal Lighting Control Products/Sensors/1250HO0516.pdf>
 - 1. Light-Level Monitoring Range: 1 lx to full sunlight with an adjustment for turn-on and turn-off levels within that range.
 - 2. Time Delay: Adjustable from 0 to 18 hours.
 - 3. Indicator: Two LEDs.
 - 4. Contact Configuration: C-Bus connection, two removable terminal blocks.

2.3 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low Voltage Electrical Power Conductors and Cables"
- B. UTP Cable: 100 ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2 Category 5

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Follow Manufactures installation instructions.

END OF SECTION 260923

SECTION 260936 - MODULAR DIMMING CONTROLS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MANUAL MODULAR MULTISCENE DIMMING CONTROLS

- A. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.
- B. Dimmers and Dimmer Modules:
1. Comply with UL 508.
 2. Include integral or external filters to suppress audible noise and radio-frequency interference.
 3. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
- C. Description: Wall-box-mounted, master-scene controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in one-, two-, or three-gang wall box under a single wall plate. Each zone station shall be adjustable to indicated number of scenes, which shall be recorded on the zone controller.
- D. Operation: Automatically change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.
- E. Each manual, modular, multiscene-dimming controller shall include a master control and remote controls.
- F. Each zone shall be configurable to control the following:
1. Fluorescent lamps with electronic ballasts.
 2. LED lamps with electronic drivers and transformers.
- G. Memory: Retain preset scenes through power failures for at least seven days.
- H. Device Plates: Style, material, and color shall comply with Division 26 Section "Wiring Devices."
- I. Master-Scene Controller: Suitable for mounting in a single, flush, wall box.
1. Switches: Master off, group dim, group bright, and selectors for each scene.
 2. LED indicator lights, one associated with each scene switch, and one for the master off switch.
- J. Fluorescent Zone Dimmer: Suitable for operating lighting fixtures and ballasts specified in Division 26 Section "Lighting," and arranged to dim number of scenes indicated for the master-scene controller. Scene selection is at the master-scene controller for setting light levels of each zone associated with scene.
1. Switch: [Rocker] [Slider] style for setting the light level for each scene.
 2. LED indicator lights, one associated with each scene.
 3. Electrical Rating: [1000] [2000] VA, 120 V.
- K. LED Zone Dimmer: Operate LED lamps at low-voltage lamps connected to a transformer and arranged to dim number of scenes indicated for the master-scene controller. Scene selection shall be at the master-scene controller for setting light levels of each zone associated with scene.
1. Switch: [Rocker] [Slider] style for setting the light level for each scene.
 2. LED indicator lights, one associated with each scene.
 3. Voltage Regulation: Dimmer shall maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent in RMS voltage.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Comply with NECA 1.
- B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used]. Conceal raceway and cables except in unfinished spaces.
- C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Label each scene control button with approved scene description.

END OF SECTION 260936

SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes manually operated lighting controls with relays control module.
- B. This section includes manually operated, PC-based units, digital lighting controls with external signal source, relays control module.
- C. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control Devices" for occupancy sensors and light level sensors.

1.2 DEFINITIONS

- A. C-Bus: A networking communications protocol.
- B. PC: Personal computer; sometimes plural as "PCs"
- C. Clipsal: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- E. CTS: An embedded computer system with a touchable color screen.
- F. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A

1.3 SUBMITTALS

- A. Product Data: For control modules, relay control panels, power distribution components, low voltage switches and plates, and conductors and cables.
- B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this project.
 - 1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with relay control panels and power distribution system components. Indicate data communications paths and identity networks, data buses, data gateways, concentrators, and other devices to be used. Describe the characteristics of gateways and other data communications lines.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control relay panels, power distribution components and software through one source from a single manufacture.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices
- D. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of lighting control functions.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Available Manufactures: Subject to compliance with requirements, manufactures offering products that may be incorporated into the Work include, but are not limited to the following:
- B. Manufactures: Subject to compliance with requirements, provide products by one of the following:
1. Square D; Schneider Electric

2.2 SYSTEM REQUIREMENTS

- A. Performance Requirements: Manual switches, an internal timing and control unit, external sensors, and networked devices or other control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.
1. The lighting control system is a networked system that communicates via C-Bus cable. The system must be able to communicate with fully digital lighting relay panels, digital switches, indoor and outdoor occupancy and photocell sensors, CTS, various interfaces and shall include all operational software for desktop computer. The intent of the specification is to integrate all lighting control into one system. The system shall provide local access to limited lighting control functions at the relays and dimmers, and full access to the entire system via a local or remote PC.
 2. The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands from any lighting relay circuits in group or zone by means of digital low-voltage wall switches, CTS commands, or other devices connected to programmable inputs in a lighting control panel.
 3. All programming and lighting scheduling shall be able to be done via a local or remote PC. Remote connection to the lighting control system shall provide real time control and real time feedback.
 4. System consists of centralized relay panel, digital switches, occupancy sensors, CTS and various digital interfaces. Verify exact components specified. Lighting relay panels, CTS, and digital switches shall communicate as one network via C-Bus. All lighting relay panels and all devices connected to lighting relay panels shall be wired per lighting control manufactures instructions.

2.3 CONTROL MODULE

- A. Control Module Description: Comply with UL 916; microprocessor-based solid-state, 365-day timing and control unit. Relay contacts shall be switched on and off by internally programmed time signals or by program controlled analog or digital signals from external sources. http://www.squaredlightingcontrol.com/viewitem.cfm/p_id/6/cat_id/81/subcat_id/21/pt_id/2

2.4 DIMMERS

- A. Clipsal 4 Channel Dimmers http://www.squaredlightingcontrol.com/viewitem.cfm/p_id/50/cat_id/89/subcat_id/55/pt_id/2
1. 2A or 4A load capacity
 2. Connects to C-Bus Network
 3. Override button present on unit for each channel.
 4. 4 Addressable channels

2.5 RELAYS

- A. Clipsal 12 Channel Relay http://www.squaredlightingcontrol.com/viewitem.cfm/p_id/47/cat_id/7/subcat_id/63/pt_id/2
1. 10A load capacity per channel
 2. Connects to C-Bus network
 3. Override button present on unit for each channel
 4. 12 Addressable channels
- B. Clipsal 4 Channel Relay http://www.squaredlightingcontrol.com/viewitem.cfm/p_id/48/cat_id/7/subcat_id/63/pt_id/2
1. 20A load capacity
 2. Connects to C-Bus network
 3. Override button present on unit for each channel
 4. 4 Addressable Channels

2.6 DYNAMIC LABEL LOW VOLTAGE SWITCHES AND PLATES

http://www.squaredlightingcontrol.com/viewitem.cfm/p_id/15/cat_id/81/subcat_id/58/pt_id/2

- A. Dynamically Labeled Push-Button Switches: Modular, momentary or variable contact, low voltage type.
 - 1. 64x128 LCD screen capable of displaying text or graphics in 8 rows separated over two pages. Page can be changed using the fifth button.
 - 2. Five buttons, one next to each row of the LCD screen with fifth button to switch pages of the LCD screen.
 - 3. Each button fitted with a blue LED that can be illuminated by a program signal.
 - 4.
- B. Legend: 64x128 LCD screen displays labels for each physical button. LCD screen is backlit.
- C. Dynamic Label Low Voltage Switches
 - 1. Low voltage switches shall be digital and communicate via C-Bus. The programming for a digital switch will reside in the switch itself. Any digital switch button shall be able to be changed via a local or remote PC. Any label on the LCD screen shall be able to be changed via a local or remote PC.
 - 2. Digital low voltage switch shall be a device that sits on the C-Bus network. Digital switch shall connect to the system bus using the same cable and connection method as the relay panels. System shall provide capability to locally and remotely program each individual switch button and dynamic label, monitor and change function of each button and the text or graphic of each label via a local or remote PC. Each button shall be capable of being programmed for On only, Off only, On/Off (toggle), Raise (Dim up), and Lower (Dim down).
 - 3. Keyed switches shall be programmable and connect to the lighting control system bus.

2.7 STATIC LABEL LOW VOLTAGE SWITCHES AND PLATES

http://www.squaredlightingcontrol.com/viewitem.cfm/p_id/5/cat_id/81/subcat_id/58/pt_id/2

- A. Static Labeled Push-Button Switches: Modular, momentary or variable contact, low voltage type.
 - 1. Two to Eight buttons with on button label and small LED light.
 - 2. Each button fitted with a blue and orange LED that can be illuminated by a program signal.
- B. Button function shall be printed on a label that covers the button.
- C. Static Label Low Voltage Switches
 - 1. Low voltage switches shall be digital and communicate via C-Bus. The programming for a digital switch will reside in the switch itself. Any digital switch button shall be able to be changed via a local or remote PC.
 - 2. Digital low voltage switch shall be a device that sits on the C-Bus network. Digital switch shall connect to the system bus using the same cable and connection method as the relay panels. System shall provide capability to locally and remotely program each individual switch button, monitor and change function of each button via a local or remote PC. Each button shall be capable of being programmed for On only, Off only, On/Off (toggle), Raise (Dim up), and Lower (Dim down).
 - 3. Keyed switches shall be programmable and connect to the lighting control system bus.

2.8 ETHERNET NETWORK INTERFACE

http://www.squaredlightingcontrol.com/viewitem.cfm/p_id/77/cat_id/85/subcat_id/62/pt_id/2

- A. Din rail mounted unit to facilitate communication between C-Bus Clipsal network and Ethernet TCP/IP network.
 - 1. Shall allow local and remote TCP/IP enabled units to communicate with the C-Bus network using a proprietary protocol.
 - 2. Will forward all C-Bus data from the C-Bus network to the connected host.

2.9 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low Voltage Electrical Power Conductors and Cables"
- B. UTP Cable: 100 ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2 Category 5

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow Manufacture's instructions.

END OF SECTION 260943

SECTION 262416 - PANELBOARDS**1.1 SECTION REQUIREMENTS**

- A. Submittals:
 - 1. Product Data.
 - 2. Acceptable Products:
 - a. Square D NF3000G3
 - b. Square D HOM612L100RB
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Seismic Performance: Circuit Breakers shall withstand the effects of earthquake motions determined according to 2003 IBC, NFPA 5000, ASCE/SE17.

PART 2 - PRODUCTS**2.1 GENERAL REQUIREMENTS FOR CIRCUIT BREAKERS**

- A. Fabricate and test Circuit Breakers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Common Work Results for Electrical."
- B. Enclosures: Surface-mounted cabinets; NEMA 250, Type 1.
 - 1. Front: Secured to box with concealed trim clamps.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- C. Incoming Mains Location: Top or bottom feed
- D. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Compression type.
 - 3. Ground Lugs and Bus Configured Terminators: Compression] type.
 - 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- F. Service Equipment Label: NRTL labeled for use as service equipment for Circuit Breakers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Circuit Breaker Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.
- I. Circuit Breaker Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION CIRCUIT BREAKERS

- A. Doors: Omit in fused-switch Circuit Breakers.
- B. Mains: Circuit breaker.
- C. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.

- D. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- E. Branch Overcurrent Protective Devices: Fused switches.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT CIRCUIT BREAKERS

- A. Mains: Circuit breaker.
- B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- C. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - 2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.5 MANUFACTURE DETAILS

- A. Model: Square D NF3000G3
 - 1. Complies with NEMA PB 1
 - 2. For details from manufacturer, see <http://static.schneider-electric.us/digest/17405.pdf>
- B. Model: Square D HOM612L100RB
 - 1. Complies with NEMA PB 1
 - 2. For details from manufacturer, see <http://ecatalog.squared.com/fulldetail.cfm?partnumber=HOM612L100RB>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install Circuit Breakers and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Common Work Results for Electrical."
- C. Mount top of trim 2286 mm above finished floor unless otherwise indicated.
- D. Stub four empty 19-mm conduits from Circuit Breaker into accessible or designated ceiling space; stub four empty conduits into space below floor.
- E. Arrange conductors into groups; bundle and wrap with wire ties.
- F. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and Shop Drawings.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Coordinate with utility companies for services and components they furnish.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.
- C. Meter Sockets: Comply with requirements of electrical power utility company.
- D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.
- E. Modular Meter Center: Factory-coordinated assembly of a main service terminal box with lugs only, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below:
 - 1. Comply with requirements of utility company for meter center.
 - 2. Housing: NEMA 250, Type 3R enclosure.
 - 3. Minimum Short-Circuit Rating: 10,000, symmetrical at rated voltage.
 - 4. Main Disconnect Device: Circuit breaker
 - 5. Coordinate first subparagraph below with Drawings for indication of trip and interrupting capacity ratings of circuit breakers.
 - 6. Tenant Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect circuit breakers in downstream tenant and to house loadcenters and panelboards that have 10,000-A interrupting capacity.
 - a. Identification: Provide legend identifying tenant's address.
 - b. Physical Protection: Tamper resistant, with hasp for padlock.
 - 7. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.
- G. Manufacture Details
 - 1. Complies with:
 - a. UL 1492, Audio/Video Products and Accessories
 - b. UL 514A, Metallic Outlet Boxes
 - c. UL 1863, Communications Circuit Accessories
 - 2. For details from Manufacturer, see [http://www.squared.com/us/products/metering_equipment.nsf/unid/9D12EE9AF8C4098885256C1D004DA340/\\$file/indvmtrsocketsFrameset.htm](http://www.squared.com/us/products/metering_equipment.nsf/unid/9D12EE9AF8C4098885256C1D004DA340/$file/indvmtrsocketsFrameset.htm)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.

- B. Install equipment for utility company metering. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install modular meter center according to NECA 400 switchboard installation requirements.

END OF SECTION 262713

SECTION 262716 - COMBINER BOX

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Solar DC Combiner Box

1.2 RELATED SECTIONS

- A. Section 481400 - Solar Energy Electrical Power Generation Equipment
- B. Section 481916 - Electrical Power Generation Inverters

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Amtec Solar

2.2 MATERIALS

- A. Amtec Solar Prominence Series 6 String
 - 1. Product Data:
 - a. Electrical Data
 - 1) Rated Voltage: 600 V
 - 2) Rated Current: 12 A
 - 3) Positive and Negative outputs: 1X 3/0-6AWG
 - b. Mechanical Data
 - 1) NEMA 4X Fiberglass enclosure
 - 2) 13.5" (Height) x 12" (Width) x 6.75" (Depth)
 - 3) Black pan with integrated wire management and silk-screening
 - 4) Hardware: Stainless Steel
 - 2. Specifications for Amtec modules can be found at manufacturer's website: <http://www.amtecsolar.com/documents/6%20String%20Spec%20Sheet%20Mar%2009.pdf>
 - 3. Complies with: UL 1741 Listed ETL Report No. 3143624MPK-001

PART 3 - EXECUTION

3.1 Installation

- A. Safety and Implementation
 - 1. Safety Covers
 - 2. Fuse holders are finger safe
 - 3. Positive busbar eliminates messy wiring to fuse blocks
 - 4. Lockable exterior latch
 - 5. Bridge punches for clean wire management

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 DEVICES

- A. Convenience Receptacles
 - 1. Complies with: NEMA WD 1, NEMA WD 6, Configuration 5-20R, and UL 498.
 - 2. Specific product will be a PlugTail from Pass and Seymour; 26352W.
 - a. See <http://www.passandseymour.com/pdf/E13-E21.pdf> for details
- B. Duplex GFCI Convenience Receptacles(120V)
 - 1. Complies with: NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
 - 2. Specific product will be a Recessed TV Box from Pass and Seymour; 2095 TRW.
 - a. See <http://www.passandseymour.com/pdf/E22-E38.pdf> for details.
- C. Duplex Convenience Receptacle (250V)
 - 1. Complies with: NEMA WD 1, NEMA WD 6, UL 498
 - 2. Specific product will be a Recessed TV Box from Pass and Seymour; 26852W
 - a. See <http://www.passandseymour.com/pdf/B29.pdf> for details.
- D. Wall Plates, Finished Areas: Smooth, high-impact thermoplastic fastened with metal screws having heads matching plate color.
 - 1. Complies with CSA, UL524
 - 2. Specific product will be a decorator opening from Pass and Seymour; TPJ26W.
 - a. See <http://www.passandseymour.com/pdf/S22.pdf> for details.
- E. Wall Plates, Unfinished Areas: Smooth, high-impact thermoplastic with metal screws.
 - 1. Complies with UL524, CSA
 - 2. Specific product will be a decorator opening from Pass and Seymour; TPJ26W.
 - a. See <http://www.passandseymour.com/pdf/S22.pdf> for details.
- F. Wall Plates, Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet locations.
 - 1. Complies with CSA, UL, NEMA WD6
 - 2. Specific product will be wall plates from Pass and Seymour; 4512.
 - a. See <http://www.passandseymour.com/pdf/R20.pdf> for details.

G. Finishes:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Install devices and assemblies plumb, level, and square with building lines.
- C. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- D. Install unshared neutral conductors on line and load side of dimmers.
- E. Mount devices flush, with long dimension vertical, and grounding terminal of receptacles on top unless otherwise indicated. Group adjacent devices under single, multigang wall plates.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Shunt Trip Switches: Comply with UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- B. Features and Accessories:
 - 1. Lugs: Suitable for number, size, trip ratings, and conductor material.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - 3. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with ground-fault indicator; relay with adjustable pickup and time-delay settings, and push-to-test feature.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.

2.2 ENCLOSURES

- A. Square D HO Enclosure
 - 1. Outdoor Locations: NEMA Type 1
 - 2. 4.81"L x 9.3" W x 3.19" D
 - 3. <http://static.schneider-electric.us/digest/17401.pdf>
- B. SQUARE D NF ENCLOSURE
 - 1. NEMA TYPE 1
 - 2. 44"L x 20.12"W x 5.75"D
 - 3. <http://static.schneider-electric.us/digest/17409.pdf>
- C. SquareD 60M Enclosure
 - 1. NEMA Type 1 Enclosure
 - 2. 5 Din Rails
 - 3. 39.4"L x 15.4" W x 3.9" D
 - 4. http://www.squaredlightingcontrol.com/viewitem.cfm/p_id/65/cat_id/88/subcat_id/98/pt_id/2

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Sections "Common work Results for Electrical."

- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

END OF SECTION 262816

SECTION 263100 - PHOTOVOLTAIC GENERATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Photovoltaic solar electric panels for electricity generation.

1.2 RELATED SECTIONS

- A. Section 481400 - Solar Energy Electrical Power Generation Equipment
- B. Section 481916 - Electrical Power Generation Inverters

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. SunPower

2.2 MATERIALS

- A. SunPower photovoltaic panels model 225BLK
 - 1. Meets UL 1703 requirements and the ASTM standards applied to photovoltaic panels including the following:
 - a. ASTM E1038-Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls
 - b. ASTM E1171- Standard Test Method for Photovoltaic Modules in Cyclic Temperature and Humidity Environments
 - c. ASTM E1596- Standard Test Methods for Solar Radiation Weathering of Photo voltaic Modules
 - d. ASTM E1597- Standard Test Method for Saltwater Pressure Immersion and Temperature Testing of Photovoltaic Modules for Marine Environments
 - e. ASTM E1802-Standard Test Methods for Wet Insulation Integrity Testing of Photovoltaic Modules
 - f. ASTM E2047- Standard Test Method for Wet Insulation Integrity Testing of Photovoltaic Arrays
 - g. ASTM E1830- Standard Test Methods for Determining Mechanical Integrity of Photovoltaic Modules
 - h. ASTM E781- Standard Practice for Evaluating Absorptive Solar Receiver Materials When Exposed to Conditions Simulating Stagnation in Solar Collectors With Cover Plates
 - i. ASTM E782- Standard Practice for Exposure of Cover Materials for Solar Collectors to Natural Weathering Under Conditions Simulating Operational Mode
 - j. ASTM E823- Standard Practice for Nonoperational Exposure and Inspection of a Solar Collector
 - k. ASTM E881- Standard Practice for Exposure of Solar Collector Cover Materials to Natural Weathering Under Conditions Simulating Stagnation Mode
 - l. ASTM E1039- Standard Test Method for Calibration of Silicon Non-Concentrator Photovoltaic Primary Reference Cells Under Global Irradiation
 - m. ASTM E1362- Standard Test Method for Calibration of Non-Concentrator Photovoltaic Secondary Reference Cells
 - n. ASTM E948- Standard Test Method for Electrical Performance of Photovoltaic Cells Using Reference Cells Under Simulated Sunlight
 - o. ASTM E1021- Standard Test Methods for Measuring Spectral Response of Photovoltaic Cells
 - p. ASTM E903- Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres
 - q. ASTM E1040- Standard Specification for Physical Characteristics of Nonconcentrator Terrestrial Photovoltaic Reference Cells
 - r. ASTM E1462- Standard Test Methods for Insulation Integrity and Ground Path Continuity of Photovoltaic Modules
 - 2. Product Data:
 - a. Electrical Data
 - 1) Peak Power: 225W
 - 2) Rated Voltage: 41 V
 - 3) Rated Current: 5.49 A
 - 4) Open Circuit Voltage: 48.5V

- 5) Short Circuit Current: 5.87 A
- 6) Maximum System Voltage: IEC, UL 1000V, 600 V
- 7) Series Fuse Rating: 20 A
- 8) Peak Power per Unit Area: 207.1W
- b. Mechanical Data
 - 1) 72 Solar Cells, all back contact monocrystalline
 - 2) Front Glass 3.2 mm tempered
 - 3) Junction box is IP-65 rated with 3 bypass diodes
 - 4) Output Cables 900 mm length cable/ multi-contact connectors
 - 5) Frame Anodized aluminum alloy type 6063
 - 6) Weight 15kg
- 3. Specifications for SunPower modules can be found at manufacturer's website: http://us.sunpowercorp.com/downloads/product_pdfs/residential/SunPower_225bk_res_en_lt_w_ra.pdf

PART 3 - EXECUTION

3.1 Installation

- A. Safety
 - 1. Cover all modules in the PV array with an opaque cloth or material before making or breaking electrical connections.
 - 2. All installations must be performed in compliance with the National Electrical Code (NEC) and any applicable local codes.
 - 3. There are no user serviceable parts within the module. Do not attempt to repair any part of the module.
 - 4. Installation should be performed only by authorized personnel.
 - 5. Remove all metallic jewelry prior to installing this product to reduce the chance of accidental exposure to live circuits.
 - 6. Use insulated tools to reduce your risk of electric shock.
 - 7. Do not stand on, drop, scratch, or allow objects to fall on modules.
 - 8. If the front glass is broken, or the back sheet is torn, contact with any module surface or module frame can cause electric shock.
 - 9. Do not install or handle the modules when they are wet or during periods of high wind.
- A. Implementation
 - 1. To reduce the possibility of electrical shock, ground the frame of the module or array before wiring the circuit using a grounding method that meets NEC requirements for grounding solar electrical systems.
 - 2. In order to install in accordance with the UL listing of this product, SunPower modules shall be grounded using grounding hardware that have been UL certified to meet requirements for grounding systems in UL467, UL1703, or UL1741 on anodized aluminum frames. Must be grounded to perform optimally.
 - 3. Array can be connected in parallel or series to increase either desired voltage or current.
 - 4. Mounting

3.2 Efficiency Testing

- A. Energy Efficiency: Verify equipment is properly installed, connected, and adjusted. Verify that equipment is operating as specified.
- B. Renewable Energy: Verify proper operation in all modes of system operation by testing. Verify proper operation under a wide range of conditions to verify energy delivery as calculated for those conditions.
 - 1. Solar Energy Systems: Comply with ASTM E1799- Standard Practice for Visual Inspections of Photovoltaic Modules.

END OF SECTION

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Generators used for temporary electricity to power tools for assembly construction and disassembly of the house.

PART 2 - PRODUCTS

2.1 GENERATOR REQUIREMENTS

- A. Must meet noise regulations of 60 dB at distance of 50 feet
- B. Must be UL listed
- C. Must have secondary containment systems to accommodate all oil, fuel, and coolant the generator contains at maximum capacities.
- D. Will not release water or liquids onto the construction site

2.2 PRODUCT RECOMMENDATIONS

- A. Manufactured by Northstar
- B. Northstar 8000 Model
- C. Model Number 165920
- D. Specifications:
 - 1. 13 HP motor
 - 2. 8000 surge Watts, or 6600 rated Watts continuous power
 - 3. 6.5 Gallon gasoline fuel tank with gauge.
 - 4. 9 ½ hour run time
 - 5. 7 receptacles
 - 6. 74.5 dB at distance of 10 feet. Equivalent to 60 dB at 50 feet.
 - 7. http://www.northerntool.com/webapp/wcs/stores/servlet/product_6970_50043_50043&issearch=165920

2.3 OTHER RECOMMENDATIONS

- A. If space to bring generator is not available during shipping, generators can be rented from Sunbelt Rentals in Washington
- D.C. The necessary requirements from the above product will be met including
 - 1. Noise requirements
 - 2. Spill containment requirements
 - 3. Necessary power requirements to power needed tools for assembly of house

PART 3 -EXECUTION**3.1 SETUP**

- A. Generator will be fueled with gasoline from an appropriate container. Use caution when refueling to prevent spilling liquid onto the site, especially volatile materials like gasoline.
- B. When within 50 feet of generator, hearing protection should be worn so as to prevent hearing loss.

END OF SECTION 263213

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data for each luminaire, including lamps.
- B. Fixtures, Emergency Lighting Units, Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with IEEE C2, "National Electrical Safety Code."
- D. Coordinate ceiling-mounted luminaires with ceiling construction, mechanical work, and security and fire-prevention features mounted in ceiling space and on ceiling.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. LED Fixtures: Comply with UL 8750 (in development).
- D. Exterior Luminaires: Comply with UL 1598 and listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- E. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- F. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2.2 BALLASTS/DRIVERS/TRANSFORMERS

- A. Drivers/Transformers for LED Lamps
 - 1. Danalite DLD-80-120:
 - a. Max Power Output: 80W.
 - b. 120V input; 24V DC output.
 - c. No Minimum load.
 - d. Class 2 Enclosed remote driver.
 - e. See Manufacturer's Specifications for details:
http://www.junolightinggroup.com/spec%20sheets/dana/E6_1_0.pdf
 - 2. Danalite DLD-100:
 - a. Max Power Output: 100W.
 - b. 100-277V input; 24V DC output.
 - c. Class 2 Enclosed Remote Driver
 - d. See Manufacturer's Specifications for details:
http://www.junolightinggroup.com/spec%20sheets/dana/E6_1_0.pdf
 - 3. CREE LR6C-GU24
 - a. Integral to fixture.
 - b. Power Factor: 0.95 or higher.
 - c. Input voltage = 120V, 60Hz
 - d. See Manufacturer's Specifications for details:
http://www.creelighting.com/downloads/LR6_spec_072908.pdf
 - 4. EnvironmentalLights.Com LPV-35-12
 - a. Max Power Output: 35W

- b. 90-264V input; 12V DC output.
 - c. 2.9 amp maximum output
 - d. IP67 waterproof rating, fully encapsulated
 - e. Operating temperature range: -30 to +75 °C
 - f. 16 AWGx2C input and output wires
 - g. See Manufacturer's Specifications for details:
http://www.environmentallights.com/products/12712/35_Watt_12_VDC_Waterproof_Power_Supply
- B. Ballasts for Compact Fluorescent Lamps: Electronic programmed rapid-start type, complying with ANSI C 82.11.
 - 1. Lamp end-of-life detection and shutdown circuit.
 - 2. Automatic lamp starting after lamp replacement.
 - 3. Sound Rating: A.
 - 4. BF: 0.95 or higher unless otherwise indicated.
 - 5. Power Factor: 0.95 or higher.
 - 6. Electronic:
 - a. Lamp end-of-life detection and shutdown circuit.
 - b. Total Harmonic Distortion Rating: Less than 15 percent.
 - c. Transient Voltage Protection: IEEE C62.41, Category A or better.

2.3 LAMPS

- A. LED Lamps: CRI 75 (minimum), color temperature 3000-3500K, average rated life of 50,000, unless otherwise indicated.
 - 1. Z-Bar High Power LED Desk Lamp: 40,000 hours.
 - 2. Narrow Dimmable High Brightness LED Ribbon Flex: 20,000 hours.
 - 3. FlexTec IFL-65A LED Warm White Rope Light: 100,000 hours.
- B. Compact Fluorescent Lamps: Four pin, low mercury, CRI 80 (minimum), color temperature 3000-3500K, average rated life of 10,000 hours at three hours' operation per start and suitable for use with dimming ballasts unless otherwise indicated.
 - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum). G24Q-1

2.4 CONTROLLING DEVICES

- A. For all lighting controls, see 260943.

2.5 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

- A. Fixture A: COVE LIGHT - DANALITE TYPE A
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide DanaLite DL100-3F-S or comparable product by one of the following:
 - a. DanaLite
 - b. Philips Color Kinetics
 - 2. Voltage: 24-V DC.
 - 3. Mounting: Cove/light shelf 5" from wall at 15".
 - 4. Nominal Dimensions: 11.5"x1"x0.5".
 - 5. Lamps: 4 nominal 1W HO Nichia LEDs, 3000K, 126 lumens, 75 CRI.
 - 6. Driver for LED Lamps: 24 Volt, Electronic Class 2 remote mount.
 - 7. Quantity of Drivers per Fixture: 1 per run.
 - 8. Lens: Frosted Polycarbonate.
 - 9. External Finish: Clear anodized aluminum.
 - 10. Minimum Cove Height: 6"
 - 11. Minimum Lamp Spacing from Wall: 3"
 - 12. See Manufacturer's Specifications for details: http://www.junolightinggroup.com/spec%20sheets/dana/E6_1_0.pdf.
- B. Fixture B: RECESSED CEILING LIGHT - CREE TYPE B
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide CREE LR6C-GU24 or comparable

- product.
- 2. Voltage: 120V AC.
- 3. Mounting: Recessed ceiling.
- 4. Nominal Dimensions: 7 3/8"x5 1/2" diameter x6"
- 5. Lamps: 12W LED module, 3500K, 92 CRI.
- 6. Driver for LED Lamps: Integral electronic.
- 7. Quantity of Drivers per Fixture: 1.
- 8. Lens: Proprietary optical system.
- 9. External Finish: Die-cast aluminum housing.
- 10. Trim and Hardware: Smooth white trim, uses GU24 Base.
- 11. Other Features: Integral power supply.
- 12. See Manufacturer's Specifications for details: http://www.creelighting.com/downloads/LR6_spec_072908.pdf

C. Fixture C: WET LOCATION RECESSED LIGHT - WILLIAMS COMPACT TYPE C

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Williams PHSQ80-213Q-EB-SS or comparable product by one of the following:
 - a. Lightolier
 - b. USA Illumination
- 2. Voltage: 120V AC.
- 3. Mounting: Recessed ceiling.
- 4. Nominal Dimensions: 9.9"x9.8"x7".
- 5. Lamps: 2 13W G24Q-1 CFLs
- 6. Ballast for Fluorescent Lamps: Electronic instant start.
- 7. Quantity of Ballasts per Fixture: 1.
- 8. Lens: C73 tempered glass.
- 9. External Finish: Pan/plaster mounting frame: galvanized steel construction.
- 10. Trim and Hardware: Die cast aluminum door, textured white powder coat standard; adjustable mounting brackets
- 11. Minimum Visual Comfort Probability: 39 for room dimensions 20'x20'x8.5'.
- 12. Maximum Luminance Ratio: 2.0
- 13. See Manufacturer's Specifications for details: <http://www.hewilliams.com/specification/34070.PDF>

D. Fixture D: WALL MOUNTED - ET2 TYPE D

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide ET2 E20940-10 HELIX or comparable product.
- 2. Voltage: 120V AC.
- 3. Mounting: Surface wall at 15" from ceiling.
- 4. Nominal Dimensions: 20"x4.5"x4".
- 5. Lamps: 2 3.2W LED Lamps, 3500K.
- 6. Driver for LED Lamps: Integral electronic.
- 7. Quantity of Drivers per Fixture: 1.
- 8. Lens: Clear/White.
- 9. External Finish: Satin Nickel
- 10. Trim and Hardware: Pivoting LED segment.
- 11. See Manufacturer's Specifications for details: http://et2online.com/E20940-10_prodspec.aspx

E. Fixture E: PHOTOVOLTAIC IN-GROUND PATH LIGHTS - METEOR SH-180C TYPE E

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Meteor SH-180C or comparable product.
- 2. Voltage: 2.3V DC.
- 3. Mounting: In-ground.
- 4. Nominal Dimensions: 7.9"x3.9"x2".
- 5. Lamps: 15 LED pieces, 55 lux.
- 6. Driver for LED Lamps: Integral electronic.
- 7. Quantity of Drivers per Fixture: 1.
- 8. Lens: Bayer super light-permeable polycarbonate.
- 9. External Finish: Stainless steel (SUS304), cast aluminum.
- 10. Trim and Hardware: Brushed/polished stainless steel.
- 11. Other Requirements: Light sensitive auto on/off.
- 12. Other Features: Crystalline solar panel 2V 380mA.
- 13. See Manufacturer's Specifications for details: <http://www.meteor-lighting.com/images/stories/Spec%20sheet%20for%20SH180%20and%20SH200.pdf>

F. Fixture F: CORNER MOUNTED FIXTURE - WILLIAMS TYPE F WITH LED LAMP

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Williams CL-4-132-FA12125-EB2/1-120 or comparable product by one of the following:

- a. Williams
 - b. LaMar
 - c. Lightolier
 - d. Acculite
2. Voltage: 120V AC.
 3. Mounting: Corner.
 4. Nominal Dimensions: 48"x8.5"x8.5".
 5. Lamps: 1 15W DirectLED FL LED tube, 1500 lumens, 4100K.
 6. Driver for LED Lamps: N/A
 7. Quantity of Drivers per Fixture: 1.
 8. Lens: N/A.
 9. External Finish: 92% minimum average reflective white powder coat with multi-stage iron/phosphate prepared metal
 10. Trim and Hardware: Spring-loaded door latches, 20 gauge die formed C.R.S.
 11. Minimum CU for typical RCR shall be as follows (typical cavity reflectances are ceiling = 80 percent, wall = 50 percent, and floor = 20 percent): RCR 7 .30 CU.
 12. See Manufacturer's Specifications for details:
<http://www.hewilliams.com/specification/58663.pdf>
- G. Fixture G: DESK LIGHT
1. Basis-of-Design Product: Subject to compliance with requirements, provide Konzept HL3001D-SIL Z-Bar High Power LED Desk Lamp or comparable product by one of the following:
 - a. Konzept
 - b. Herman Miller
 2. Voltage: 100-240V AC.
 3. Mounting: Desk.
 4. Nominal Dimensions: Base: 9" diameter, Flexible arm: 38.75", Lamp holder: 14".
 5. Lamps: 6 1.5W High powered LEDs 3200-3700K warm white.
 6. Transformer for LED Lamps: Integrated 100V-240V, 50/60 Hz.
 7. Lens: N/A.
 8. External Finish: Silver.
 9. Trim and Hardware: Aluminum/Plastic
 10. Other Requirements: 532 lux (minimum)
 11. See Manufacturer's Specifications for details:
[http://www.scu-cca-solar.org/submittals/KONCEPT_Z-Bar_High_Power\(2\).pdf](http://www.scu-cca-solar.org/submittals/KONCEPT_Z-Bar_High_Power(2).pdf)
- H. Fixture H: GUARD RAIL EXTERIOR ROPE LIGHT
1. Basis-of-Design Product: Subject to compliance with requirements, provide FlexTec IFL-65A LED Warm White Rope Light or comparable product.
 2. Voltage: 120V DC
 3. Mounting: Guard rail.
 4. Nominal Dimensions: 48"x0.5" diameter.
 5. Lamps: 0.8W/foot Premium LED Diodes 36N LED, 2700-3000K.
 6. Transformer for LED Lamps: Integral inline rectifier, 100-240V AC to 12V DC.
 7. Quantity of Transformers per Fixture: 1 per 50'.
 8. Lens: Clear PVC.
 9. External Finish: N/A.
 10. Trim and Hardware: N/A.
 11. Other Features: 0.66" LED spacing, Minimum Cutting: 1.97 in.
 12. Other Requirements: IP64 Waterproof/weatherproof. Mount with FlexTec Anodized Reflector Trim 206REFS.
 13. See Manufacturer's Specifications for details:
<http://www.1000bulbs.com/LED-Rope-Light-B/33724/>
- I. Fixture L: END CAP EXTERIOR UPLIGHT
1. Basis-of-Design Product: Subject to compliance with requirements, provide EnvironmentalLights.com Waterproof Sheath Narrow Dimmable High Brightness LED Ribbon Flex by the foot or comparable product.
 2. Voltage: 12V DC.
 3. Mounting: Ground.
 4. Nominal Dimensions: Part 1: 50.44"x0.43x0.12", Part 2: 21.37" x0.43x0.12", Part 3: 5" x0.43x0.12", Part 4: 84"x0.43x0.12".
 5. Lamps: 1.97W/foot LED, 3000K, 79 lumens/foot.
 6. Transformer for LED Lamps: 100-240V AC to 12V DC.
 7. Quantity of Transformers per Fixture: 1 per run.
 8. Lens: N/A.
 9. External Finish: IP64 Waterproof/weatherproof.

10. Trim and Hardware: N/A.
 11. Other Features: 0.5" LED spacing
 12. Other Requirements: Minimum Cutting: 1.97 in.
 13. See Manufacturer's Specifications for details:
http://www.environmentallights.com/products/12575/Dimmable_LED390_Ribbon_foot_Warm_Wh
- J. Fixture J: CUSTOM LED FIXTURE BY CCA
1. Basis-of-Design Product: Subject to compliance with requirements, provide a custom LED fixture.
 2. Voltage: 12V DC
 3. Mounting: Exterior Surface Wall.
 4. Nominal Dimensions: Part 1: 5"x36"; Part 2: 5"x46"
 5. Lamps: Part 1: 2 strips of 36" 1.97W/foot LED, 3000K, 79 lumens/foot; Part 2: 2 strips of 46" 1.97W/foot LED, 3000K, 79 lumens/foot.
 6. Transformer for LED Lamps: 100-240V AC to 12V DC.
 7. Quantity of Transformers per Fixture: 1.
 8. Lens: Frosted glass.
 9. External Finish: N/A.
 10. Trim and Hardware: N/A.
 11. Other Requirements: IP64 Waterproof/weatherproof housing.
 12. See Manufacturer's Specifications for details:
http://www.environmentallights.com/products/12575/Dimmable_LED390_Ribbon_foot_Warm_Wh
- K. Fixture M: PHOTOVOLTAIC LED LIGHTS FOR PLANTING ACCENTS - METEOR SH-220C TYPE M
1. Basis-of-Design Product: Subject to compliance with requirements, provide Meteor SH-200C or comparable product.
 2. Voltage: 2.5V DC.
 3. Mounting: In-ground.
 4. Nominal Dimensions: 2.7"x2.4"x2.2".
 5. Lamps: 4 LED pieces, 25 lux.
 6. Driver for LED Lamps: integrated.
 7. Quantity of Drivers per Fixture: 1.
 8. Lens: Bayer super light-permeable polycarbonate.
 9. External Finish: Stainless steel (SUS304), cast aluminum.
 10. Trim and Hardware: Brushed/polished stainless steel.
 11. Other Requirements: Light sensitive auto on/off
 12. Other Features: Crystalline solar panel 2V 380mA, IP68.
 13. See Manufacturer's Specifications for details: <http://www.meteor-lighting.com/images/stories/Spec%20sheet%20for%20SH180%20and%20SH200.pdf>

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set units level, plumb, and square with ceiling, walls, and ground surface, and secure.
- B. Support for Recessed and Semirecessed Grid-Type Fixtures:
1. Install ceiling support system wires at a minimum of four wires for each fixture, located not more than 150 mm from fixture corners.
 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
- C. Attach Guard-rail mounted fixture with FlexTec Anodized Reflector Trim.
- D. Adjust aimable lighting fixtures to provide required light intensities.
- E. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's written instructions.

END OF SECTION 265000

SECTION 270528 – CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes all Back Boxes and Conduit.
- B. Related Systems
 - 1. 27 15 13 – Communications Copper Horizontal Cabling
 - 2. 27 15 00 – Communications Horizontal Cabling
 - 3. 27 15 43 – Communications Faceplates and Connectors

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate layout and installation of conduit and boxes with other construction the penetrates walls or is supported by them.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Pass & Seymour
- B. Southwire

2.2 CONDUIT

- A. Liquidtight flexible Nonmetallic conduit <http://www.southwire.com/ProductCatalog/XTEInterfaceServlet?contentKey=p rodcat sheet236>
 - 1. Various sizes as specified in relevant drawings
 - 2. NEC Type designation – Type LFNC-B
 - 3. ANSI/NFPA-70, NEC Article 356
 - 4. UL Listed

2.3 OLD WORK BOXES

- A. Single Gang Old Work Outlet Boxes <http://www.passandseymour.com/pdf/P04.pdf>
 - 1. S118W
 - 2. 3" Ø L, 2" Ø W, 3" 1/32 D
 - 3. 18.0 Cubic Inches Volume
 - 4. UL Listed

2.4 SWITCH & OUTLET BOXES

- A. Single Gang Outlet Boxes <http://www.passandseymour.com/pdf/PO3.pdf>
 - 1. P122R & P122RN
 - 2. 3" Ø L, 2" Ø W, 3" 3/8 D
 - 3. 22.5 Cubic Inches Volume
 - 4. UL Listed

2.5 LOW VOLTAGE BRACKET / BOX

- A. Single Gang Low Voltage Bracket / Box <http://www.av-outlet.com/images/arlington/LV.pdf>
 - 1. UL Listed

PART 3 - EXECUTION**3.1 GENERAL COMMUNICATION EQUIPMENT INSTALLATION REQUIREMENTS**

- A. Install communication equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
- B. Install communication equipment to provide for ease of disconnecting the equipment with minimum interference to other installations.
- C. Install communication equipment to allow right of way for piping and conduit installed at required slope.
- D. Install communication equipment to ensure that connecting pathways and cables are clear of obstructions and of the working and access space of other equipment.
- E. Install required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- F. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Comply with requirements in Division 08 Section "Access Doors and Frames."
- G. Install sleeve and sleeve seals of type and number required for sealing communication service penetrations of exterior walls.

3.2 SLEEVE AND SLEEVE-SEALS INSTALLATION

- A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- B. Cut sleeves to length for mounting flush with both wall surfaces.
- C. Extend sleeves installed in floors 50 mm above finished floor level.
- D. Size pipe sleeves to provide 6.4-mm annular clear space between sleeve and cable unless sleeve seal is to be installed.
- E. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- F. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."
- G. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- H. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 25-mm annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- I. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 25-mm annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.3 FIRESTOPPING

- A. Apply firestopping to communications penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Division 07 Section "Penetration Firestopping."

END OF SECTION 270528

SECTION 271013 - STRUCTURED RESIDENTIAL CABLING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, Shop Drawings, system schematic, floor plans with cabling point labeling, and cabling color scheme.
- B. Performance Requirements: Coordinate the features of materials and equipment so they form an integrated system complying with TIA/EIA-570-A. Match components and interconnections for optimum performance.
- C. Comply with NFPA 70, "National Electrical Code."
- D. Comply with TIA/EIA-570-A.

PART 2 - PRODUCTS

2.1 DISTRIBUTION DEVICE

- A. Description: Equipment to support network, including signal amplification, cross connects, network hubs, and service terminations.
 - 1. Auxiliary disconnect outlet and distribution device cords for telephone service.
 - 2. Cross-connect devices, patch panels, cable termination devices, and accessories shall meet the data transmission speed and bandwidth of the associated cabling.
 - 3. Comply with TIA/EIA-570-A, Grade 2 service standard.
 - 4. Comply with TIA/EIA-570-A, Grade service standard noted on Drawings.
- B. Telephone: For one line from the exchange access provider; with cross-connect device to enable the selection and pairing of incoming lines with outlet lines.
 - 1. Place outlet cabling in a star topology.
 - 2. Cross Connect: Modular, IDC-type, cross-connect device with modules designed for punch-down caps or tools.
 - 3. Provide space for installation and connection of an ADSL gateway distribution device furnished by access provider.
- C. Power Outlets: UL 1449; cabinet mounted, with two 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacle(s), with surge protection, and including the following:
 - 1. LED indicator lights for power and protection status.
 - 2. Exceeds UL943 voltage surge requirements; survives 100x the required UL 3kA/6kV voltage surge test cycles.
 - 3. See section 262726 for further information.

2.2 WIRING DEVICES

- A. Modular; each outlet configuration field fabricated from factory-made components. Listed and labeled as complying with TIA/EIA-568-B.2, TIA/EIA-B.3, and UL 1863.
- B. Mount connectors on single or multigang faceplate.
 - 1. Faceplates: High-impact plastic; colors as selected by Architect. Colors shall be white.
 - 2. Outlet shall accept the following components:
 - a. Telephone and Data Jacks: IDC connector for UTP, modular, RJ-45.

2.3 GROUNDING AND BONDING

- A. Materials: Comply with NFPA 70 and UL 467.

2.4 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and with applicable requirements in Division 27 Section "Common Work Results for Communications."
- B. Cable Labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Comply with BICSI RNCM.
- B. Install firestopping according to TIA/EIA-569-A.
- C. Ground equipment complying with ANSI-J STD-607-A.
- D. Cable Installation:
 - 1. Install exposed cable parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
 - 2. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 - 3. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 4. Secure and support cable at intervals not exceeding 760 mm and not more than 150 mm from boxes, outlets, and terminals.
 - 5. Install UTP cable using techniques, practices, and methods that are consistent with Category 5e rating of components and that ensure Category 5e of completed and linked signal paths, end to end.
 - a. Do not untwist more than 13 mm of Categories 5e and 6 cable at connector terminations.
 - 6. Install fire and carbon monoxide warning device cable between the security system cabinet and the outlet as follows:
 - a. Four-Conductor Cable: Smoke detectors, combination strobe/horn appliance.
 - b. Four-Conductor Cable: Heat detectors, horns.
 - 7. Protection against Physical Damage:
 - a. Install cabling and nonmetallic raceways complying with NFPA 70, "Wiring Methods" Article. All cabling in this Section shall comply with provisions for nonmetallic-sheathed cabling listed in that article.
 - b. Install insulated grommets or bushings when cable passes through openings in metal studs or enters boxes and cabinets.
 - c. Installing cable in shallow grooves, as described in NFPA 70, "Wiring Methods" Article, is not permitted.
- E. Wiring within Distribution Device:
 - 1. Group cable-connecting hardware into separate logical fields.
 - 2. Train conductors to terminal points with no excess.
 - 3. Use lacing bars to restrain cable, to prevent straining connections, and to prevent bending cable to smaller radii than minimums recommended by manufacturer.
- F. Separation from EMI Sources:
 - 1. Comply with TIA/EIA-570-A for separating telecommunication cabling from potential EMI sources, including electrical power lines and equipment. Comply with the following minimum separation distances from possible sources of EMI:
 - a. Power Lines or Electrical Equipment near Open Cabling or Cabling in Nonmetallic Raceways: 50 mm.
 - b. Electrical Motors and Transformers, 5 kVA or HP and Larger: 1220 mm.
 - c. Fluorescent Fixtures: 125 mm.
 - 2. Maintain electrical branch circuit conductors (line, neutral, and grounding wires) together by sheathing or bundling to minimize inductive coupling. 50 mm may be reduced if cabling crosses at right angles.

3. Install cabling in grounded metallic raceways where the required separation is not practical.

3.2 IDENTIFICATION

A. Cable and Wire Identification:

1. Label each cable within 100 mm of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Within Connector Fields in Distribution Devices: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

- #### **B. Cable Schedule:** Post in distribution device. List incoming and outgoing cables and their designations, origins, and destinations. Furnish an electronic copy of final comprehensive schedules for Project.

END OF SECTION 271013

SECTION 271119 - COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes all termination blocks for the telecommunication system.
- B. Related Systems
 - 1. 27 15 13 - Communications Copper Horizontal Cabling

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- D. Grounding: Comply with ANSI-J-STD-607-A.

1.4 COORDINATION

- A. Coordinate layout and installation of faceplates and connectors with back boxes and other construction the penetrates walls or is supported by them.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Value Tech Supply

2.2 GROUNDING REQUIREMENTS

- A. Comply with requirements in Division 27 Section "Common Work Results for Communications" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

2.3 66 PUNCH DOWN BLOCKS

- A. 66 PUNCH DOWN BLOCK <http://www.valuetechsupply.com/1031011.html?productid=1031011&channelid=FROOG>
 - 1. Terminates 22 through 26 AWG wire.
 - 2. UL Listed

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Mount punch down block to wall.
- B. Connect all telecom wiring to the punch down block.

END OF SECTION 271119

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes all Audio Video Communications Horizontal Cabling
- B. Related Systems
 - 1. 27 15 43 - Communications Faceplates and Connectors
 - 2. 27 05 28 - Conduits and Backboxes for Communication Systems

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Grounding: Comply with ANSI-J-STD-607-A.

1.4 COORDINATION

- A. Coordinate layout and installation of conduit and boxes with other construction the penetrates walls or is supported by them.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. MonoPrice
- B. Ram Electronics

2.2 GROUNDING REQUIREMENTS

- A. Comply with requirements in Division 27 Section "Common Work Results for Communications" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

2.3 IN-WALL HDMI CABLE

- A. High Speed HDMI 1.3a Cable http://www.monoprice.com/products/product.asp?c_id=102&cp_id=10240&cs_id=1024001&p_id=3990&seq=1&format=2
 - 1. Male termination at both ends of cable
 - 2. 25ft
 - 3. Tin conductor plating with gold connector finish
 - 4. Gauge: 22AWG
 - 5. HDMI 1.3a Certified
 - 6. CL2 Rated for In Wall Installation

- 7. UL Listed
- B. 5-RCA Component Audio/Video Cable http://www.monoprice.com/products/product.asp?c_id=102&cp_id=10235&cs_id=1023501&p_id=2857&seq=1&format=3 - specification
 - 1. Male termination at both ends of cable
 - 2. 25ft
 - 3. Gold Plated RCA Plugs
 - 4. Gauge: 18 AWG Video, 26AWG Audio
 - 5. CL2 Rated for In Wall Installation
 - 6. UL Listed
- C. DVI Cable http://www.monoprice.com/products/product.asp?c_id=102&cp_id=10209&cs_id=1020901&p_id=2097&seq=1&format=3 - specification
 - 1. Male termination at both ends of cable
 - 2. 25ft
 - 3. Gauge: 24 AWG
 - 4. CL2 Rated for In Wall Installation
 - 5. UL Listed
- D. 3-RCA Composite Audio/Video Cable
 - 1. Use product specified in Section 2.3 Subsection B
 - 2. Use green cable as composite video cable.
 - 3. Use audio cables as normal.
- E. Speaker Cable http://www.monoprice.com/products/product.asp?c_id=102&cp_id=10239&cs_id=1023904&p_id=4045&seq=1&format=2
 - 1. Unterminated at both ends
 - 2. Gauge 18 AWG
 - 3. CL2 Rated for In Wall Installation
 - 4. UL Listed
- F. 3.5mm Mini Stereo Cable
<http://www.ramelectronics.net/audio-video/wallplates-a-v/plenum-cables/mini-stereo-plug-plenum-cable-mpsmpsp/prodMPSMPSP.html>
 - 1. Male termination at both ends
 - 2. Rated for In-Wall installations
 - 3. 25ft

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Install cables from junction boxes behind wall plates to run down under floor or building to cable termination location in building. Conceal all cables except in unfinished spaces.
 - 1. Do not run cable through any nearby conduit unless specified on relevant drawings.
 - 2. Comply with requirements for raceways and boxes specified in Division 26 Section "Common Work Results for Electricals."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.2 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Cables may not be spliced. Secure and support cables at intervals not exceeding 760 mm and not more than 150 mm from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 2. Cold-Weather Installation: Bring cable to room-temperature before dereeling. Heat lamps shall not be used for heating.
- C. Open-Cable Installation
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Cable shall not be run through structural members in contact with pipes ducts or other potentially damaging items.
- D. Separation from EMI Sources

1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 127 mm.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 300 mm.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 610 mm.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 64 mm.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 150 mm.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 300 mm.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 76 mm.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 150 mm.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 1200 mm.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 127 mm.

3.3 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Bond metallic equipment to the ground bar, using not smaller than No. 6 AWG equipment grounding conductor.

END OF SECTION 271500

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes all RJ cable, connectors, and terminators.
- B. Related Systems
 - 1. 27 15 43 - Communications Faceplates and Connectors
 - 2. 27 15 28 - Conduits and Backboxes for Communication Systems

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- D. Grounding: Comply with ANSI-J-STD-607-A.

1.4 COORDINATION

- A. Coordinate layout and installation of conduit and boxes with other construction the penetrates walls or is supported by them.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Leviton
- B. Monoprice

2.2 UTP CABLE HARDWARE SYSTEM REQUIREMENTS

- A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools.
- B. Patch Cords: Factory-made, four-pair cables in various lengths; terminated with eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure desired performance. Patch cords shall have latch guards, to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.

2.3 GROUNDING REQUIREMENTS

- A. Comply with requirements in Division 27 Section "Common Work Results for Communications" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

2.4 IDENTIFICATION OF PRODUCTS REQUIREMENTS

- A. Comply with TIA/EIA 606-A, and shall meet UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.5 CATEGORY 6 UTP DATA CABLE

- A. 1000ft Cat6 UTP Solid PVC Cable Un-terminated http://www.monoprice.com/products/product.asp?c_id=102&cp_id=10234&cs_id=1023402&p_id=2270&seq=1&format=2
 - 1. 4 pair unshielded twisted pair
 - 2. PVC Jacket
 - 3. Gauge: 24 AWG
 - 4. Color : Blue
 - 5. Rated for In-Wall Installation
 - 6. Meets EIA/TIA CAT6 Specifications
 - 7. Comply with IEEE 802.3, IEEE 802.3u, IEEE 802.12

2.6 C-BUS CABLE

- A. 1000ft Cat5e UTP PVC Cable Un-terminated http://www.monoprice.com/products/product.asp?c_id=102&cp_id=10233&cs_id=1023304&p_id=886&seq=1&format=2
 - 1. 4-pair unshielded twisted pair
 - 2. PVC Jacket
 - 3. Gauge: 24AWG
 - 4. Color: Black
 - 5. Rated for In-Wall Installation
 - 6. Compliant with EIA/TIA standards
 - 7. Cable is terminated with specific configuration as specified in figure 7 and table 6.4 of [http://ecatalog.squared.com/pubs/Power Management/Lighting Control/Square D Clipsal Lighting Control Products/Touch Screens/63249-420-209.pdf](http://ecatalog.squared.com/pubs/Power%20Management/Lighting%20Control/Square%20D%20Clipsal%20Lighting%20Control%20Products/Touch%20Screens/63249-420-209.pdf)

2.7 TELECOM CABLE

- A. 1000ft Cat5e UTP PVC Cable Un-terminated http://www.monoprice.com/products/product.asp?c_id=102&cp_id=10233&cs_id=1023304&p_id=885&seq=1&format=2
 - 1. 4-pair unshielded twisted pair
 - 2. PVC Jacket
 - 3. Gauge: 24 AWG
 - 4. Color: Grey
 - 5. Rated for In-Wall Installation

2.8 CATEGORY 6 TERMINATION

- A. 8P8C Female UTP Quickport Snap-in Connector http://www.leviton.com/OA_HTML/ibeCCtPltmDspRte.jsp?item=276741§ion=10236
 - 1. Comply with T568A and T56B wiring standards
 - 2. Meet standards for cULus, NEC Article 800, and FCC Part 68.
 - 3. Meets TIA/EIA CAT6 Specifications.
 - 4. Designed for use with Leviton QuickPort compatible products.
 - 5. Color: Blue
- B. 8P8C Male UTP EZ-RJ45 Connector http://www.leviton.com/OA_HTML/ibeCCtPltmDspRte.jsp?item=6517§ion=10216
 - 1. Meets standards for FCC part 68.
 - 2. Exceeds CAT5e performance requirements

2.9 C-BUS CABLE TERMINATION

- A. 8P8C Female UTP Quickport Snap-in Connector http://www.leviton.com/OA_HTML/ibeCCtpltmDspRte.jsp?item=133512§ion=10233
 - 1. Comply with T568A and T568B wiring standards
 - 2. Meets TIA/EIA CAT5 specifications.
 - 3. Complies with all National Electric Codes
 - 4. UL Listed
 - 5. Color: Black
- B. 8P8C Male UTP EZ-RJ45 Connector
 - 1. Use product specified in section 2.4, sub-section B

2.10 TELECOM CABLE TERMINATION

- A. RJ14 Female Quickport Snap-In Connector http://www.leviton.com/OA_HTML/ibeCCtpltmDspRte.jsp?item=8754
 - 1. Complies with TIA/EIA standards
 - 2. Meets FCC Part 68
 - 3. UL Listed

PART 3 - EXECUTION**3.1 WIRING METHODS**

- A. Install cables from junction boxes behind wall plates to run down under floor or building to cable termination location in building. Conceal all cables except in unfinished spaces.
 - 1. Do not run cable through any nearby conduit unless specified on relevant drawings.
 - 2. Comply with requirements for raceways and boxes specified in Division 26 Section "Common Work Results for Electricals."
- B. For C-Bus cable, connect cable in daisy chain pattern from each C-Bus device to the next, taking the appropriate pathway through the building to create the connection.
 - 1. Comply with any notes on relevant drawings
 - 2. Comply with requirements for raceways and boxes specified in Division 26 Section "Common Work Results for Electricals."
- C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.2 USE OF CABLE

- A. Comply with execution steps of specification sheets referencing products in this document.
- B. For C-Bus cable, terminate cable in accordance with section 2.6 sub-section A, item 7 of this document.
- C. For RJ-14 Cable use white/orange wire as RJ14 pin 1, use blue wire as RJ14 pin 2, use white/blue wire as RJ14 pin 3, and use orange wire as RJ14 pin 4.

3.3 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 760 mm and not more than 150 mm from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 6. Cold-Weather Installation: Bring cable to room-temperature before dereeling. Heat lamps shall not be used for heating.
 - 7. Do not untwist UTP cables more than 12 mm from the point of termination to maintain cable geometry.

- C. Open-Cable Installation
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Suspend UTP cable not in a wireway or pathway a minimum of 200 mm above ceilings by cable supports.
 - 3. Cable shall not be run through structural members in contact with pipes ducts or other potentially damaging items.
- D. Separation from EMI Sources
 - 1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 127 mm.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 300 mm.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 610 mm.
 - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 64 mm.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 150 mm.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 300 mm.
 - 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 76 mm.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 150 mm.
 - 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 1200 mm.
 - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 127 mm.

3.4 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Bond metallic equipment to the ground bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Comply with TIA/EIA-606-A.
 - 1. Administration Class: [1] [2].
 - 2. Color-code, cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
- B. Labels shall be preprinted or computer-printed type with printing area and type color that is contrasting with cable jacket color, but still complying with TIA/EIA-606-A.

END OF SECTION 271513

SECTION 271543 – COMMUNICATIONS FACEPLATES AND CONNECTORS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes all wall plates for Data, Telecom, and A/V Cable and connectors
- B. Related Systems
 - 1. 27 15 13 – Communications Copper Horizontal Cabling
 - 2. 27 15 00 – Communications Horizontal Cabling
 - 3. 27 05 28 – Conduits and Back Boxes for Communication Systems

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- D. Grounding: Comply with ANSI-J-STD-607-A.

1.4 COORDINATION

- A. Coordinate layout and installation of faceplates and connectors with back boxes and other construction the penetrates walls or is supported by them.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Leviton
- B. Pass & Seymour

2.2 UTP CABLE HARDWARE SYSTEM REQUIREMENTS

- A. Jacks and Jack Assemblies: Modular, color-coded, one to six position modular receptacle units with integral IDC-type terminals.

2.3 CONSOLIDATION POINTS

- A. Description: Consolidation points shall comply with requirements for cable connecting hardware.
 - 1. Mounting: Recessed in Wall

2.4 GROUNDING REQUIREMENTS

- A. Comply with requirements in Division 27 Section "Common Work Results for Communications" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

2.5 IDENTIFICATION OF PRODUCTS REQUIREMENTS

- A. Comply with TIA/EIA 606-A, and shall meet UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 WALLPLATES

- A. QuickPort Wallplate Single Gang 1-port white http://www.leviton.com/OA_HTML/ibeCCtpltmDspRte.jsp?item=303753§ion=10426
 - 1. Accepts QuickPort snap-in modules
 - 2. UL Listed
- B. QuickPort Wallplate Single Gang 2-port white http://www.leviton.com/OA_HTML/ibeCCtpltmDspRte.jsp?item=308742§ion=10426
 - 1. Accepts QuickPort snap-in modules
 - 2. UL Listed
- C. QuickPort Wallplate Single Gang 3-port white http://www.leviton.com/OA_HTML/ibeCCtpltmDspRte.jsp?item=308744§ion=10426
 - 1. Accepts QuickPort snap-in modules
 - 2. UL Listed
- D. QuickPort Wallplate Sing Gang 6-port white http://www.leviton.com/OA_HTML/ibeCCtpltmDspRte.jsp?item=303747§ion=10426
 - 1. Accepts QuickPort snap-in modules
 - 2. UL Listed
- E. Blank Plate – Box Mounted <http://www.passandseymour.com/pdf/S10.pdf>
 - 1. White Color
 - 2. One Gang
 - 3. UL514 Listed

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Inset QuickPort snap-in modules into wallplates. Insert wallplate over junction box.
- B. Install other wallplates according to manufacture's instructions.

3.2 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.3 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

- B. Comply with ANSI-J-STD-607-A.
- C. Bond metallic equipment to the ground bar, using not smaller than No. 6 AWG equipment grounding conductor.

END OF SECTION 271543

SECTION 272100 - DATA COMMUNICATIONS NETWORK EQUIPMENT**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes all Networking Hardware
- B. Related Systems
 - 1. 27 22 00 - Data Communications Hardware

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Kyocera

2.2 DATA COMMUNICATIONS ROUTERS

- 1. Kyocera KR1 Mobile Router
 - a. Enables wireless broadband network with 1xEV-DO PC card
 - b. LAN Interface: WiFi® - 802.11b & g with antenna, 4 Ethernet ports
 - c. Security: 64-bit or 128-bit WEP encryption, WPA-PSK authentication
 - d. Dimensions: 8.5 in x 5.3 in x 1.3 in (215 mm x 135 mm x 32 mm)
 - e. <http://www.kyocera-wireless.com/kr1-router/tech-specs.htm>

2.3 DATA COMMUNICATIONS SWITCHES

- A. D-Link DGS 8-Port 1000 Desktop Switch <http://www.dlink.com/products/?pid=495>
 - 1. Compliant with all Ethernet wiring standards including IEEE 802.3ab
 - 2. 8 RJ-45 female connection ports
 - 3. Wall mountable
 - 4. FCC Class B, CE, VCCI
 - 5. UL Listed

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Comply with product installation manual and related NEC codes

END OF SECTION 272100

SECTION 272200 - DATA COMMUNICATIONS HARDWARE**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes all computer hardware.
- B. Related Systems
 - 1. 27 21 00 - Data Communications Network Equipment

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Grounding: Comply with ANSI-J-STD-607-A.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Apple Computer

2.2 LAPTOP

- 1. Apple 17-inch Macbook Pro
 - a. Display: 17-inch (diagonal) high-resolution LED-backlit glossy widescreen display, 1920-by-1200 resolution
 - b. Battery and Power: Built-in 95-watt-hour lithium-polymer battery
 - c. Wireless: Built-in AirPort Extreme Wi-Fi (based on IEEE 802.11n draft specification); built-in Bluetooth 2.1 + EDR (Enhanced Data Rate) module
 - d. Processor and Memory: 2.66GHz Intel Core 2 Duo processor; 4GB (two 2GB SO-DIMMs) of 1066MHz DDR3 SDRAM
 - e. Meets ENERGY STAR requirements; EPEAT Gold rating
 - f. <http://www.apple.com/macbookpro/specs.html>

2.3 DESKTOP

- 1. Mac mini
 - a. Intel Processor
 - b. DVI Output connection with adapter
 - c. Integrated Graphics Processor
 - d. CD + DVD Reading capability

2.4 HANDHELD

- 1. Apple iPod Touch
 - a. Display: 3.5-inch (diagonal) widescreen Multi-Touch display
 - b. Wireless: Wi-Fi (802.11b/g)
 - c. Battery Life: Up to 36 hours of music playback; up to 6 hours of video playback
 - d. <http://www.apple.com/ipodtouch/specs.html>

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Comply with product installation manual and related NEC codes
- B. Join all devices to home network using a hard line connection if possible or wireless connection.

END OF SECTION 272200

SECTION 272219 - DATA COMMUNICATIONS SERVERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data

PART 2 - PRODUCTS

- A. DATA ACQUISITION SERVER
1. Description: Acquire data from pulse and analog sensors, and communicate with Modbus devices, send data through an internal web server
 2. System: Embedded CPU with Linux operating system, 32 MB ram, 16 MB flash
 3. Communication: RJ45 10/100 Ethernet, V.34 bis, 33.600 bps
 4. Compatibility: Modbus/RTU, Modbus/TCP, TCP/IP, PPP, HTTP/HTML, FTP, NTP, XML, SNMP-Trap
 5. Power Supply 24VDC, 1A, class wall brick transformer
 6. Inputs: Voltage 0-10vdc, Current 4-20mA, Resistance 100-100k ohms, Pulse dry contact outputs maximum rate 10hz minimum pulse width 50ms
 7. Outputs: optically isolated outputs, opto-fet, dry contacts, 30vdc, 150mA max
 8. Operating conditions: temperature 0-50°C, 0-95% RH non-condensing
 9. Specific product specification: http://www.obvius.com/pdfs/A8812_Datasheet.pdf
- B. CABLES
1. RS 485 three wire cable for communication between data acquisition server and other Modbus equipment to be daisy-chained

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with product installation manual and related NEC codes

END OF SECTION 272219

SECTION 274116 - INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT**PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes all televisions systems and sound systems.
- B. Related Systems
 - 1. 27 15 00 - Communications Horizontal Cabling
 - 2. 27 41 23 - Audio Video Accessories

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

1.4 COORDINATION

- A. Coordinate layout and installation of devices with all other devices in building.

PART 2 - PRODUCTS**2.1 MANUFACTURES**

- A. Samsung
- B. Denon
- C. Sony
- D. Triad

2.2 TELEVISIONS

- A. Samsung 40" LED HDTV http://www.samsung.com/us/consumer/detail/detail.do?group=televisions&type=televisions&ubtype=ledtv&model_cd=UN40B6000VFXZA
 - 1. Aspect Ratio: Widescreen
 - 2. Screen size: 39.9"
 - 3. Refresh Rate: 120Hz
 - 4. Wall mountable
 - 5. UL Listed

2.3 A/V RECEIVERS

- A. Denon 7.1 CH Home Theatre Receiver <http://www.usa.denon.com/ProductDetails/4527.asp>
 - 1. 7.1 Channel or 5.1 channel
 - 2. Automatic switching of video signal
 - 3. RS-232 control enabled

2.4 VIDEO DISC PLAYERS

- A. Blu-ray Disc Player <http://www.sonystyle.com/webapp/wcs/stores/servlet/ProductDisplay?catalogId=10551&storeId=10151&langId=-1&productId=8198552921665368427>
 - 1. Output of 480i to 1080p
 - 2. Reads all video discs formats
 - 3. DTS Decoding

2.5 SPEAKERS

- A. Triad InWall Gold/4 Omni <http://www.triadspeakers.com/products/iwg4o.html>
 - 1. Width: 10-3/4"
 - 2. Frequency Response: 60Hz – 20kHz
 - 3. Sensitivity: 86 dB/1W/1m

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Mount TV to wall according to manufactures instructions.
- B. Place sound amplifier in entertainment cabinet and connect all speakers to it.
- C. Follow manufactures instruction for all other products listed.

END OF SECTION 274116

SECTION 274123 - AUDIO VIDEO ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes all audio/video accessories
- B. Related Systems
 - 1. 27 41 16 - Integrated Audio Video Systems and Equipment

1.2 SUBMITTALS

- A. Product Data: Manufacture specification sheets for all products listed under products section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

1.4 COORDINATION

- A. Coordinate layout and installation of devices with all other devices in building.

PART 2 - PRODUCTS

2.1 MANUFACTURES

- A. Samsung

2.2 TELEVISION WALL MOUNTS

- A. Samsung Ultra Slim Wall Mount http://www.samsung.com/us/consumer/detail/accessories.do?group=televisions&type=televisions&subtype=ledtv&model_cd=UN40B6000VFXZA
 - 1. For mounting UN40B6000 television.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Follow manufactures instruction for all other products listed.

END OF SECTION 274123

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data and Shop Drawings.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS**2.1 PATHWAYS**

- A. Support of Open Cabling: NRTL labeled for support of Category 5e cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
- B. Conduit and Boxes: Comply with Division 26 Section "Common Work Results for Electrical."
 - 1. Minimum Outlet Box Size: 50 mm wide, 75 mm high, 64 mm deep.
- C. Backboards: 19 mm, 1220 by 2440 mm plywood.

2.2 UTP CABLE

- A. Description: 100 ohm, four-pair UTP, covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2, Category 6.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, General Purpose: Type CMG
- B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- C. Plenum-Type Cable: NFPA 70, Type CMP.
 - 1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Plastic insulation.
 - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - 4. Plastic jacket.
 - 5. Pairs shall be cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with NFPA 262.

2.3 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CM[or CMG].
 - 1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.4 LOW-VOLTAGE CONTROL CABLE

- A. Paired Lock Cable: NFPA 70, Type CMG.
1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
 2. PVC insulation.
 3. Unshielded.
 4. PVC jacket.
 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Type, Paired Lock Cable: NFPA 70, Type CMP.
1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
 2. PVC insulation.
 3. Unshielded.
 4. PVC jacket.
 5. Flame Resistance: Comply with NFPA 262.

2.5 CONTROL CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, [Type THHN-THWN, complying with UL 83, in raceway] [Type XHHN, complying with UL 44, in raceway].
- B. Class 2 Control Circuits: Stranded copper, [Type THHN-THWN, complying with UL 83, in raceway] [power-limited cable, complying with UL 83, concealed in building finishes] [power-limited tray cable, complying with UL 83, in cable tray] [Type XHHN, complying with UL 44, in raceway].
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
- B. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- C. Comply with requirements in Division 26 Section "Common Work Results for Electrical." for installation of conduits and wireways.
- D. Backboards: Install backboards with 2440-mm dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters (except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used). Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Comply with requirements for raceways and boxes specified in Division 26 Section "Common Work Results for Electrical."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
1. Comply with TIA/EIA-568-B.1.
 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 3. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 4. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation: Comply with TIA/EIA-568-B.2.
- D. Open Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend copper cable not in a wireway or pathway a minimum of 200 mm above ceilings by cable supports not more than 400 mm apart.
 3. Do not install cables through structural members or in contact with pipes, ducts, or other potentially damaging items.
- E. Separation from EMI Sources: Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment. Comply with the following minimum separation distances from possible sources of EMI:
1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 127 mm.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 300 mm.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 610 mm.
 2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 64 mm.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 150 mm.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 300 mm.
 3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 76 mm.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 150 mm.
 4. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 1200 mm.
 5. Separation between Cables and Fluorescent Fixtures: A minimum of 127 mm.

3.4 FIRESTOPPING

- A. Firestopping: Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

- A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.

END OF SECTION 280513

SECTION 283100 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. System Description: Noncoded, conventional, hardwired, zoned, 24-V dc loop system.
 - 1. Initiating Device Circuits: NFPA 72, Class B, Style B.
 - 2. Notification Appliance Circuits: NFPA 72, Class B, Style Y.
- B. Submittals: Product Data and system operating description.
- C. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals, make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations.
- D. Comply with NFPA 72.
- E. UL listed and labeled.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 ALARM-INITIATING DEVICES

- A. Smoke Detectors: UL 268, 9-V dc, battery operated
- B. Horns: Electric-vibrating-polarized type, 85 dBA at 3 m.
- C. See <http://www.usielectric.com/pdf/SS-775-LRC.pdf> for details.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and test systems according to NFPA 72. Comply with NECA 1.
- B. Wiring Method: No wiring required

END OF SECTION 283100

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify [utility locator service] [Miss Utility] [Call Before You Dig] [Dig Safe System] [One Call] <Insert name> for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control[and plant-protection] measures are in place.
- E. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance.
- B. Protect site improvements to remain from damage. Restore damaged improvements to condition existing before start of site clearing.
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect remaining trees and shrubs from damage and maintain vegetation. Employ a licensed arborist to repair tree and shrub damage. Restore damaged vegetation. Replace damaged trees that cannot be restored to full growth, as determined by arborist.
- E. Do not store materials or equipment or permit excavation within drip line of remaining trees.
- F. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to [erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction] [a sediment and erosion control plan, specific to the site, that complies with EPA document No. EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent].
- G. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities.

3.2 SITE CLEARING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
- B. Strip topsoil. Stockpile topsoil that will be reused in the Work.
 - 1. Stockpile surplus topsoil to allow for respreading deeper topsoil.

- C. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- D. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Neatly saw-cut length of existing pavement to remain before removing existing pavement.
- E. In areas not to be further excavated, fill depressions resulting from site clearing. Place and compact satisfactory soil materials in 150-mm- thick layers to density of surrounding original ground.
- F. Dispose of waste materials, including trash, debris, and excess topsoil, off Owner's property. Burning waste materials on-site is not permitted.
 - 1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 311000

SECTION 328400 - PLANTING IRRIGATION**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS**2.1 COMPONENTS**

- A. Pipe Materials: PVC pipe, ASTM D 2241, PVC 1120, SDR 26.
 - 1. Fittings: PVC plastic pipe fittings, ASTM D 2467, Schedule 80, socket type with ASTM F 656 primer and ASTM D 2564 solvent cement.
 - a. 2" PVC pipe with 2% slope min.
 - b. See manufacturer's specifications for details:
<http://www.clearpvcpipe.com/index.asp?PageAction=VIEWPROD&ProdID=143>
 - 2. Fittings: HDPE, ASTM F 771; PE 3408 compound; SDR 15. Dripworks, 1" Flattube
 - a. Insert Fittings: ASTM D 2609, nylon or propylene plastic.
 - b. 1" Easy Loc X 3/4" Loc Reducing Coupler
 - c. Model # ELRC134
 - d. See Manufacturer's Specifications:
<http://www.dripworksusa.com/store/easyloc.php>
 - 3. Fittings: ABS fitting, ASTM F 771; PE 3408 compound; SDR 15.
 - a. ABS Vent Elbow, 2"
 - b. Model # 80720
 - e. See Manufacturer's Specifications:
<http://plumbing.hardwarestore.com/52-298-abs-fittings/abs-vent-elbow-653581.aspx>
- B. Automatic Drain Valves: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 17 to 20 kPa.
 - 1. 3-way diverter valve
 - 2. See manufacturer's specifications for details:
<http://www.oasisdesign.net/greywater/divertervalves.htm>
- C. Geofabric Cloth:

1. Geotextile Fabric Underlay # AQGE05X15
 2. Dimensions: 5' X 15'
 3. See manufacturer's specifications for details:
<http://pondusa.com/liners3.htm>
- D. Sump Basin:
1. Sump Basin Sink Tray # 4RK10
 2. Capacity: 11 Gallons
 3. Dimensions: 17" L X 14" H
 4. See manufacturer's specifications for details:
<http://www.grainger.com/Grainger/items/4RK10>
- E. Valve Box:
1. Orbit 12" Standard Rectangular Valve Box
 2. Model # 53030
 3. See manufacturer's specifications for details:
http://www.homedepot.com/webapp/wcs/stores/servlet/ProductDisplay?recordId=6603&storeZip=94303&langId=-1&endecaDataBean=com.homedepot.sa.el.wc.catalog.beans.EndecaDataBean%406b375d16&searchRedirect=53030&storeCity=East+palo+alto&rough=Value&navFlow=3&mode=autoSelectAndSet&productId=100010579&jspStoreDir=hdus&reload=true&storeState=CA&catalogId=10053&zip=94305&storeId=10051&keyword=53030&distance_1=100&showStores=false&ddkey=Search
- F. Drain Rock:
1. Size: 3/4"
 2. See manufacturer's specifications for details:
<http://www.pdbs.us/materials.html>
- G. Chip Bark:
1. Wood Chips (small, medium, large)
 2. See manufacturer's specifications for details:
<http://www.pdbs.us/materials.html>
- H. Infiltration Basin

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components having pressure rating equal to or greater than system operating pressure.
- B. Lay piping on solid subbase, uniformly sloped without humps or depressions. Slope circuit piping down toward drain valve a minimum of 0.4 percent.
- C. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone to 300 mm below grade. Cover

with asphalt-saturated felt and excavated material.

D. Minimum Cover: Provide the following minimum cover over top of buried piping:

1. Pressure Piping: 915 or 460 mm below frost depth, whichever is greater.
2. Circuit Piping: 300 mm.
3. Drain Piping: 300 mm.
4. Sleeves: 600 mm.

E. Install water meters in meter boxes with shutoff valve on meter inlet. Include valve on meter outlet and valved bypass around meter.

F. Install pressure regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet and valved bypass.

END OF SECTION 328400

SECTION 329100 - PLANTING PREPARATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Maintain ground covers and plants until established, but not less than six months.

PART 2 - PRODUCTS

2.1 PLANTING SOIL MIX

- A. Planting Medium for Organic Vegetables
 - 1. Mix topsoil with the following soil amendments in the following quantities:
 - a. Topsoil: ASTM D 5268, with pH range of 5.5 to 7, free of stones 1 inch or larger and other extraneous materials harmful to plant growth.
 - i. See manufacturer's specifications for details:
<http://www.pdbs.us/materials.html>
 - b. Lime: ASTM C 602, Class T, agricultural limestone.
 - i. Hi-Yield Agricultural Limestone
 - ii. See manufacturer's specifications for details:
<http://www.gardenharvestsupply.com/product/hi-yield-agricultural-limestone-6-lb-bag>
 - c. Compost: Well-composted, stable, and weed-free organic matter; pH range of 5.5 to 8.
 - i. Organic Compost
 - ii. See manufacturer's specifications for details:
<http://www.sunnygeesorganic.com/product/OC1001>
 - d. Chip Bark:
 - 1. Wood Chips (small, medium, large)
 - 2. manufacturer's specifications for details:
<http://www.pdbs.us/materials.html>
 - a. Sulfur
 - i. Tiger 90 Soil Sulfur
 - ii. See manufacturer's specifications for details:
http://www.groworganic.com/item_F2210_Tiger_90_Soil_Sulfur_50_Lbs.html?welcome=T&theses=4814984
- B. Planting Medium for Greywater Treatment
 - 1. Chip Bark:
 - a. Wood Chips (small, medium, large)
 - b. See manufacturer's specifications for details:
<http://www.pdbs.us/materials.html>
 - 2. Washed Gravel Substrate:
 - a. Washed Pea Gravel

- b. See manufacturer's specifications for details:

<http://www.thestonestore.com/washedgravelproducts.html>
- C. Planting Medium for Hydroponics
 - 1. Washed Gravel Substrate:
 - a. #3 Hudson Valley River Jacks
 - b. See manufacturer's specifications for details:
<http://www.thestonestore.com/washedgravelproducts.html>
 - 2. Commercial Fertilizer:
 - a. Earth Juice, for Hydroponics
 - 1) For vegetative growth:
 - i. Earth Juice Grow Organic Fertilizer
 - ii. See manufacturer's specifications for details:
<http://www.planetnatural.com/site/earth-juice-grow.html>
 - 2) For fruiting, flowering and production:
 - i. Earth Juice Bloom Organic Fertilizer
 - ii. See manufacturer's specifications for details:
<http://www.planetnatural.com/site/earth-juice-bloom.html>
 - 3) Catalyst:
 - i. Earth Juice Catalyst
 - ii. See manufacturer's specifications for details:
<http://www.planetnatural.com/site/earth-juice-catalyst.html>
 - 4) Meta-K:
 - i. Earth Juice Meta-K Organic Fertilizer
 - ii. See manufacturer's specifications for details:
<http://www.planetnatural.com/site/earth-juice-meta-k.html>
- D. Commercial Fertilizer: Commercial-grade complete fertilizer, consisting of 1lb per 100sq ft of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - 1. For Grassland Plants and Organic Vegetation for consumption:
 - a. Earth Juice Microblast
 - b. See manufacturer's specifications for details:
<http://www.planetnatural.com/site/earth-juice-microblast.html>

PART 3 - EXECUTION

3.1 PREPARATION

- A. Planting Bed Establishment: Loosen subgrade to a depth of 4 inches. Remove stones sticks, roots, and rubbish. Spread planting soil mixture to a depth of 4inches, but not less than required to meet finish grades. Work first layer into top of loosened subgrade.
- B. Trees and Shrubs: Excavate pits with sides sloped inward and with bottom of excavation slightly raised at center to assist drainage. Excavate approximately three times as wide as ball diameter. Scarify sides of plant pit smeared or smoothed during excavation.
 - 1. Set trees and shrubs plumb and in center of pit with top of ball flush with adjacent finish grades.
 - 2. Remove burlap and wire baskets from tops of balls and partially from sides, but do not remove from under balls. Carefully remove root balls from containers without damaging root ball or plant. Do not use planting stock if ball is cracked or broken before or during planting operation.
 - 3. Place planting soil mix around ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Water again after placing and tamping final layer of planting soil mix.
 - 4. Prune, thin, and shape trees and shrubs after planting.
- C. Plant ground cover and plants 12 inches apart. Dig holes large enough to allow root spread. Plant stock working soil around roots and leave a slight saucer around plants to hold water. Water after planting. Do not cover plant crowns with wet soil.
- D. Edgings: Install edgings and anchor with stakes driven below top elevation of edging.

- E. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing, and resetting to proper grades or

vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- F. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

END OF SECTION 329100

SECTION 329300 - PLANTS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Maintain ground covers and plants until established, but not less than six months.

PART 2 - PRODUCTS**2.1 PLANTING MATERIALS**

- A. Tree and Shrub Material: Nursery grown, with healthy root systems, well shaped, fully branched, healthy, and free of insects, eggs, larvae, defects, and disfigurement.
 - 1. Grassland
 - a. Showy Fringe Pod - *Thysanocarpus radians*
 - 1) Communities: Valley Grassland, Foothill Woodland
 - 2) Elevation: between 0 and 3000 feet
 - 3) See <http://www.baynatives.com/?SC=plant-list.php> for Supplier
 - b. Soaproot - *Chlorogalum pomeridianum*
 - 1) Communities: California except Sierra Nevadas and desert and western Oregon
 - 2) See <http://www.baynatives.com/?SC=plant-list.php> for Supplier
 - c. Turkey Mullein - *Eremocarpus setigerus*
 - 1) Communities: Coastal Sage Scrub, Foothill Woodland, Valley Grassland, Northern Oak Woodland, Southern Oak Woodland
 - 2) Elevation: between 0 and 6000 feet
 - 3) Height: under 1 ft
 - 4) Life Cycle: annual
 - 5) Growth Type: flower
 - 6) Flower Size: small, 1/4 - 1 in
 - 7) Flower Type: inconspicuous
 - 8) Bloom Time: summer
 - 9) Native to California
 - 10) California Range: coast - inland
 - 11) Water Requirements: low
 - 12) Salt Tolerance: medium
 - 13) Characteristics/Comments: toxic/irritating
 - 14) Fire Resistant
 - 15) Seed Count (Per Pound): 48,000
 - 16) See <http://www.ssseeds.com/database/plant2testvv.php3> for Supplier
 - 2. Vernal Pool
 - a. Nodding Beggartick - *Bidens cernua*
 - 1) Communities: Freshwater Wetlands, wetland-riparian
 - 2) Elevation: between 0 and 7000 feet
 - 3) See <http://www.renyswildflowers.com/view.html#vs=2&ncname=Bidens%20cernua> for Supplier
 - b. Willow Dock - *Rumex salicifolius*
 - 1) Communities: Yellow Pine Forest, Red Fir Forest, Lodgepole Forest, Foothill Woodland, Chaparral, Valley Grassland, many plant communities, wetland-riparian
 - 2) Elevation: between 0 and 11500 feet
 - 3) Height: 1 ft - 3 ft
 - 4) Life Cycle: perennial
 - 5) Growth Type: flower
 - 6) Flower Size: minute
 - 7) Inflorescence size: 1 - 5 in
 - 8) Flower Type: clustered
 - 9) Bloom Time: summer

- 10) Flower Color: green
- 11) Water Requirements: medium
- 12) Seed Count (Per Pound): 325,000
- 13) See <http://www.ssseeds.com/database/plant2testvv.php3> for Specification document.
- c. Point Reyes Checkerbloom - *Sidalcea calycosa*
 - 1) Communities: Foothill Woodland, Northern Oak Woodland, Coastal Salt Marsh, wetland-riparian
 - 2) Elevation: between 0 and 4000 feet
 - 3) See <http://www.baynatives.com/?SC=plant-list.php> for Supplier
- d. White-tipped Clover - *Trifolium wormskioldii*
 - 1) Yellow Pine Forest, Red Fir Forest, Lodgepole Forest, Subalpine Forest, Foothill Woodland, Chaparral, Valley Grassland, many plant communities, wetland-riparian
 - 2) Elevation: between 0 and 10000 feet
 - 3) See <http://www.baynatives.com/?SC=plant-list.php&fltr=Trifolium> for Supplier
- e. Pale Spikerush - *Eleocharis macrostachya*
 - 1) Communities: many plant communities, wetland-riparian
 - 2) Elevation: between 0 and 8200 feet
 - 3) Height: 1 ft - 3 ft
 - 4) Life Cycle: perennial
 - 5) Growth Type: shrub
 - 6) Flower Size: minute
 - 7) Inflorescence size: 1 - 5 in
 - 8) Flower Type: clustered
 - 9) Bloom Time: summer
 - 10) Flower Color: brown
 - 11) California Range: coast - inland - mountain
 - 12) Water Requirements: medium - high
 - 13) Fire Resistant
 - 14) Seed Count (Per Pound): 840,000
 - 15) See http://www.ssseeds.com/database/db_testvv.php3?uid=172 for Specification document.
- f. Folded Calicoflower - *Downingia ornatissima* var. *ornatissima*
 - 1) Community: wetland-riparian
 - 2) Wetlands: occurs almost always under natural conditions in wetlands
 - 3) Elevation: between 0 and 500 feet
 - 4) See http://www.calflora.org/cgi-bin/species_query.cgi?where-taxon=Downingia+ornatissima+var.+ornatissima for more information.
- g. Narrow-leaved Cattail - *Typha angustifolia*
 - 1) Communities: Freshwater Wetlands, wetland-riparian
 - 2) Habitat: freshwater-marsh
 - 3) Wetlands: occurs almost always under natural conditions in wetlands
 - 4) Elevation: between 0 and 6561 feet
 - 5) http://www.freshwaterfarms.com/product_list.pdf#search=%22Typha%20angustifolia%22
- h. Slender Hairgrass - *Deschampsia elongate*
 - 1) Communities: Yellow Pine Forest, Red Fir Forest, Lodgepole Forest, Subalpine Forest, Foothill Woodland, Chaparral, Valley Grassland, many plant communities, wetland-riparian
 - 2) Wetlands: usually occurs in wetlands, but occasionally found in non wetlands
 - 3) Elevation: between 4500 and 10000 feet
 - 4) Height: 1 ft - 3 ft
 - 5) Life Cycle: perennial
 - 6) Growth Type: grass
 - 7) Inflorescence size: 1 - 5 in
 - 8) Flower Type: grass spikelet
 - 9) Bloom Time: cool (grasses)
 - 10) California Range: coast - desert - inland
 - 11) Water Requirements: medium - low
 - 12) Characteristics: fast growing
 - 13) Fire Resistant
 - 14) Seed Count (Per Pound): 2,000,000
 - 15) <http://www.ssseeds.com/database/plant2testvv.php3>
- i. Water Plantain - *Alisma plantago-aquatica*
 - 1) Communities: Sagebrush Scrub, Mixed Evergreen Forest, Valley Grassland, wetland-riparian
 - 2) Habitat: streambanks, meadows
 - 3) Wetlands: occurs almost always under natural conditions in wetlands
 - 4) Elevation: between 0 and 5000 feet
 - 5) See <http://www.pondmart.com/ProductDetails.asp?ProductCode=17202> for Supplier
- j. White Navarretia - *Navarretia leucocephala* ssp. *Minima*
 - 1) Communities: Sagebrush Scrub, Yellow Pine Forest, Red Fir Forest, wetland-riparian
 - 2) Wetlands: usually occurs in wetlands, but occasionally found in non wetlands
 - 3) Elevation: between 0 and 7000 feet
 - 4) <http://www.pnwflowers.com/flower/navarretia-intertexta>
- k. Dwarf Sack Clover - *Trifolium depauperatum* var. *depauperatum*
 - 1) Communities: Valley Grassland, Mixed Evergreen Forest, wetland-riparian

- 2) Wetlands: equally likely to occur in wetlands or non wetlands
- 3) Elevation: between 0 and 2953 feet
- 4) http://www.calflora.org/cgi-bin/species_query.cgi?where-taxon=Trifolium+depauperatum
- l. Vernal Pool Buttercup – *Ranunculus bonariensis* var. *trisepalus*
 - 1) Communities: Foothill Woodland, Valley Grassland, wetland-riparian
 - 2) Wetlands: occurs almost always under natural conditions in wetlands
 - 3) Elevation: between 0 and 3300 feet
 - 4) Toxicity: Minor, Dermatitis
 - 5) <http://www.sacsplash.org/pages/flowers/16vernalpoolbuttercup.pdf>
- m. Vernal Pool Goldfield – *Lasthenia fremontii*
 - 1) Community: wetland-riparian
 - 2) Wetlands: occurs almost always under natural conditions in wetlands
 - 3) Elevation: between 0 and 2297 feet
 - 4) <http://www.sacsplash.org/vernalpools/plants2.pdf>
- n. Field Owl's Clover – *Castilleja campestris* ssp. *Campestris*
 - 1) Community: wetland-riparian
 - 2) Wetlands: occurs almost always under natural conditions in wetlands
 - 3) Elevation: between 0 and 7500 feet
 - 4) <http://www.sacsplash.org/pages/flowers/11fieldowlslover.pdf>
- o. Woolly Marbles – *Psilocarphus brevissimus* var. *brevissimus*
 - 1) Communities: community not given, species associated with a peculiar habitat, wetland-riparian
 - 2) Wetlands: occurs almost always under natural conditions in wetlands
 - 3) Elevation: between 33 and 4921 feet
 - 4) <http://www.sacsplash.org/plants/psibre.htm>
- p. Ropevine – *Clematis ligusticifolia* var. *California*
 - 1) Communities: Yellow Pine Forest, Red Fir Forest, Lodgepole Forest, Foothill Woodland, Chaparral, Valley Grassland, many plant communities, wetland-riparian
 - 2) Habitat: streambanks
 - 3) Wetlands: equally likely to occur in wetlands or non wetlands
 - 4) Elevation: between 0 and 7000 feet
 - 5) Toxicity: Minor, Dermatitis
 - 6) <http://www.baynatives.com/?SC=plant-list.php>
- q. Field Sedge – *Carex praegracilis*
 - 1) Category: Grass-like
 - 2) Family: Cyperaceae (Sedges)
 - 3) Origin: California
 - 4) Evergreen: Yes, Flower
 - 5) Color: Brown
 - 6) Bloomtime: Spring
 - 7) Height: <1 foot
 - 8) Width: Spreading
 - 9) Exposure: Sun or Shade
 - 10) Seaside: Yes
 - 11) Irrigation: Medium Water Needs
 - 12) Winter Hardiness: 0-10° F
 - 13) <http://www.baynatives.com/?SC=plant-list.php>
- r. Brown Dogwood – *Cornus glabrata*
 - 1) Communities: Yellow Pine Forest, Foothill Woodland, Chaparral, Valley Grassland, many plant communities, wetland-riparian
 - 2) Wetlands: usually occurs in wetlands, but occasionally found in non wetlands
 - 3) Elevation: between 0 and 5000 feet
 - 4) Toxicity: Dermatitis
 - 5) <http://www.baynatives.com/?SC=plant-list.php>
- 3. Edible Garden
 - a. Cosmo Savoy (frilly romaine) Lettuce
 - b. Red Fire (looseleaf) Lettuce
 - c. Sangria (red butter) Lettuce
 - d. Chard (ruby red)
 - e. Frisée (curly endive)
 - f. Mustard (Osaka purple)
 - g. Shungiku (edible chrysanthemum)
 - h. Purple Sprouting Broccoli
 - i. Red Scarlet O'Hara Cabbage
 - j. Blue curly Vendura Kale
 - k. White Bunching Onions
 - l. Petit Pois (French baby peas)
 - m. <http://www.upstartorganicseedlings.com/>
- 4. Herb Garden
 - a. Chives
 - b. Cilantro
 - c. French Sorrel

- d. Italian Parsley
- e. Oregano
- f. Marjoram
- g. Thyme
- h. <http://www.upstartorganicseedlings.com/>

2.2 SOIL AND AMENDMENTS

- A. Topsoil: ASTM D 5268, with pH range of 5.5 to 7, free of stones 1 inch or larger and other extraneous materials harmful to plant growth.
- B. Lime: ASTM C 602, Class T, agricultural limestone.
- C. Compost: Well-composted, stable, and weed-free organic matter; pH range of 5.5 to 8.
- D. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.
- E. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

2.3 PLANTING SOIL MIX

- A. Mix topsoil with the following soil amendments in the following quantities:
- B. Topsoil: ASTM D 5268, with pH range of 5.5 to 7, free of stones 1 inch or larger and other extraneous materials harmful to plant growth.
- C. Lime: ASTM C 602, Class T, agricultural limestone.
- D. Compost: Well-composted, stable, and weed-free organic matter; pH range of 5.5 to 8.
- E. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.
- F. Washed Gravel Substrate: #3 Hudson Valley River Jacks
- G. Commercial Fertilizer: Commercial-grade complete fertilizer, consisting of 1lb per 100sq ft of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - 1. Earth Juice Microblast, for Grassland Plants and Organic Vegetation for consumption
 - 2. Earth Juice, for Hydroponics
 - a. For vegetative growth, use Grow.
 - b. For fruiting, flowering and production use Bloom.
 - c. Add Catalyst as directed on product's label.
 - d. Include Meta-K.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Planting Bed Establishment: Loosen subgrade to a depth of 4 inches. Remove stones sticks, roots, and rubbish. Spread planting soil mixture to a depth of 4inches, but not less than required to meet finish grades. Work first layer into top of loosened subgrade.
- B. Trees and Shrubs: Excavate pits with sides sloped inward and with bottom of excavation slightly raised at center to assist drainage. Excavate approximately three times as wide as ball diameter. Scarify sides of plant pit smeared or smoothed during excavation.
 - 1. Set trees and shrubs plumb and in center of pit with top of ball flush with adjacent finish grades.
 - 2. Remove burlap and wire baskets from tops of balls and partially from sides, but do not remove from under balls. Carefully remove root balls from containers without damaging root ball or plant. Do not use planting stock if ball is cracked or broken before or during planting operation.
 - 3. Place planting soil mix around ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit

- is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Water again after placing and tamping final layer of planting soil mix.
4. Prune, thin, and shape trees and shrubs after planting.
- C. Plant ground cover and plants 12 inches apart. Dig holes large enough to allow root spread. Plant stock working soil around roots and leave a slight saucer around plants to hold water. Water after planting. Do not cover plant crowns with wet soil.
- D. Edgings: Install edgings and anchor with stakes driven below top elevation of edging.
- E. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- F. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

END OF SECTION 329300

SECTION 329433 - PLANTERS**PART 1 - GENERAL****1.1 SECTION REQUIREMENTS**

- A. Submittals: Product Data.

PART 2 - PRODUCTS**2.1 COMPONENTS**

- A. Wood planter box, Species: Redwood
 - 1. Custom, Refer to Image
 - 2. 22'-2" x 18" x 12"
- B. Unglazed Slab Built Vitrified Ceramic Pots
 - 1. Square, Custom 10" x 10" x 8"
- C. Plants.
 - 1. See SECTION 329300 for Herb selections.

END OF SECTION 329433

SECTION 334700 - PONDS AND RESERVOIRS**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. 33 47 13.13 Pond Liner
- B. 33 25 63 Rock Basin
- C. 33 41 13 Storm Drainage Piping

1.2 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS**2.1 COMPONENTS**

- A. Structure for pond:
 - 1. Framing: Reclaimed Redwood
See SECTION 06 10 00.
- B. Pipe Materials: PVC pipe, ASTM D 2241, PVC 1120, SDR 26
2" pipe, gravity feed into storage tank.
 - 1. See Section 07 50 00 Membrane Roofing
- C. Pond Liner: EPDM. Firestone Geomembrane, cured single-ply synthetic rubber membrane, 102mm.
See Manufacturer's Specifications:
http://www.firestonebpe.com/lining/syst_comp/epdm_geomembrane/_en/index.shtm
- D. Gravel, uniformly sized, washed: #3 Hudson Valley River Jacks
<http://www.thestonestore.com/washedgravelproducts.html>
- E. Aquatic plants.
See SECTION 329300 for plants.

END OF SECTION 334700

SECTION 412213 - MOBILE CRANE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. This specification includes the requirements, terms of use, and product data of a mobile crane used to unload and load the modules of the house for the competition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Terex

2.2 MODEL

- A. T-340-1 Truck Crane

2.3 GENERAL NOTES

- A. Rated loads as shown on Lift Charts pertain to this machine as originally manufactured and equipped. Modifications to the machine or use of optional equipment other than that specified can result in a reduction of capacity.
- B. Construction equipment can be hazardous if improperly operated or maintained. Operation and maintenance of this machine shall be in compliance with the information in the Operator's, Parts and Safety Manuals supplied with this machine. If these manuals are missing, order replacements from the manufacturer through your distributor.
- C. These warnings do not constitute all of the operating conditions for the crane. The operator and job site supervision must read the operators manual, CIMA safety manual, applicable OSHA regulations, and ASME safety standards for cranes.
- D. This crane and its load ratings are in accordance with power crane & shovel association, standard no. 4, sae crane load stability testcode J765A, sae method of test for crane structure J1063 and applicable safetycode for cranes, derricks and hoists, asme/ansi b30.5

2.4 CAPACITIES

- 1.) Maximum Lifting Capacity: 40 t (36.36 mt)
- 2.) Maximum Boom Length: 30 - 94 ft (9.23 - 28.49 m)
- 3.) Elevation Degree (min to max.): -4 to 77 degrees
- 4.) Standard Jib Length: 32-49 ft (9.75-14.86m)
- 5.) Optional Jib Length: 32 ft (9.75m)
- 6.) Maximum Tip Height with Jib:147 ft (44.81m)
- 7.) Drive/Steer: 6X4X2
- 8.) Engine Model: Cummins ISC 300
- 9.) Horsepower: 300 hp (224 kW)
- 10.) Max Speed: 60 mph (96 km/h)
- 11.) Max Gradeability: 56%
- 12.) Overall Length: 26 ft 4 in (8.03m)
- 13.) Overall Width: 8 ft (2.46m)
- 14.) Overall Height: 10 ft 8.75 in (3.27m)
- 15.) Lightest Gross Vehicle Weight: (minimum counterweight) 47,101 lb (21,365 kg)
- 16.) Gross Vehicle Weight Typical Equipment: (maximum counterweight) 57,275 lbs (25,979 kg)

2.5 See manufacturers specification at:

<http://www.terex.com/main.php?obj=prod&action=VIEW&id=d65db72ae72987e738c2ee4044594260&nav=prod&cid=487c16c8ff145d0843f57512eafb8592>

PART 3 - EXECUTION

3.1 SETUP

1. Crane load ratings are based on the crane being leveled and standing on a firm, uniform supporting surface.
2. Crane load ratings on outriggers are based on all outrigger beams being fully extended or in the case of partial extension ratings mechanically pinned in the appropriate position, and the tires free of the supporting surface.
3. Crane load ratings on tires depend on appropriate inflation pressure and the tire conditions. Caution must be exercised when increasing air pressures in tires. Consult Operator's Manual for precautions.
4. Use of jibs, lattice-type boom extensions, or fourth section pullouts extended is not permitted for pick and carry operations.
5. Consult appropriate section of the Operator's and Service Manual for more exact description of hoist line reeving.
6. The use of more parts of line than required by the load may result in having insufficient rope to allow the hook block to reach the ground.
7. Properly maintained wire rope is essential for safe crane operation. Consult Operator's Manual for proper maintenance and inspection requirements.
8. When spin-resistant wire rope is used, the allowable rope loading shall be the breaking strength divided by five (5), unless otherwise specified by the wire rope manufacturer.
9. Do not elevate the boom above 60° unless the boom is positioned in-line with the crane's chassis or the outriggers are extended. Failure to observe this warning may result in loss of stability.

3.2 - OPERATION

1. Crane load ratings must not be exceeded. Do not attempt to top the crane to determine allowable loads.
2. When either radius or boom length, or both, are between listed values, the smaller of the two listed load ratings shall be used.
3. Do not operate at longer radii than those listed on the applicable load rating chart (cross hatched areas shown on range diagrams).
4. The boom angles shown on the Capacity Chart give an approximation of the operating radius for a specified boom length. The boom angle, before loading, should be greater to account for boom deflection. It may be necessary to retract the boom if maximum boom angle is insufficient to maintain rated radius.
5. Power telescoping boom sections must be extended equally.
6. Rated loads include the weight of hook block, slings, and auxiliary lifting devices. Their weights shall be subtracted from the listed rated load to obtain the net load that can be lifted. When lifting over the jib the weight of any hook block, slings, and auxiliary lifting devices at the boom head must be added to the load. When jibs are erected but unused add two (2) times the weight of any hook block, slings, and auxiliary lifting devices at the jib head to the load.
7. Rated loads do not exceed 85% on outriggers or 75% on tires, of the tipping load as determined by SAE Crane Stability Test Code J765a. Structural strength ratings in chart are indicated with an asterisk (*).
8. Rated loads are based on freely suspended loads. No attempt shall be made to drag a load horizontally on the ground in any direction.
9. The user shall operate at reduced ratings to allow for adverse job conditions, such as: Soft or uneven ground, out of level conditions, high winds, side loads, pendulum action, jerking or sudden stopping of loads, hazardous conditions, experience of personnel, two machine lifts, traveling with loads, electric wires, etc., (side pull on boom or jib is hazardous). Derating of the cranes lifting capacity is required when wind speed exceeds 20 MPH. the center of the lifted load must never be allowed to move more than 3' feet off the center line of the base boom section due to the effects of wind, inertia, or any combination of the two. Use 2 feet off the center line of the base boom for a two section boom, 3 feet for a three section boom, or 4 feet for a four section boom."
10. The maximum load which can be telescoped is not definable, because of variations in loadings and crane maintenance, but it is permissible to attempt retraction and extension if load ratings are not exceeded.
11. Load ratings are dependent upon the crane being maintained according to manufacturer's specifications.
12. It is recommended that load handling devices, including hooks, and hook blocks, be kept away from boom head at all times.
13. 360° capacities apply only to machines equipped with a front outrigger jack and all five (5) out- rigger jacks properly set. If the front (5th) outrigger jack is not properly set, the work area is restricted to the over side and over rear areas as shown on the Crane Working Positions diagram. Use the 360° load ratings in the overside work areas.
14. Do not lift with outrigger beams positioned between the fully extended and intermediate (pinned) positions.
15. Truck Cranes not equipped with equalizing (bogie) beams between the rear axles may not be used for lifting "on tires". Truck Cranes equipped with equalizing beams and rear air suspension should "dump" the air before lifting "on tires".

3.3 SPECIAL RESTRICTIONS

1. Crane may not leave access road when on the National Mall. Crane is not allowed to travel on any of the grass on the mall.
2. Crane must wait aside the National mall for Solar Decathlon Operations Director to approve site access.

END OF SECTION

SECTION 412323 - BOOM LIFT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. This specification describes the terms of use, requirements, and product data for a boom lift to be used during the assembly and disassembly of the house.

1.2 RELATED SECTIONS:

- A. 416223 - Forklifts

1.3 STANDARDS COMPLIANCE

- A. ANSI A92.5
- B. CSA B354.4
- C. CE Compliance
- D. AS 1418.10

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Genie

2.2 PRODUCTS

- A. Z-34/22 DC
 - 1. Measurements
 - a. Working Height Maximum: 40.5 ft
 - b. Platform Height Maximum: 34.5 ft
 - c. Horizontal reach Maximum: 22.25 ft
 - d. Up and Over Clearance: 14.9 ft
 - e. Platform Length: 2.5 ft
 - f. Platform Width: 4.5 ft
 - g. Height - Stowed: 6.5 ft
 - h. Length - Stowed: 18.5 ft
 - i. Storage Height: 7.5 ft
 - j. Storage Length: 13.5 ft
 - k. Wheelbase: 6 ft
 - l. Ground clearance - center: 6 in
 - 2. Productivity
 - a. Lift Capacity: 500 lbs
 - b. Platform Rotation: 180 Degrees
 - c. Vertical Jib Rotation: 139 Degrees
 - d. Drive Speed - Stowed: 4 mph
 - e. Drive Speed-Raised: .68 mph
 - f. Gradeability stowed: 30%
 - g. Turning Radius- Inside: 5ft 9 in
 - h. Turning Radius-Outside: 13 ft 1 in
 - i. Controls: 24V DC proportional
 - j. Drive: 2WD
 - k. Jib: 4 ft boom

- I. Tires: Air Filled
- 3. Power
 - a. Power source: 48V DC (eight 6V batteries 315 Ah capacity)
 - b. Auxiliary Power Unit: 24V DC
 - c. Hydraulic Tank Capacity: 4 gal
- 4. Weight
 - a. 11,000 lbs

PART 3 - EXECUTION

3.1 Safety and Implementation

- A. All operators must comply with all safety standards and regulations set forth for by the Solar Decathlon.
- B. All operators must be certified to operate equipment and carry certification card at all times during operation.
- C. Boom lift must only travel on pads provided to protect the grass of the National Mall.

END OF SECTION

SECTION 416223 - FORK LIFTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. This specification describes the terms of use, requirements, and product data for the fork lifts needed for assembly and disassembly of the house.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Gradall
- B. Toyota

2.2 PRODUCTS

- A. 534D10-45 Telescopic Forklift
 - 1. Dimensions
 - a. Length to fork face: 19.7 ft
 - b. Width Over Tires: 8.2 ft
 - c. Overall Height: 7.7 ft
 - d. Wheelbase: 11.2 ft
 - e. Ground Clearance: 19.3 ft
 - f. Turning Radius Outside Tires: 14.6 ft
 - 2. Lift
 - a. Max Lift Height: 45 ft
 - b. Max Forward Reach: 31.5 ft
 - c. Max Lift Capacity: 10000 lb
 - d. Max Load at Max Reach: 3000 lb
 - 3. Engine
 - a. Power: 114 hp
 - b. Torque: 2500 rpm
 - c. Displacement: 274.6 cu in
 - d. Cylinders: 4
 - 4. Operational
 - a. Weight: 25300 lb
 - b. Fuel Capacity: 38 gal
 - c. Hydraulic System Fluid Capacity: 40 gal
 - d. Operating Voltage: 12V
 - e. Alternator Supplied Amperage: 65 A
 - f. Drawbar Pull: 21000 lb
 - g. Tire Size: 14x24-12PR
 - h. Max Speed: 19 mph
 - 5. Specifications for Gradall Forklift can be found at: <http://www.ritchiespecs.com/specification?type=Lifting+%26+Material+Handling&category=Telescopic+Forklift&make=Gradall&model=534D10-45&modelid=94431>
- B. 8FGU15 Internal Combustion Pneumatic Warehouse Forklift
 - 1. Performance
 - a. 2007 EPA/CARB certified engine with closed loop 3-way catalytic muffler system
 - b. Toyota 136 cu. in., 4-cylinder, OHV gasoline engine (4Y-ECS)
 - c. Toyota 152 cu. in., 4-cylinder, OHV diesel engine (1DZ-II)
 - d. Electronic fuel injection (gasoline only)
 - e. UL "G" gasoline engine
 - f. UL "D" diesel engine
 - g. One-way automatic fork leveling
 - h. Independent brake & inching pedals
 - i. Integrated monitoring system - includes
 - 1) Digital hour meter display
 - 2) Engine coolant temperature gauge
 - 3) Fuel gauge (gasoline only)

- 4) Check engine light
 - 5) Sedimentor warning light (diesel only)
 - 6) Glow indicator light (diesel only)
 - 7) Engine oil pressure warning light
 - 8) Battery charge warning light
 - 9) OPSS activation light
 - 10) SAS/OPSS warning light
 - j. 2-stage limited free lift mast (V)
 - k. Adjustable headlights with guards
 - l. Foot-activated parking brake
 - m. Alternator with built-in regulator
 - n. Transistorized ignition assembly
 - o. Automatic transmission with oil cooler
 - p. Full floating powertrain
 - q. Hydraulic valve lifters
 - r. Integrated head light and turn signal lever
 - s. Electric shift control
2. Durability
- a. Control Area Network (CAN-bus) communication
 - b. Fully-stamped steel side panels
 - c. Moisture resistant electric connectors
 - d. High cooling capacity radiator with fan shroud
 - e. Low maintenance battery
 - f. Large capacity engine cooling fan
 - g. 7" cyclone air cleaner with high positioned external air-intake (6" diameter on 8FGCU15.18.S20)
 - h. Plate iron front fenders
 - i. Anti-restart ignition key switch
 - j. Stamped steel engine hood
 - k. Fully-sealed air-intake system
 - l. Self-adjusting brakes
3. Load and Capacities
- a. Load Capacity: 3000 lb
 - b. Engine HP/rpm: 51/2570
 - c. Max Travel Speed: 11.5 mph
 - d. Maximum Lift Speed Full Load (f.p.m.): 131
 - e. Maximum Gradeability Full Load (%): 45
 - f. Basic Tilt Angle Stack (in): 92.1
 - g. Turning Radius: 76 in
 - h. Dimensions
 - 1) Length: 87.8 in
 - 2) Width: 42.1 in
 - 3) Height: 81.9 in
4. Manufacturer specifications for Toyota Pneumatic Forklift can be found at: <http://www.directindustry.com/prod/toyota-industrial-equipment/electric-forklift-truck-14115-27200.html>

PART 3 - EXECUTION

3.1 Safety and Implementation

- A. All operators must comply with all safety standards and regulations set forth for by the Solar Decathlon.
- B. All operators must be certified to operate equipment and carry certification card at all times during operation.
- C. Forklifts must only travel on protective pads provided to protect the grass of the National Mall.

END OF SECTION

SECTION 481916 - ELECTRICAL POWER GENERATION INVERTERS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes:
 - 1. Inverter

1.2 RELATED SECTIONS

- A. Section 263100 - Photovoltaic Generation

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Sunny Boy SMA

2.2 MATERIALS

- A. Sunny Boy SMA inverter model SBA 5000 US
 - 1. Meets the requirements of L1741 Static Inverters and Charge Controllers for use in Photovoltaic Power Systems and UL1998 Software in Programmable Components.
 - 2. Product Data:
 - a. Electrical Data
 - 1) Input Data (DC)
 - a) Max Array Input: 6250 W
 - b) Max DC Voltage: 6000 V
 - c) Peak Power Tracking Voltage: 250 - 480 V
 - d) DC Max Input Current: 21 A
 - e) DC Voltage Ripple < 5%
 - f) Number of Fused String Inputs: 4
 - g) PV Start Voltage
 - 2) Output Data (AC)
 - a) AC Nominal Power: 5000 W
 - b) AC Maximum Output Power: 5000 W
 - c) AC Maximum Output Current (@ 208, 240, 277 V): 24 A, 20.8 A, 18 A
 - d) AC Frequency / Range 60 HZ/ 59.3 Hz- 60.5 Hz
 - e) Power Factor: 1
 - b. Mechanical Data
 - 1) Dimensions (W x H x D in inches): 18.4 x 24.1 x 9.5
 - 2) Weight/ Shipping Weight: 143 lbs/ 154 lbs
 - 3) Ambient temperature range: -13 to + 113 °F
 - 4) Power Consumption: standby / nighttime: < 7 W / 0.25 W
 - 3. Specifications for Sunny Boy modules can be found at manufacturer's website: http://www.sma-america.com/en_US/products/grid-tied-inverters/sunny-boy/sunny-boy-5000us-6000us-7000us.html

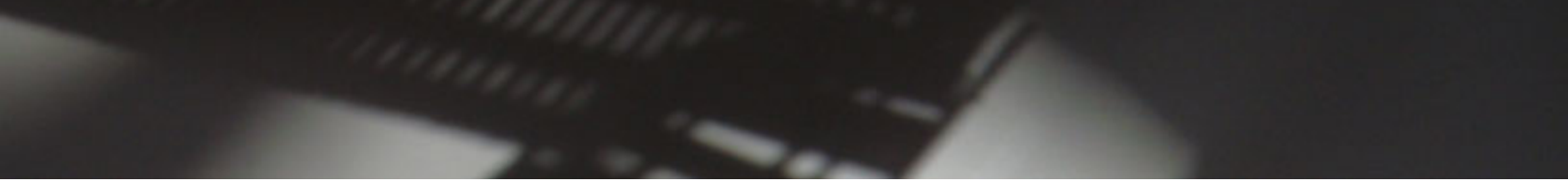
PART 3 - EXECUTION**3.1 Installation**

- A. Safety and Implementation
 - 1. To avoid injury, be sure to use proper lifting techniques and secure the help of someone to assist in the unpacking and installation of the inverter.

2. Do not install the Sunny Boy during periods of precipitation or high humidity (>95%).
3. Moisture trapped within the enclosure may cause corrosion and damage to the electronic components.
4. Must provide sufficient air circulation to dissipate the heat generated by the inverter.
5. To prevent electrical shock or other injury, check for existing electrical or plumbing installations in the walls before drilling mounting holes for the Sunny Boy.
6. Ensure that there are studs in the wall at the places where you intend to drill the mounting holes.
7. Always turn OFF all breakers and switches in the PV system before connecting any wires to or disconnecting any wires from the Sunny Boy.
8. Always wait a minimum of 5 minutes for stored potentials in the Sunny Boy to discharge completely before opening the enclosure.
9. Before connecting the Sunny Boy to the electrical utility grid, contact the local utility company. This connection must be made only by qualified personnel.
10. You must connect the wires that carry the AC voltage from the Sunny Boy to the utility grid in the order described in this procedure. Deviating from this procedure could expose you to lethal voltages that can cause serious injury and/ or death.
11. Verify that the DC current of your installation does not exceed the maximum values specified in the type rating label.

END OF SECTION

STRUCTURAL CALCULATIONS



STRUCTURAL CALCULATIONS

2009 Solar Decathlon Refract House

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Santa Clara, CA 95053

Prepared For:

U.S. Department of Energy

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SUMMARY OF SHEETS THAT HAVE BEEN STAMPED BY A PROFESSIONAL ENGINEER

Per Rule 6-2 of the SD2009 Rules v1.1, the following is a list of the sheets and pages that have been stamped in the hard copy by Mark Aschheim, PE

- Structural Calculations, pages 271 to 319 of the Project Manual
- Constructon Drawings, sheets S-001, S-002, S-003, S-101, S-102, S-103, S-111, S-112, S-121, S-201, S-202, S-203, S-301, S-501, S-511, S-521, S-531 ,S-532, S-601, and S-701

STRUCTURAL NARRATIVE

There is great importance to the structural design of the Refract House. Our goal was to design a strong, yet efficient, innovative, and sustainable house that satisfies the needs of everyone from Team California. Refract House is designed in three modules, all of which are self-sustaining structures in themselves. Since Refract House has to be transported across the country, the greatest concern was placed on maintaining the intent of the finished house during transportation. If each module is able to effectively function as a self standing structure and survive the 3,000 mile journey to the Washington D.C. Mall, then all three buildings will be able to effectively stand adjacent together.

The first step in designing the structure of the Refract House was to determine the governing design criteria, which consisted of gravity, wind, and seismic loads. When comparing the greatest seismic and wind loads for Santa Clara, CA and Washington D.C. the seismic loads from Santa Clara were found to govern. From here we were able to adequately design the lateral resisting system.

To accommodate the feeling of openness from the architectural design, moment frames were deemed to be a necessary addition to resist the lateral loads in the transverse direction while shear walls were used to resist lateral loads in the longitudinal direction. Finally, a custom steel angle was designed as the backbone for each module, through which all the lateral and gravity load transfers before it finally exits the buildings through the foundations.

Finally, always keeping innovation and sustainability in mind, new open-web bamboo beams have been designed to be used as the roof joists for the house. These beams are similar to the beams used by Santa Clara University in the 2007 Solar Decathlon, however they have been altered to improve the ease of construction. The beams have an open-web so ducting, electrical wiring, and piping can easily be run through, while still providing structural support for the roof.

MATERIAL PROPERTIES

Structural Steel fy = 50 ksi

Channels and Angles fy = 36 ksi

Connections

Welds	E70XX
High Strength Bolts	A325-X
Machine Bolts	A307 or A37

Wood Framing

Sawn Lumber

Horizontal Framing:

2x4 & 2x6	D.F.	No. 2
2x8 & wider	D.F.	No. 1 or Better
3x & 4x beams	D.F.	No.1

Vertical Framing:

2x & 3x studs	D.F.	Stud
4x Posts	D.F.	No. 1
6x & larger Posts	D.F.	No.1

Mudsills & Ledgers	D.F.	No. 2
--------------------	------	-------

Others U.O.N.	D.F.	Stud or Better
---------------	------	----------------

Glu-Laminated Lumber

Fb =	2400 psi
Fc =	1850 psi
Fv =	265 psi
E =	1.8 x 10 ⁶ psi

GRAVITY LOADS

Roof		
PV Panels	Sun Power	3.0 psf
Racking System	Uni-Rac System	5.0 psf
Roofing	TPO Roofing	1.5 psf
Sheathing	1/2" Plywood	1.6 psf
Framing	Bamboo Open-Web Joists @ 16"	2.5 psf
Beam	2.0E 5-1/4" x 9-1/4" PSL	3.0 psf
Insulation	Spray Soy Based	3.0 psf
Radiant Cooling	1-1/8" Warmboard	3.5 psf
Ceiling	5/8" Wood Finish	1.7 psf
MEP	Conduit, Ducting, and Piping	1.0 psf
Misc.		1.2 psf
Dead Load		27.0 psf

Live Load 20.0 psf

Floors		
Finish	5/8" Bamboo Floor	3.0 psf
Sheathing	1-1/8" Warmboard	3.5 psf
Framing	2 x 10 @ 16"	2.0 psf
Insulation	Spray Soy Based	3.0 psf
MEP	Conduit, Ducting, and Piping	1.0 psf
Misc.		2.5 psf
Dead Load		15.0 psf

Live Load 50.0 psf

Exterior Wall		
Exterior Finish	Wood Siding	4.0 psf
Sheathing	(2) 1/2" Plywood	2.8 psf
Studs	2x6 @ 24" o.c.	3.1 psf
Interior Finish	5/8" EcoRock Gyp	2.5 psf
Insulation	Spray Soy based	2.0 psf
Glazing	Windows and Mullions	2.0
Misc.		1.6 psf
Dead Load		18.0 psf

Interior Wall		
Finish	(2) 5/8" EcoRock Gyp	6.2 psf
Framing	2x4 @ 16" o.c.	1.5 psf
Misc.		2.3 psf
Dead Load		10.0 psf

Other Loads	
Moment Frame	1100.0 lb/frame
Steel Foundation Track	45.0 plf
Mechanical Equipment	1000.0 lb

SEISMIC DESIGN BASE SHEAR

2006 International Building Code

Zip Code = 95053

Spectral Response Accelerations S_s and S_1 S_s and S_1 = Mapped Spectral Acceleration ValuesSite Class B - $F_a = 1.0$, $F_v = 1.0$

Data are based on a 0.01 deg grid spacing

Period Centroid S_a

(sec) (g)

0.2 1.500 S_s , Site Class D1.0 0.600 S_1 , Site Class D*Period Maximum S_a*

(sec) (g)

0.2 1.500 S_s , Site Class D1.0 0.600 S_1 , Site Class D*Period Minimum S_a*

(sec) (g)

0.2 1.500 S_s , Site Class D1.0 0.600 S_1 , Site Class D

Latitude = 37° 20' 17" N

Longitude = 121° 53' 14" W

Occupancy Category: II

I = 1.0 (ASCE 7, Table 11.5-1)

hx = 18 ft

Ordinary. Steel
Moment FrameLight Framed Walls
w/ Panels Rated For Shear Resistance

R = 3.5

6.5

Ct = 0.028

0.020

x = 0.80

0.75

Ta = Ct x (h)^x = 0.28 sec

0.17

Values from USGS Ground Motion Parameter Calculator:

Fa = 1.000

Fv = 1.000

Ss = 1.500 g

S1 = 0.600 g

> 0.6g

Sms = Fa x Ss = 1.500 g

Sds = 2 x Sms / 3 = 1.000 g

> 0.5

Seis. Design Cat.: D

Sm1 = Fv x S1 = 0.60 g

Sd1 = 2 x Sm1 / 3 = 0.40 g

Cs = Sds / (R / I) = 0.286

0.154

(ASCE 7-05, Eq 12.8-2)

Cs max = Sd1 / Ta (R / I) = 0.40

0.40

(ASCE 7-05, Eq 12.8-3)

Cs min = 0.5 x S1 / (R / I) = 0.086

0.086

(ASCE 7-05, Eq 12.8-6)

Cs = 0.286

0.154

(Controls)

V = Cs x W = 0.286 W

0.154 W

r = 1.300

E = r x V = 0.371 W

0.200 W

Module A**Building Weight:**

Level	N-S Seismic Load			E-W Seismic Load		
	Area (sf)	Flat Load (psf)	Weight (lbs.)	Area (sf)	Flat Load (psf)	Weight (lbs.)
Roof	250	27	6750	250	27	6750
Floor	250	15	3750	250	15	3750
Ext. Wall (N)	300	18	5400	300	18	5400
Ext. Wall (S)	225	18	4050	225	18	4050
Ext. Wall (E)	140	18	2520	140	18	2520
Ext. Wall (W)	140	18	2520	140	18	2520
Total Wt.			29215			29215

$$E = \begin{matrix} 10851 \text{ lbs} \\ (R=3.5) \end{matrix} \qquad \begin{matrix} 5843 \text{ lbs} \\ (R=6.5) \end{matrix}$$

Module A**Force Distribution:**

Level	hx^k (ft)	N-S Seismic Load				E-W Seismic Load			
		wx (lbs.)	wx*hx^k	$\frac{wx*hx^k}{S(wi*hi)}$	Fx (lbs)	wx (lbs.)	wx*hx^k	$\frac{wx*hx^k}{S(wi*hi)}$	Fx (lbs)
Roof	14.5	15095	218878	0.861	9344	15095	218878	0.861	5032
Ground	2.5	14120	35300	0.139	1507	14120	35300	0.139	811
Total		29215	254178	0.861	10851	29215	254178	0.861	5843

Module B**Building Weight:**

Level	N-S Seismic Load			E-W Seismic Load		
	Area (sf)	Flat Load (psf)	Weight (lbs.)	Area (sf)	Flat Load (psf)	Weight (lbs.)
Roof	315	27	8505	315	27	8505
Floor	315	15	4725	315	15	4725
Ext. Wall (N)	360	18	6480	360	18	6480
Ext. Wall (S)	190	18	3420	190	18	3420
Ext. Wall (E)	125	18	2250	125	18	2250
Ext. Wall (W)	140	18	2520	140	18	2520
Int. Wall	21	10	210	21	10	210
Total Wt.			33875			33875

$$E = \begin{matrix} 12582 \text{ lbs} \\ (R=3.5) \end{matrix} \qquad \begin{matrix} 6775 \text{ lbs} \\ (R=6.5) \end{matrix}$$

Module B**Force Distribution:**

Level	hx^k (ft)	N-S Seismic Load				E-W Seismic Load			
		wx (lbs.)	wx*hx^k	$\frac{wx*hx^k}{S(wi*hi)}$	Fx (lbs)	wx (lbs.)	wx*hx^k	$\frac{wx*hx^k}{S(wi*hi)}$	Fx (lbs)
Roof	14.5	17045	247153	0.855	10752	17045	247153	0.855	5789
Ground	2.5	16830	42075	0.145	1830	16830	42075	0.145	986
Total		33875	289228	0.855	12582	33875	289228	0.855	6775

Module C**Building Weight:**

Level	N-S Seismic Load			E-W Seismic Load		
	Area (sf)	Flat Load (psf)	Weight (lbs.)	Area (sf)	Flat Load (psf)	Weight (lbs.)
Roof	190	27	5130	190	27	5130
Floor	190	15	2850	190	15	2850
Ext. Wall (N)	0	18	0	0	18	0
Ext. Wall (S)	150	18	2700	150	18	2700
Ext. Wall (E)	234	18	4212	234	18	4212
Ext. Wall (W)	163	18	2934	163	18	2934
Int. Wall	65	10	650	65	10	650
Total Wt.			22161			22161

$$E = \frac{4432 \text{ lbs}}{(R=6.5)} = \frac{8231 \text{ lbs}}{(R=3.5)}$$

Module C**Force Distribution:**

Level	hx ^k (ft)	N-S Seismic Load				E-W Seismic Load			
		wx (lbs.)	wx*hx ^k	$\frac{wx*hx^k}{S(wi*hi)}$	Fx (lbs)	wx (lbs.)	wx*hx ^k	$\frac{wx*hx^k}{S(wi*hi)}$	Fx (lbs)
Roof	14.5	11478	166431	0.862	3819	11478	166431	0.862	7093
Ground	2.5	10683	26708	0.138	613	10683	26708	0.138	1138
Total		22161	193139	0.862	4432	22161	193139	0.862	8231

WIND LOAD

(Method 2 ASCE 7-05)

Basic Wind Speed	V_{3s}	=	85.00 mph	(Figure 6-1)
Importance Factor	I	=	1.0	(Table 6-1)
Exposure Category		=	B	
Velocity Pressure Exposure Coefficient	K_z	=	0.90	(Table 6-3)
Velocity Pressure Exposure Coefficient	K_h	=	0.85	
Topographic Factor	K_{zt}	=	1.0	
Wind Directionality Factor	K_d	=	0.85	(Table 6-4)
Gust Effect Factor	G	=	0.85	
Enclosure Classification		=	Enclosed	
Internal Pressure Coefficient	GC_{pi}	=	0.18	
	GC_{pi}	=	-0.018	
Wall External Pressure Coefficients	C_p	=	0.8	Windward Wall
		=	-0.5	Leeward Wall
		=	-0.07	Side Wall
Roof External Pressure Coefficients	C_p	=	-0.3	Windward Wall
		=	-0.6	Leeward Wall
Velocity Pressure	$q_z = (0.00256)(K_z)(K_{zt})(K_d)(V_{3s}^2)(I) =$		14.15	
Velocity Pressure	$q_h = (0.00256)(K_h)(K_{zt})(K_d)(V_{3s}^2)(I) =$		13.36	
Design Wind Load	$p = qGC_p - q_i(Gc_{pi}) =$		9.86 psf	
<i>Module A</i>				
	Width.n-s	=	12.0 ft	
	Width.e-w	=	30.0 ft	
	Height	=	18.0 ft	
	Vwind.n-s	=	2130 lbs	(seismic controls)
	Vwind.e-w	=	5326 lbs	(seismic controls)
<i>Module B</i>				
	Width.n-s	=	12.0 ft	
	Width.e-w	=	35.0 ft	
	Height	=	18.0 ft	
	Vwind.n-s	=	2130 lbs	(seismic controls)
	Vwind.e-w	=	6213 lbs	(seismic controls)
<i>Module C</i>				
	Width.n-s	=	12.0 ft	
	Width.e-w	=	25.0 ft	
	Height	=	18.0 ft	
	Vwind.n-s	=	2130 lbs	(seismic controls)
	Vwind.e-w	=	4438 lbs	(seismic controls)

STEEL ANGLE**Loads**

$W_{\text{Live Load}}$	402.5 plf		
$W_{\text{Dead Load}}$	421.5 plf	Tributary Width	11.5 ft
$D + L$	824 plf	Average Wall Height	10 ft

Properties

		Area (in ²)	y (in)	A*y (in ³)	y
t_1	0.5	1	9.72	6.75	65.61
t_2	0.72	2	1.5	0.25	0.375
d_1	13.5	3	0.765	0.67	0.5126
b	3.72	Σ	11.985		66.498
d_2	1.01				
I_x	222.0146 in ⁴				
I	9 ft				
E	29000000 psi				

Deflection

$(D+L)/240$	Δ_{max}	=	$wl^4/(8EI)$	=	0.089 in	OK
	$\Delta_{\text{allowable}}$	=	$l/360$	=	0.3 in	
$L/360$	Δ_{max}	=	$wl^4/(8EI)$	=	0.089 in	OK
	$\Delta_{\text{allowable}}$	=	$l/480$	=	0.225 in	

Flexure

M_{Max}	<	M_N/ff				
ff	=	1.67	Where:			
σ	=	$(M_y * y)/I_x$	σ	=	f_y	= 36 ksi
M_y	=	1005.146538 k-in	y	=	7.9516 in	
M_N	=	$1.5 * M_y$				
						1507.71981 k-in
M_{max}	=	$wl^2/2$				
M_{max}	=	400.464 k-in				
						400.464 k-in
						M_N/ff
						= 903 k-in
						OK FOR FLEXURE

JOIST CALCULATIONS

Roof	1.25
Floor	1.00

DF #2	1,600,000	875	95
DF #1 or BTR	1,700,000	1150	95
LSL	1,550,000	2325	310
LVL	1,900,000	2600	285
Bamboo	2,500,000	800	90

Roof Joist 9-1/4" Bamboo Open-Web Joist

Spacing = 16 in o.c.
Span = 11.5 ft

Properties:

d	=	9.25 in	L	=	11.5 ft
b	=	2.5 in			
A	=	23.13 in ²	CF	=	1.04
S _x	=	35.65 in ³	Cr	=	1.15
I _x	=	164.89 in ⁴			
E	=	2,500,000 psi			
EI	=	140,300,000			

Loads:

D	=	27 psf	wD	=	36.0 plf
L _r	=	20 psf	wL _r	=	26.7 plf
D + L _r	=	47 psf	wD+L _r	=	62.7 plf
D / 0.9	=	30.0 psf			
(D+L _r)/1.25	=	37.6 psf			
CD	=	1.25			

controls

Check Bending:

M	=	1036 lb-ft	=	12432 lb-in
f _b	=	349 psi		
F _b	=	800 psi		
CL	=	1.0		
F _b '	=	1191 psi	OK	

Check Shear:

V	=	360 lbs		
f _v	=	23 psi		
F _v	=	90 psi		
F _v '	=	113 psi	OK	

Check Deflection:

DL	=	0.07 in	or	$\frac{L}{1845}$	OK
DD+L	=	0.18 in	or	$\frac{L}{785}$	OK

Span = 11.5 ft

Loads:

D = 27 psf
L = 20 psf
D + L = 47 psf

wD = 54.0 plf
wLr = 40.0 plf
wD+L = 94.0 plf

Properties:

d	=	9.25	in
b	=	1.5	in
A	=	13.88	in ²
Sx	=	21.39	in ³
Ix	=	98.93	in ⁴
E	=	1,600,000	psi

L = 11.5 ft
CF = 1.04
Cr = 1.15

Loads:

	D	=	27	psf
	Lr	=	20	psf
	D + Lr	=	47	psf
D /	0.9	=	30.0	psf
	(D+Lr)/1.25 =	=	37.6	psf
	CD	=	1.25	

wD = 54.0 plf
wLr = 40.0 plf
wD+Lr = 94.0 plf

controls

Check Bending:

M	=	1554 lb-ft	=	18647 lb-in
fb	=	872 psi		
Fb	=	875 psi		
CL	=	1.0		
F`b	=	1303 psi	OK	

OK

Check Shear:

V	=	541 lbs
f _v	=	58 psi
F _v	=	95 psi
F _v	=	119 psi

OK

Check Deflection:

DL	=	0.10 in	or	$\frac{L}{1388}$	OK
DD+L	=	0.23 in	or	$\frac{L}{591}$	OK

Roof Rim Joist

5-1/8" x 9"

24F-V4 Glu-Lam

Spacing = 5.75 ft

Span = 15.0 ft

Properties:

d	=	9 in
b	=	5.125 in
A	=	46.13 in ²
S _x	=	69.19 in ³
I _x	=	311.34 in ⁴
E	=	1,800,000 psi

L = 11.5 ft

Loads:

D	=	27 psf	wD =	155.3 plf
L _r	=	20 psf	wL _r =	115.0 plf
D + L _r	=	47 psf	wD+L _r =	270.3 plf
D / 0.9	=	30.0 psf		
(D+L _r)/1.25 =	=	37.6 psf		
CD	=	1.25		

controls

Check Bending:

M	=	4468 lb-ft	=	53611 lb-in
f _b	=	775 psi		
F _b	=	2400 psi		
CL	=	1.0		
F _b	=	3000 psi	OK	

Check Shear:

V	=	1554 lbs		
f _v	=	51 psi		
F _v	=	265 psi		
F _v	=	331 psi	OK	

Check Deflection:

DL	=	0.19 in	or	$\frac{L}{727}$	OK
DD+L	=	0.45 in	or	$\frac{L}{309}$	OK

24 in o.c.

L = 11.5 ft
CF = 1.01
Cr = 1.15

wD = 30.0 plf
wL = 100.0 plf
wD+L = 130.0 plf

M =	2149 lb-ft	=	25789 lb-in
fb =	815 psi		
Fb =	875 psi		
CL =	1.0		
F`b =	1015 psi	OK	

V =	748 lbs	
f _v =	66 psi	
F _v =	180 psi	
F` _v =	180 psi	OK

DL =	0.14 in	or	$\frac{L}{999}$	OK
D+L =	0.18 in	or	$\frac{L}{768}$	OK

or

$\frac{L}{999}$ OK

OK

$$\frac{L}{768} \quad \text{OK}$$

OK

Floor Joist at Cantilever End Module C

16F-V1 DF/SW 5-1/8"x6" Glu-Lam

Properties:

d =	6 in	L =	12.4 ft
b =	5.125 in		
A =	30.75 in ²	CF =	1.10
S _x =	30.75 in ³	Cr =	1
I _x =	92.25 in ⁴		
E =	1,400,000 psi		

Loads:

D =	15 psf	Hi	
L =	50 psf	wD =	50.0 plf
D + L =	65 psf	wL =	150.0 plf
D / 0.9 =	16.7 psf	wD+L =	200.0 plf
(D+L)/1.0 =	65.0 psf		
CD =	1.00	(controls)	

Check Bending:

M =	2166 lb-ft	=	25992 lb-in
f _b =	845 psi		
F _b =	1600 psi		
CL =	1.0		
F _b ' =	1758 psi	OK	

Check Shear:

V =	862 lbs		
f _v =	42 psi		
F _v =	265 psi		
F _v ' =	265 psi	OK	

Check Deflection:

DL =	0.33 in	or	$\frac{L}{451}$	OK
DD+L =	0.44 in	or	$\frac{L}{338}$	OK

Double Floor Joists at Cantilever

(2) Cut-Down 2x12's DF#2

Properties:

d =	10.5 in	L =	11.5 ft
b =	3 in		
A =	31.50 in ²	CF =	1.02
Sx =	55.13 in ³	Cr =	1.15
Ix =	289.41 in ⁴		
E =	1,600,000 psi		

Loads:

D =	15 psf	Hi	
L =	50 psf	wD =	53.8 plf
D + L =	65 psf	wL =	180.2 plf
D / 0.9 =	16.7 psf	wD+L =	234.0 plf
(D+L)/1.0 =	65.0 psf		
CD =	1.00	(controls)	

Check Bending:

M =	2290 lb-ft	=	27480 lb-in
fb =	499 psi		
Fb =	900 psi		
CL =	1.0		
F`b =	1054 psi	OK	

Check Shear:

V =	972 lbs		
fv =	46 psi		
Fv =	180 psi		
F`v =	180 psi	OK	

Check Deflection:

DL =	0.32 in	or	$\frac{L}{437}$	OK
DD+L =	0.41 in	or	$\frac{L}{337}$	OK

Roof Module Seam

3.5 x 16 PSL

Maximum Load Applied at Roof of Module B = 10752 lbs

 $C_o = 1.6$ (Seismic)*Connection*

Bolt =	3/4" Countersunk
Capacity =	630 lb
# Req'd =	11

Beam Length =	12 ft	
Spacing=	13 in O.C.	--> USE 12" O.C.

BEAMS

Roof Beam Over Nana Walls

Roof	1.25
Floor	1.00

3x10 D.F. #1 Trib. Width = 2 ft

D.F. #1	1700000	1000	95
LVL	1900000	2600	285
PSL	2000000	2900	290

Properties:

$$\begin{aligned}
 d &= 9.25 \text{ in} & L &= 12.0 \text{ ft} \\
 b &= 2.5 \text{ in} \\
 A &= 23.13 \text{ in}^2 & CF &= 1.04 \\
 S_x &= 35.65 \text{ in}^3 \\
 I_x &= 164.89 \text{ in}^4 \\
 E &= 2E+06 \text{ psi}
 \end{aligned}$$

Loads:

$$\begin{aligned}
 D &= 27 \text{ psf} & wD &= 54.0 \text{ plf} \\
 L &= 20 \text{ psf} & wL &= 40.0 \text{ plf} \\
 D + L &= 47 \text{ psf} & wD+L &= 94.0 \text{ plf} \\
 D / 0.9 &= 30.0 \text{ psf} \\
 (D+L) / 1.25 &= 37.6 \text{ psf} & \text{control} \\
 CD &= 1.25
 \end{aligned}$$

Check Bending:

$$\begin{aligned}
 M &= 1692 \text{ lb-ft} = 20304 \text{ lb-in} \\
 f_b &= 570 \text{ psi} \\
 F_b &= 1000 \text{ psi} \\
 CL &= 1.0 \\
 F'b &= 1295 \text{ psi} \quad \text{OK}
 \end{aligned}$$

Check Shear:

$$\begin{aligned}
 R &= 564 \text{ lbs} \\
 f_v &= 37 \text{ psi} \\
 F_v &= 95 \text{ psi} \\
 F'v &= 119 \text{ psi} \quad \text{OK}
 \end{aligned}$$

Check Deflection:

$$\begin{aligned}
 D_L &= 0.07 \text{ in} & \text{or} & \frac{L}{2163} & \text{OK} \\
 D_{D+L} &= 0.16 \text{ in} & \text{or} & \frac{L}{920} & \text{OK}
 \end{aligned}$$

Glu-Lam

9x5-1/8 GLB -> 24F-V4

Trib. Width = 6 ft

Properties:

d =	9 in	L =	14.0 ft
b =	5.125 in		
A =	46.13 in ²	CF =	1.03
S _x =	69.19 in ³		
I _x =	311.34 in ⁴		
E =	2E+06 psi		

Loads:

D =	27 psf	wD =	162.0 plf
L =	20 psf	wL =	120.0 plf
D + L =	47 psf	wD+L =	282.0 plf
D / 0.9 =	30.0 psf		
(D+L)/1.0 =	47.0 psf	(controls)	
CD =	1.00		

Check Bending:

M =	6909 lb-ft	=	82908 lb-in
f _b =	1198 psi		
F _b =	2900 psi		
CL =	1.0		
F _b ' =	2994 psi	OK	

Check Shear:

R =	1974 lbs		
f _v =	64 psi		
F _v =	285 psi		
F _v ' =	285 psi	OK	

Check Deflection:

D _L =	0.17 in	or	$\frac{L}{1009}$	OK
D _{D+L} =	0.39 in	or	$\frac{L}{429}$	OK

Header over South Slider of Module B

3x10 DF-L No. 1

Trib. Width = 6 ft

Properties:

d =	9.25 in	L =	9.0 ft
b =	2.5 in		
A =	23.13 in ²	CF =	1.03
S _x =	35.65 in ³		
I _x =	164.89 in ⁴		
E =	2E+06 psi		

Loads:

D =	27 psf	wD =	162.0 plf
L =	20 psf	wL =	120.0 plf
D + L =	47 psf	wD+L =	282.0 plf
D / 0.9 =	30.0 psf		
(D+L)/1.0 =	47.0 psf	(controls)	
CD =	1.00		

Check Bending:

M =	2855 lb-ft	=	34263 lb-in
f _b =	961 psi		
F _b =	1000 psi		
CL =	1.0		
F _b ' =	1029 psi	OK	

Check Shear:

R =	1269 lbs		
f _v =	82 psi		
F _v =	285 psi		
F _v ' =	285 psi	OK	

Check Deflection:

D _L =	0.06 in	or	$\frac{L}{1709}$	OK
D _{D+L} =	0.15 in	or	$\frac{L}{727}$	OK

Header over Mechanical Room Door

4x6 DF-L No. 1

Trib. Width = 1 ft

Properties:

$$\begin{aligned}
 d &= 3.5 \text{ in} & L &= 10.0 \text{ ft} \\
 b &= 5.5 \text{ in} \\
 A &= 19.25 \text{ in}^2 & CF &= 1.15 \\
 S_x &= 11.23 \text{ in}^3 \\
 I_x &= 19.65 \text{ in}^4 \\
 E &= 2E+06 \text{ psi}
 \end{aligned}$$

Loads:

$$\begin{aligned}
 D &= 27 \text{ psf} & wD &= 27.0 \text{ plf} \\
 L &= 20 \text{ psf} & wL &= 20.0 \text{ plf} \\
 D + L &= 47 \text{ psf} & wD+L &= 47.0 \text{ plf} \\
 D / 0.9 &= 30.0 \text{ psf} \\
 (D+L)/1.0 &= 47.0 \text{ psf} & (\text{controls}) \\
 CD &= 1.00
 \end{aligned}$$

Check Bending:

$$\begin{aligned}
 M &= 588 \text{ lb-ft} = 7050 \text{ lb-in} \\
 f_b &= 628 \text{ psi} \\
 F_b &= 1000 \text{ psi} \\
 CL &= 1.0 \\
 F^*b &= 1147 \text{ psi} & \text{OK}
 \end{aligned}$$

Check Shear:

$$\begin{aligned}
 R &= 235 \text{ lbs} \\
 f_v &= 18 \text{ psi} \\
 F_v &= 285 \text{ psi} \\
 F^*v &= 285 \text{ psi} & \text{OK}
 \end{aligned}$$

Check Deflection:

$$\begin{aligned}
 D_L &= 0.14 \text{ in} & \text{or} & \frac{L}{838} & \text{OK} \\
 D_{D+L} &= 0.34 \text{ in} & \text{or} & \frac{L}{357} & \text{OK}
 \end{aligned}$$

Header over Punched Door and Sidelite Entry PSL

Trib. Width = 5.75 ft

Properties:

d =	3.25 in	L =	3.5 ft
b =	5.5 in		
A =	17.88 in ²	CF =	1.16
S _x =	9.68 in ³		
I _x =	15.73 in ⁴		
E =	2E+06 psi		

Loads:

D =	27 psf	wD =	155.3 plf
L =	20 psf	wL =	115.0 plf
D + L =	47 psf	wD+L =	270.3 plf
D / 0.9 =	30.0 psf		
(D+L)/1.0 =	47.0 psf	(controls)	
CD =	1.00		

Check Bending:

M =	414 lb-ft	=	4966 lb-in
f _b =	513 psi		
F _b =	1000 psi		
CL =	1.0		
F [*] _b =	1156 psi	OK	

Check Shear:

R =	473 lbs		
f _v =	40 psi		
F _v =	285 psi		
F [*] _v =	285 psi	OK	

Check Deflection:

D _L =	0.01 in	or	$\frac{L}{3234}$	OK
D _{D+L} =	0.03 in	or	$\frac{L}{1376}$	OK

COLUMNS

Post: 4x6 post - DF #1

Pmax = 3214 lbs.

Properties:

d = 5.5 in
b = 3.5 in
A = 19.25 in²
E = 1.6E+06 psi
KcE = 0.3
c = 0.8

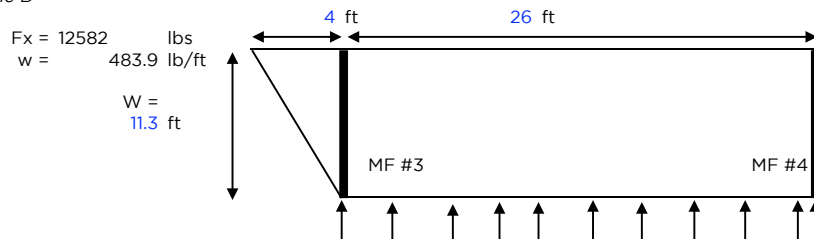
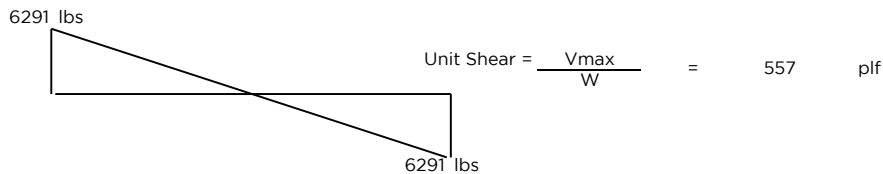
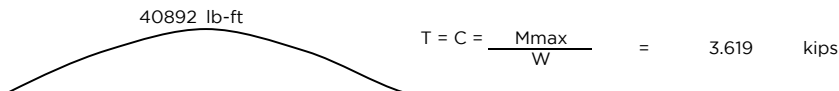
le = 12 ft
CD = 1.0
CF = 1.15

Check Post:

fc = 167 psi
Fc = 1500 psi
F*c = 1725 psi
FcE = 700 psi
FcE / F*c = 0.406
Cp = 0.364
F`c = 628 psi OK

Check Sill Plate:

fc = 167 psi
F`c(p) = 625 psi OK (Bearing on Sill Plate)

DIAPHRAGMS*Module B**Shear Diagram**Moment Diagram***DIAPHRAGM DESIGN**

ASD: Unit Shear = 0.7E
 Unit Shear = 389.7 plf

Sheathing
 19/32 Structural I

Nailing 7/16" Crn, 1-3/4" Leg, 16 Ga., Stainless, Sencote
 Edge = 1-3/4" 16 GA Staples @ 2-1/2"
 Intermediate = 1-3/4" 16 GA Staples @ 4"

STAPLES TO HAVE 7/16" CROWNS PLACED PARALLEL TO LONG DIRECTION OF FRAMING MEMBERS

CHORD DESIGN*Strength Check*

Chord = (2) 2x6 DF-L No. 1
 $F_t = 675 \text{ psi}$
 $C_D = 1.6 \text{ (Seismic)}$
 $f_t = F_t \times C_D$
 $f_t = 1080 \text{ psi}$

Effective Area of 2 x 6
 $A = 8.25 \text{ in}^2$

$$F'_t = \frac{T_{\max}}{A} = \frac{3619}{8.25} = 438.6 \text{ psi}$$

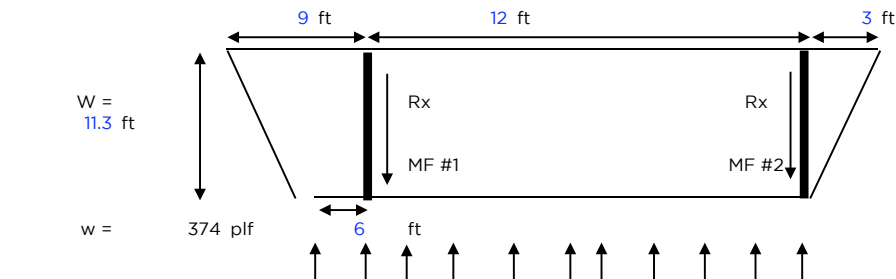
$$F'_t < f_t \quad \text{OK}$$

Chord Splice

Transfer Load = 1809.4 lbs Space Butt Joints @ 5' Minimum

Nail = 10d
 Capacity = 118 lb
 # Req'd = 10

NAILER DESIGN



Moment Frame	Rx (lbs.)
1	6619
2	2725
Total	9344

Maximum Load Transfer From Moment Frame = 6619 lbs

Provide 2x8 Nailer Per TPO Roofing Submittal

Strength Check

$$\begin{aligned} F_t &= 675 \text{ psi} \\ C_o &= 1.6 \text{ (Seismic)} \\ f_t &= F_t \times C_o \\ f_t &= 1080 \text{ psi} \end{aligned}$$

Effective Area of 2 x 8 w/ Bolt Reduction

$$A = 9.375 \text{ in}^2$$

$$F'_t = \frac{T_{max}}{A} = \frac{6619}{9.375} = 706 \text{ psi}$$

$$F'_t < f_t \quad \text{OK}$$

Connection

$$\begin{aligned} \text{Bolt} &= 1/2" \text{ Countersunk} \\ \text{Capacity} &= 290 \text{ lb} \\ \# \text{ Req'd} &= 15 \end{aligned}$$

NAIL DESIGN

Maximum Load Transfer From Moment Frame = 6619 lbs

Connection

$$\begin{aligned} \text{Nail} &= 6d \\ \text{Capacity} &= 72 \text{ lb} \\ \# \text{ Req'd} &= 91.929 \end{aligned}$$

Double nail along nailer

$$\begin{aligned} \# \text{ Rows of Nails} &= 46 \\ \text{Nail Spacing} &= 3 \text{ in O.C.} \end{aligned}$$

SHEAR WALLS

Module A

E-W Seismic Load on Shear Walls:

Shear Wall	Wall Type	Fx (lbs.)	Px=Fx/1.4 (lbs.)	b (ft)	h (ft)	Aspect Ratio h:b	Reduction Factor	v (ASD) (plf)	v.allow (plf)	Plywood (in)	Edge Nail (in)	Other Edge Nailing (in)	ri
A	Segmented	2516	1797	6.1	9.3	1.5245902	1.00	295	530	15/32 Str I	8d @ 2.5"	8d @ 6"	0.819672131
B	Segmented	2516	1797	5.6	8.7	1.5535714	1.00	321	600	15/32 Str I	8d @ 2"	8d @ 6"	0.89
Total		5032	3594										

Module B

E-W Seismic Load on Shear Walls:

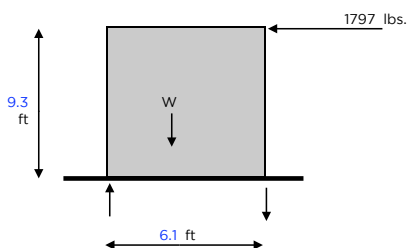
Shear Wall	Wall Type	Fx (lbs.)	Px=Fx/1.4 (lbs.)	b (ft)	h (ft)	Aspect Ratio h:b	Reduction Factor	v (ASD) (plf)	v.allow (plf)	Plywood (in)	Edge Nail (in)	Other Edge Nailing (in)	ri
C	Perforated	2895	2068	17.7	7.86	0.4440678	1.00	117	280	15/32 Str I	8d @ 6"	8d @ 6"	0.282485876
D	Segmented	2895	2068	6.2	8.9	1.4354839	1.00	334	530	15/32 Str I	8d @ 2.5"	8d @ 6"	0.806451613
Total		5789	4136										

Module C

N-S Seismic Load on Shear Walls:

Shear Wall	Wall Type	Fx (lbs.)	Px=Fx/1.4 (lbs.)	b (ft)	h (ft)	Aspect Ratio h:b	Reduction Factor	v (ASD) (plf)	v.allow (plf)	Plywood (in)	Edge Nail (in)	Other Edge Nailing (in)	ri
E	Segmented	916	654	3.5	8.8	2.5142857	0.80	235	360	15/32 Str I	8d @ 4"	8d @ 6"	0.684931507
F	Segmented	994	710	2.875	8.5	2.9565217	0.68	365	670	15/32 Str I	8d @ 1.75"	8d @ 6"	0.905300774
G	Segmented	1910	1364	7.5	8.8	1.1733333	1.00	182	360	15/32 Str I	8d @ 4"	8d @ 6"	0.666666667
Total		3819	2728										

SHEAR WALL - A:



Check Loads:

Px =	1797 lbs.	
W =	0 lbs.	** Assume Weight of Wall is 0 to be conservative
Mot =	16712 lb-ft	
Tasd =	2740 lbs.	

Check Holddown:

Ta.hd =	3075 lbs.	OK
---------	-----------	----

Check 4x6 Post:

Ta.4x6 =	18769 lbs.	OK
----------	------------	----

Check Overturning:

W =	0 lbs	
Mr =	18758 lb-ft	
Mot =	16712 lb-ft	
Mr	> Mot	OK

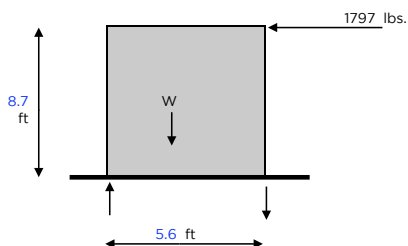
Mudsill - Rim Joist

Connector =	SDS 1/4" x 6"
Capacity =	560 lbs
# Required =	4
Req'd Spacing =	18 in

Clips to Top Plate:

Clip =	A35
Capacity =	450 lbs
# Req'd =	4
Req'd Spacing =	18 in

SHEAR WALL - B:



Check Loads:

Px =	1797 lbs.	
W =	0 lbs.	** Assume Weight of Wall is 0 to be conservative
Mot =	15634 lb-ft	
Tasd =	2792 lbs.	

Check Holddown:

Ta.hd =	3075 lbs.	OK
---------	-----------	----

Check 4x6 Post:

Ta.4x6 =	18940 lbs.	OK
----------	------------	----

Check Overturning:

W =	0 lbs	
Mr =	17220 lb-ft	
Mot =	15634 lb-ft	
Mr	> Mot	OK

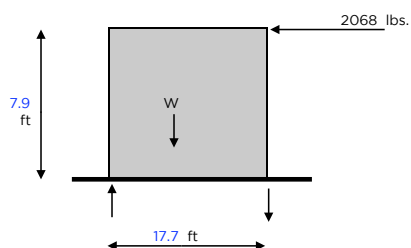
Mudsill - Rim Joist

Connector =	SDS 1/4" x 6"
Capacity =	560 lbs
# Required =	4
Req'd Spacing =	17 in

Clips to Top Plate:

Clip =	A35
Capacity =	450 lbs
# Req'd =	4
Req'd Spacing =	17 in

SHEAR WALL - C:

Check Loads:

Px = 2068 lbs.
 W = 0 lbs.
 Mot = 16334 lb-ft
 Tasd = 923 lbs.

** Assume Weight of Wall is 0 to be conservative

Check Holddown:

Ta.hd = HDU2 SDS2.5
 3075 lbs. OK

Check 4x6 Post:

Ta.4x6 = 18940 lbs. OK

Check Overturning:

W = 0 lbs.
 Mr = 54428 lb-ft
 Mot = 16334 lb-ft
 Mr > Mot OK

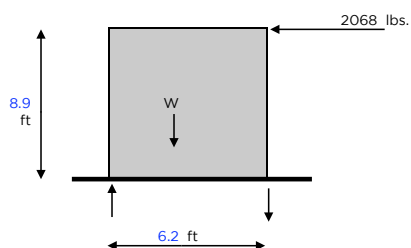
Mud sill - Rim Joist

Connector = SDS 1/4" x 6"
 Capacity = 560 lbs
 # Required = 4
 Req'd Spacing = 53 in

Clips to Top Plate:

Clip = A35
 Capacity = 450 lbs
 # Req'd = 5
 Req'd Spacing = 42 in

SHEAR WALL - D:

Check Loads:

Px = 2068 lbs.
 W = 0 lbs.
 Mot = 18405 lb-ft
 Tasd = 2969 lbs.

** Assume Weight of Wall is 0 to be conservative

Check Holddown:

Ta.hd = HDU2 SDS2.5
 3075 lbs. OK

Check 4x6 Post:

Ta.4x6 = 18940 lbs. OK

Check Overturning:

W = 0 lbs.
 Mr = 19065 lb-ft
 Mot = 18405 lb-ft
 Mr > Mot OK

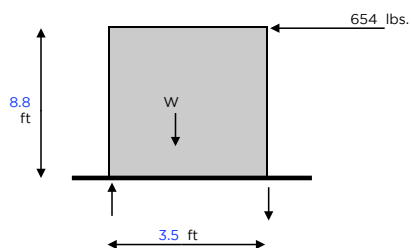
Mud sill - Rim Joist

Connector = SDS 1/4" x 6"
 Capacity = 560 lbs
 # Required = 4
 Req'd Spacing = 19 in

Clips to Top Plate:

Clip = A35
 Capacity = 450 lbs
 # Req'd = 5
 Req'd Spacing = 15 in

SHEAR WALL - E:

Check Loads:

Px = 654 lbs.
 W = 0 lbs.
 Mot = 5755 lb-ft
 Tasd = 1644 lbs.

** Assume Weight of Wall is 0 to be conservative

Check Holddown:

Ta.hd = HDU2 SDS2.5
 3075 lbs. OK

Check 4x6 Post:

Ta.4x4 = 18940 lbs. OK

Check Overturning:

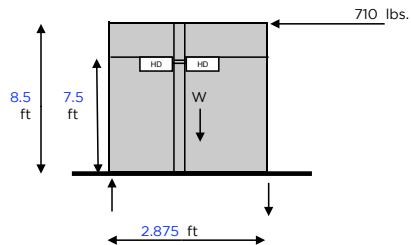
W = 0 lbs.
 Mr = 10763 lb-ft
 Mot = 5755 lb-ft
 Mr > Mot OK

Mud sill - Rim Joist

Connector = SDS 1/4" x 6"
 Capacity = 560 lbs
 # Required = 2
 Req'd Spacing = 21 in

Clips to Top Plate:

Clip = A35
 Capacity = 450 lbs
 # Req'd = 2
 Req'd Spacing = 21 in

SHEAR WALL - F:Check Loads:

Px = 710
 W = 0 lbs.
 Mot = 6035 lb-ft
 Tasd = 2099 lbs.

** Assume Weight of Wall is 0 to be conservative

Check Holddown:

Ta.hd = HDU2 SDS2.5
 3075 lbs. OK

Check 4x6 Post:

Ta.4x4 = 18940 lbs. OK

Check Overturning:

W = 0 lbs
 Mr = 8841 lb-ft
 Mot = 6035 lb-ft
 Mr > Mot OK

Mud sill - Rim Joist

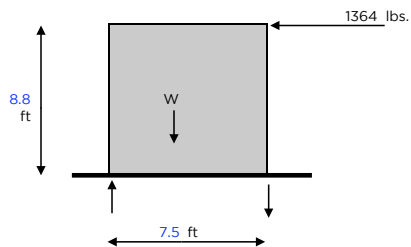
Connector = SDS 1/4" x 6"
 Capacity = 560 lbs
 # Required = 2
 Req'd Spacing = 17 in

Clips to Top Plate:

Clip = A35
 Capacity = 450 lbs
 # Req'd = 2
 Req'd Spacing = 17 in

Horizontal Hold-Down

Hold-Downs = HDU2 SDS2.5
 Ta. hd = 3075 lbs
 Tasd = 805 lbs
 Ta. hd > Tasd OK

SHEAR WALL - G:Check Loads:

Px = 1364
 W = 0 lbs.
 Mot = 12004 lb-ft
 Tasd = 1600 lbs.

** Assume Weight of Wall is 0 to be conservative

Check Holddown:

Ta.hd = HDU2 SDS2.5
 3075 lbs. OK

Check 4x6 Post:

Ta.4x4 = 18940 lbs. OK

Check Overturning:

W = 0 lbs
 Mr = 23063 lb-ft
 Mot = 12004 lb-ft
 Mr > Mot OK

Mud sill - Rim Joist

Connector = SDS 1/4" x 6"
 Capacity = 560 lbs
 # Required = 3
 Req'd Spacing = 30 in

Clips to Top Plate:

Clip = A35
 Capacity = 450 lbs
 # Req'd = 4
 Req'd Spacing = 23 in

DRIFTS

$$Ds = \frac{8 v h^3}{E A b} + \frac{v h}{G_t} + 0.75 h e_n + \frac{h DTD}{b}$$

$$E = 2E+06 \text{ psi}$$

$$G_t = 35000 \text{ lb/in of depth}$$

Hold-Down Displacement:

Shear Wall	Tasd (lbs.)	T (lbs.)	Tie-Down	D @ Cap. (in)	Elong. (in)	Shrink (in)	Crush (in)	Slip (in)	DTD (in)
A	2740	3836	HDU2 SDS2.5	0.088	0.078	0.02	0.02	0.00	0.118
B	2792	3908	HDU2 SDS2.5	0.088	0.080	0.02	0.02	0.00	0.120
C	923	1292	HDU2 SDS2.5	0.088	0.026	0.02	0.02	0.00	0.066
D	2969	4156	HDU2 SDS2.5	0.088	0.085	0.02	0.02	0.00	0.125
E	1644	2302	HDU2 SDS2.5	0.088	0.047	0.02	0.02	0.00	0.087
F	2099	2939	HDU2 SDS2.5	0.088	0.060	0.02	0.02	0.00	0.100
G	1600	2241	HDU2 SDS2.5	0.088	0.046	0.02	0.02	0.00	0.086

Drift:

Shear Wall	v (ASD) (plf)	v (plf)	h (ft)	A (sq. in.)	b (ft)	t (in)	nail o.c. (in)	Vn (lbs.)	en (in)	Ds (in)
A	295	412	9.3	19.25	6.1	0.469	2.5	86	0.0026	0.68
B	321	449	8.7	19.25	5.6	0.469	2	75	0.0017	0.60
C	117	164	7.9	19.25	17.7	0.469	6	82	0.0023	0.24
D	334	467	8.9	19.25	6.2	0.469	2.5	97	0.0038	0.77
E	235	329	8.8	19.25	3.5	0.469	4	110	0.0017	0.64
F	365	511	8.5	19.25	2.875	0.469	1.75	75	0.0005	0.80
G	182	255	8.8	19.25	7.5	0.469	4	85	0.0025	0.44

Drift Check:

Shear Wall	Ds (in)	h (ft)	Cd	DM (in)	DMmax (in)	
A	0.68	9.30	4.5	2.14	2.79	OK
B	0.60	8.70	4.5	1.88	2.61	OK
C	0.24	7.86	4.5	0.76	2.36	OK
D	0.77	8.90	4.5	2.42	2.67	OK
E	0.64	8.80	4.5	2.00	2.64	OK
F	0.80	8.50	4.5	2.51	2.55	OK
G	0.44	8.80	4.5	1.38	2.64	OK

MOMENT FRAMES

Moment Frame Type; = Ordinary Moment Frame

Response Modification Coefficient; $R = 3.5$

Overstrength Factor; $ff_o = 3$

Deflection Amplification Factor; $C_d = 3$

Importance Factor; $I = 1$

Module A

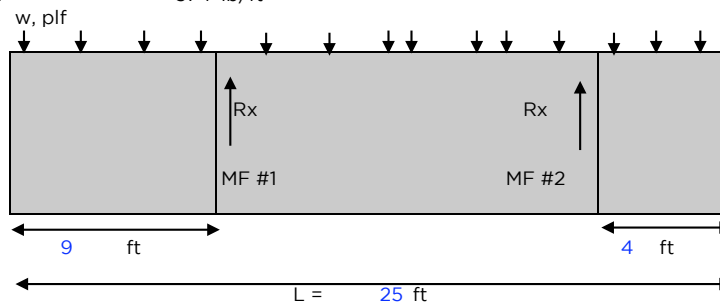
N-S Seismic Load on **Moment Frames**:

Moment Frame	Rx (lbs.)
1	6619
2	2725
Total	9344

Total Load $F_x = 9344 \text{ lb}$

Distributed Load $w = 374 \text{ lb/ft}$

PLAN VIEW
OF RESISTING
SYSTEM

*Module B*

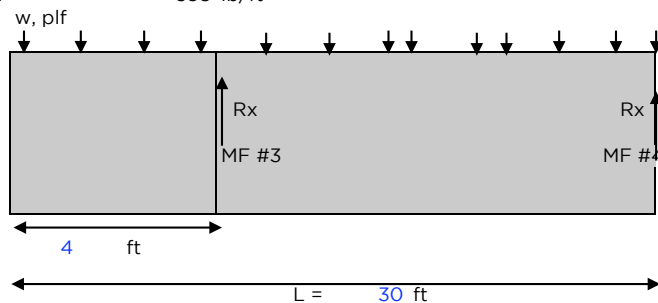
N-S Seismic Load on **Moment Frames**:

Moment Frame	Rx (lbs.)
3	6203
4	4549
Total	10752

Total Load $F_x = 10752 \text{ lb}$

Distributed Load $w = 358 \text{ lb/ft}$

PLAN VIEW
OF RESISTING
SYSTEM



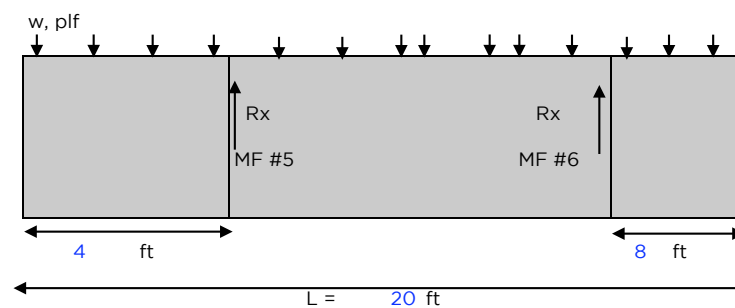
Module C

E-W Seismic Load on **Moment Frames:**

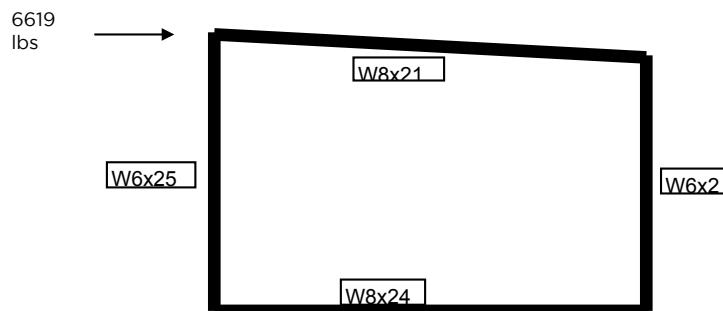
Moment Frame	R _x (lbs.)
5	1773
6	5320
Total	7093

Total Load F_x = 7093 lb
Distributed Load w = 355 lb/ft

PLAN VIEW
OF RESISTING
SYSTEM



Maximum Moment Frame Lateral Load = 6619 lb



Drift Check

$\Delta_s =$ 0.79 in (See Appendix A)
 $\Delta_{max} = C_d \Delta_s / I =$ 2.37 in
 $\Delta_{allow} = .025 h_{sx} =$ 3.6 in
 $\Delta_{max} < \Delta_{allow}$ OK

Beam Check: W8x21

Properties

A _g	6.16	in ²
d	8.28	in
Z _x	20.4	in ³
F _y	50	ksi
E	29000	ksi
J	0.282	in ⁴
I _y	9.77	in ⁴
I _x	75.3	in ⁴
c	1	
S _x	18.2	in ³
h _o	7.88	in
r _y	1.26	in
C _w	152	in ⁶
R _m	1.0	
t _f	0.32	in
t _w	0.25	in
h/t _w	27.5	
b	5.27	in

Flexure

Check for Compact Section

Flange

$$\begin{aligned}\lambda_p &= 9.15161 \\ \lambda_r &= 19.989 \\ b/2t &= 6.59\end{aligned}$$

Web

$$\begin{aligned}\lambda_p &= 90.312 \\ \lambda_r &= 137.274 \\ h/t_w &= 27.5\end{aligned}$$

Section is Compact

Check for Lateral Torsional Buckling

$$\begin{aligned}L_b &= 144 \text{ in} \\ L_p &= 1.76 \cdot r_y \cdot (E/F_y)^{1/2} \\ L_p &= 53.4069 \text{ in} \\ L_r &= 1.95 r_{ts} (E/(0.7 F_y)) (J_c/(S_x h_o))^{1/2} (1 + (1 + 6.76 (0.7 F_y S_x h_o / (E J_c))^2)^{1/2})^{1/2} \\ L_r &= 177.62 \\ C_b &= 1.14\end{aligned}$$

$$\begin{aligned}M_{px} &= 1020 \text{ kip-in} \\ M_N &= C_b [M_p - (M_p - 0.7 F_y S_x) ((L_b - L_p)/(L_r - L_p))] \\ M_N &= 844.352 \text{ kip-in} \\ M_N/ff &= 505.6 \text{ kip-in} \\ M_{max} &= 20.204 \text{ kip-ft} \quad (\text{See Appendix A}) \\ M_{max} &= 242.448 \text{ kip-in} \\ M_{Max} &< M_N/ff \quad \text{OK}\end{aligned}$$

Shear

$$\begin{aligned}ff &= 1.5 \\ C_v &= 1.0 \\ A_w &= 2.07 \text{ in}^2 \\ V_N &= 0.6 F_y A_w C_v \\ V_N &= 62.1 \text{ kips} \\ V_N/ff &= 41.4 \text{ kips} \\ V_{max} &= 3.365 \text{ kips} \\ V_{Max} &< V_N/ff \quad \text{OK}\end{aligned}$$

Beam Check: W8x24

Properties

A_g	7.08	in ²
d	7.93	in
Z_x	23.1	in ³
F_y	50	ksi
E	29000	ksi
J	0.346	in ⁴
I_y	18.3	in ⁴
I_x	82.7	in ⁴
c	1	
S_x	20.9	in ³
h_o	7.53	in
r_y	1.61	in
C_w	259	in ⁶
R_m	1.0	
t_w	0.245	in
h/t_w	25.9	
b	6.5	in
tf	0.4	

Flexure

Check for Compact Section

Flange

$$\lambda_p = 9.15161$$

$$\lambda_r = 19.989$$

$$b/2t = 8.12$$

Web

$$\lambda_p = 90.312$$

$$\lambda_r = 137.274$$

$$h/t_w = 25.9$$

Section is Compact

Check for Lateral Torsional Buckling

$$L_b = 144 \text{ in}$$

$$L_p = 1.76 * r_y * (E/F_y)^{1/2}$$

$$L_p = 68.2421 \text{ in}$$

$$L_r = 1.95 r_{ts} (E / (0.7 F_y)) (J_c / (S_x h_o))^{1/2} (1 + (1 + 6.76 (0.7 F_y S_x h_o / (E J_c))^2)^{1/2})^{1/2}$$

$$L_r = 179.42$$

$$C_b = 1.14$$

$$M_{px} = 1154.3 \text{ kip-in}$$

$$M_N = C_b [M_p - (M_p - 0.7 F_y S_x) ((L_b - L_p) / (L_r - L_p))]$$

$$M_N = 987.455 \text{ kip-in}$$

$$M_N / ff = 591.291 \text{ kip-in}$$

$$M_{max} = 18.772 \text{ kip-ft}$$

(See Appendix A)

$$M_{max} = 225.264 \text{ kip-in}$$

$$M_{max} < M_N / ff \quad \text{OK}$$

Shear

$$ff = 1.5$$

$$C_v = 1.0$$

$$A_w = 1.94285 \text{ in}^2$$

$$V_N = 0.6 F_y A_w C_v$$

$$V_N = 58.2855 \text{ kips}$$

$$V_N / ff = 38.857 \text{ kips}$$

$$V_{max} = 3.2 \text{ kips}$$

$$V_{max} < V_N / ff \quad \text{OK}$$

Column Check: W6x25

Properties

A_g	7.34	in ²
d	6.38	in
Z_x	18.9	in ³
F_y	50	ksi
E	29000	ksi
J	0.461	in ⁴
I_y	17	in ⁴
I_x	54	in ⁴
c	1	
S_x	16.7	in ³
h_o	5.93	in
r_y	1.52	in
C_w	150	in ⁶
R_m	1.0	
t_w	0.32	in
h/t_w	15.5	
b	6.08	in
t_f	0.455	in

Flexure

Check for Compact Section

Flange

$$\lambda_p = 9.15161$$

$$\lambda_r = 19.989$$

$$b/2t = 6.68$$

Web

$$\lambda_p = 90.312$$

$$\lambda_r = 137.274$$

$$h/t_w = 15.5$$

Section is Compact

Check for Lateral Torsional Buckling

$$L_b = 144 \text{ in}$$

$$L_p = 1.76 r_y (E/F_y)^{1/2}$$

$$L_p = 64.4273 \text{ in}$$

$$L_r = 1.95 r_{ty} (E/(0.7F_y)) (Jc/(S_x h_o))^{1/2} (1 + (1 + 6.76 (0.7F_y S_x h_o / (E J c))^2)^{1/2})^{1/2}$$

$$L_r = 234.13$$

$$C_b = 1.14$$

$$M_{px} = 945 \text{ kip-in}$$

$$M_N = C_b [M_p - (M_p - 0.7F_y S_x) ((L_b - L_p)/(L_r - L_p))]$$

$$M_N = 884.604 \text{ kip-in}$$

$$M_N/ff = 529.703 \text{ kip-in}$$

$$M_{max} = 21.144 \text{ kip-ft} \quad (\text{See Appendix A})$$

$$M_{max} = 253.728 \text{ kip-in}$$

$$M_{Max} < M_N/ff \quad \text{OK}$$

Shear

$$ff = 1.5$$

$$C_v = 1.0$$

$$A_w = 2.0416 \text{ in}^2$$

$$V_N = 0.6 F_y A_w C_v$$

$$V_N = 61.248 \text{ kips}$$

$$V_N/ff = 40.832 \text{ kips}$$

$$V_{max} = 3.2 \text{ kips}$$

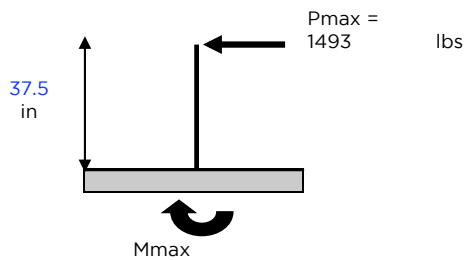
$$V_{Max} < V_N/ff \quad \text{OK}$$

CANTILEVER COLUMN*Module B*

Moment Frame 3 = 1493 lbs
 Moment Frame 4 = 1141 lbs

GOVERNS

$E = 0.7p Q_E$
 $E = 0.91Q_E$
 $E = 5268 \text{ lbs}$



Column = W6x25
 $E = 29000 \text{ ksi}$
 $F_y = 50 \text{ ksi}$
 $S_y = 5.6 \text{ in}^3$
 $I_y = 17.1 \text{ in}^4$
 $A_w = 2.0416 \text{ in}^2$
 $C_v = 1.0$
 $C_d = 3.00$
 $I = 1.00$
 $ff_b = 1.67$
 $ff_v = 1.5$

Flexure Check

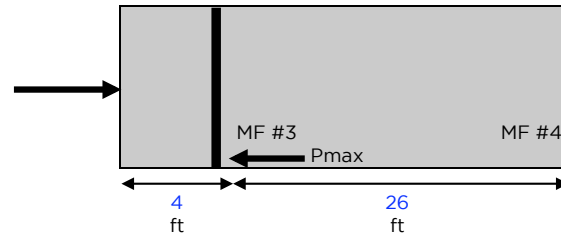
$M_{max} = 55.98 \text{ kip-in}$
 $M_n = F_y S_y$
 $M_n = 280 \text{ kip-in}$
 $M_n/ff_b = 167.7 \text{ kip-in}$
 $M_n/ff_b > M_{max} \quad \text{OK}$

Shear Check

$V_{max} = 1.493 \text{ kips}$
 $V_n = 0.6F_y A_w C_v$
 $V_n = 61.2 \text{ kips}$
 $V_n/ff_v = 40.8 \text{ kips}$
 $V_n/ff_v > V_{max} \quad \text{OK}$

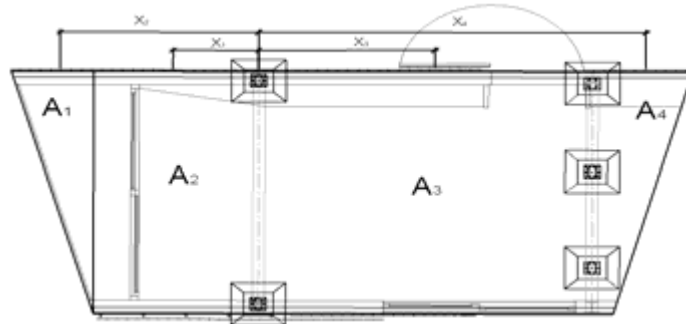
Drift Check

$\Delta_{max} = PL^3/EI$
 $\Delta_{max} = 0.1587 \text{ in}$
 $\text{Drift} = C_d \Delta_{max}/I$
 $\text{Drift} = 0.4762 \text{ in}$
 $\text{Drift Allow} = 0.9375 \text{ in}$
 $\text{Drift} < \text{Drift Allow} \quad \text{OK}$



VERTICAL OVERTURNING*Module A*

	Area	
1	18	ft ²
2	69	ft ²
3	146	ft ²
4	19	ft ²
Average Wall Height	11.5	ft



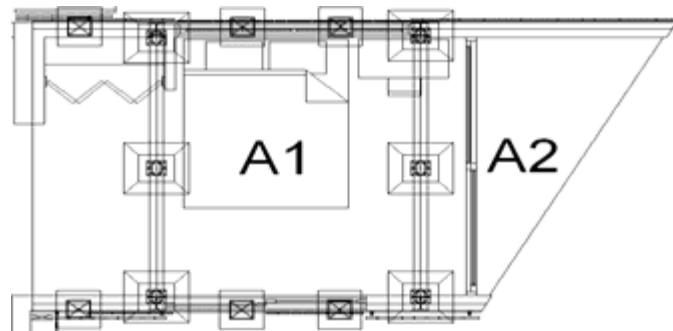
	Loads			X ₁ (ft)	X ₂ (ft)	X ₃ (ft)	X ₄ (ft)	M _{OT} (lb-ft)	M _{RES} (lb-ft)
Dead	Roof	27	psf	7	3	6.33	13.76	8991	32027
	Floor	15	psf	7	3	6.33	13.76	4995	17793
	Exterior Wall	18	psf	7.5	3	6.33	14.31	12110	36110
	Moment Frame	1100	lb/frame					0	13933
	Steel Support Track	45	plf	7.5	3	6.33	14.31	1823	5730
	Foundations	50	lb/support					0	1900
Live	Roof	20	psf	7	3	6.33	13.76	6660	0
	Floor	50	psf	7	3	6.33	13.76	16650	0
						Σ		51228	107493

Note: Where X is the distance from Moment Frame to the center of mass for each element.
Assumes worst case scenario occurs when no live load is on A₃ and A₄.

$$\frac{M_{\text{RESISTING}}}{M_{\text{OVER TURNING}}} = \frac{107493}{51228} = 2.10 > 2 \quad \text{--> OK}$$

Module C

	Area	
1	135.9	ft ²
2	55.6	ft ²
Average Wall Height	11.5	ft



	Loads			X ₁ (ft)	X ₂ (ft)	M _{RES} (lb-ft)	M _{OT} (lb-ft)
Dead	Roof	27	psf	6	4	22016	6005
	Floor	15	psf	6	4	12231	3336
	Exterior Wall	18	psf	6	4	14677	4003
	Moment Frame	1100	lb/frame			0	0
	Steel Support Track	45	plf	6	4	36693	10008
	Foundations	50	lb/support			0	0
Live	Roof	20	psf	6	4	16308	4448
	5/29/09	50	psf	6	4	40770	11120
					Σ	142695	38920

Note: Where X is the distance from Moment Frame to the center of mass for each element.
Assumes worst case scenario occurs when no live load is on A₁ and A₂.

$$\frac{M_{\text{RESISTING}}}{M_{\text{OVER TURNING}}} = \frac{142695}{38920} = 3.67 > 2 \quad \text{--> OK}$$

FOUNDATIONS

MODULE A

GOVERNING LOAD COMBINATION: $D+0.75L+0.75LR$
 USE 1500PSF PER 16"X16" FOOTING = 3000 LBS/FOOTING
 ALLOWABLE: 1500PSF, 1/3 INCREASE FOR WIND AND EARTHQUAKE = 2000PSF

DIMENSIONS

MODULE A

Length: 25 ft
 Height: 12 ft
 Width: 11.5 ft
 Wind 118.3 plf

GRAVITY

DEAD LOAD

TOTAL MODULE

29215 lbs

LIVE LOAD

FLOOR
 ROOF

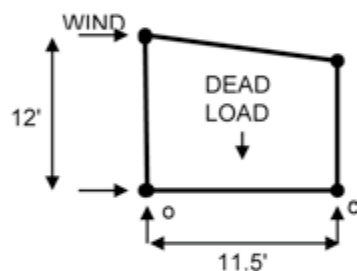
50 psf
 20 psf

10781
 4313
 44309 lbs

1500PSF BEARING PRESSURE REQUIRES:

30 SF FT FOR FOOTINGS
 1500

Lateral - For Washington D.C.



$M_o = 0 \Rightarrow$
 \Rightarrow

$c = [(WIND)(12') + (DEAD)(11.5/2)]/2$
 $c = 25241.7 \text{ LBS}$

WIND= 2959 LBS

DEAD= 44309 LBS

2000_{psf} BEARING PRESSURE REQUIRES:

12.6 SQ FT FOR FOOTINGS PER SIDE

SOUTH: SEISMIC PIERS
 STANDARD PIERS

QTY	AREA	SQ FT
1	4	SQ FT
5	1.8	SQ FT
13	sq.ft.	PROVIDED

NORTH: SEISMIC PIERS
 STANDARD PIERS

QTY	AREA	SQ FT
2	4	SQ FT
4	1.8	SQ FT
15.2	sq.ft.	PROVIDED

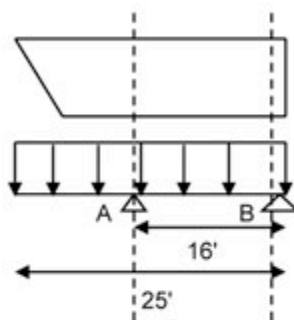
28	TOTAL SQ FT PROVIDED
1571	PSF PER FOOTING

FOUNDATIONS

MODULE A

Cantilever Load

	D (psf)	L (psf)	Total (psf)	Trib B (ft)	w (plf)
Roof	27	20	47	6	282
Floor	15	50	65	6	390
Walls	18	0	18	12	216
Total					888



$w = 888 \text{ plf}$

$R_A = 15,300 \text{ lbs}$
 $R_B = 5,520 \text{ lbs}$

AT 1500_{psf} BEARING PRESSURE THIS REQUIRES:

10.2 SQ FT FOR FOOTINGS

A: SEISMIC PIERS
STANDARD PIERS

QTY	AREA	
3	4	SQ FT
0	1.8	SQ FT
<hr/>		
12	SQ FT	PROVIDED
1275 PSF PER FOOTING		

AT 1500_{psf} BEARING PRESSURE THIS REQUIRES:

3.7 SQ FT FOR FOOTINGS

B: SEISMIC PIERS
STANDARD PIERS

QTY	AREA	
3	4	SQ FT
0	1.8	SQ FT
<hr/>		
12	SQ FT	PROVIDED
460 PSF PER FOOTING		

FOUNDATIONS

MODULE B

GOVERNING LOAD COMBINATION: $D+0.75L+0.75LR$
 USE 1500PSF PER 16"X16" FOOTING = 3000 LBS/FOOTING
 ALLOWABLE: 1500PSF, 1/3 INCREASE FOR WIND AND EARTHQUAKE = 2000PSF

DIMENSIONS

MODULE B

LENGTH: 30 FT
 HEIGHT: 12 FT
 WIDTH: 11.5 FT
 WIND 118.3 PLF

GRAVITY

DEAD LOAD

TOTAL MODULE

33875

LIVE LOAD

FLOOR
 ROOF

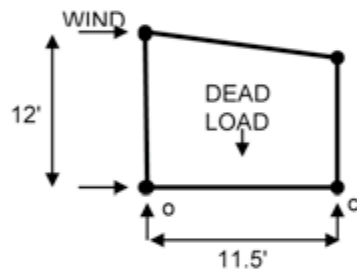
50 PSF
 20 PSF

12938
 5175
 51988 LBS

1500_{PSF} BEARING PRESSURE REQUIRES:

35 SQ FT FOR FOOTINGS

LATERAL - FOR WASHINGTON DC



$M_o = 0 \Rightarrow$
 \Rightarrow

$c = [(WIND)(12') + (DEAD)(11.5/2)]/2$
 $c = 25859.1 \text{ LBS}$

WIND= 3550 LBS

DEAD= 44309 LBS

2000_{PSF} BEARING PRESSURE REQUIRES:

12.9 SQ FT FOR FOOTINGS PER SIDE

SOUTH: SEISMIC PIERS
 STANDARD PIERS

QTY	AREA	
1	4	SQ FT
6	1.8	SQ FT
14.8		SQ FT PROVIDED

NORTH: SEISMIC PIERS
 STANDARD PIERS

2	4	SQ FT
6	1.8	SQ FT
18.8		SQ FT PROVIDED

34	TOTAL SQ FT PROVIDED
1547	PSF PER FOOTING

FOUNDATIONS

MODULE C

Governing Load Combination: $D+0.75L+0.75L_s$

Use 1500psf per 16"x16" footing = 3000 lbs/footing

Allowable: 1500psf, 1/3 increase for wind and earthquake = 2000psf

DIMENSIONS

MODULE C

LENGTH:	20	FT
HEIGHT:	12	FT
WIDTH:	11.5	FT
WIND	118.3	PLF

GRAVITY

DEAD LOAD

TOTAL MODULE

22161

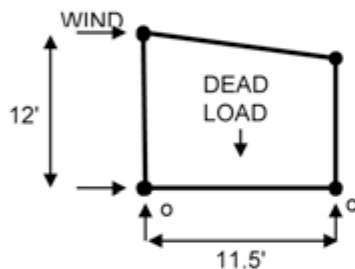
LIVE LOAD

FLOOR
ROOF50 PSF
20 PSF8625
345034236 LBS1500_{psf} BEARING PRESSURE REQUIRES:

23

SQ FT OF FOOTINGS

LATERAL - FOR WASHINGTON DC



WIND= 2367 LBS

DEAD= 44309 LBS

 $M_o=0 \Rightarrow$
 \Rightarrow $c = [(WIND)(12') + (DEAD)(11.5/2)]/2$
 $c = 24624.2$ LBS2000_{psf} BEARING PRESSURE REQUIRES:

12.3

SQ FT FOR FOOTINGS PER SIDE

SOUTH: SEISMIC PIERS
STANDARD PIERS

QTY	AREA	
2	4	SQ FT
3	1.8	SQ FT
<u>13.4</u>		SQ FT PROVIDED

NORTH: SEISMIC PIERS
STANDARD PIERS

QTY	AREA	
2	4	SQ FT
3	1.8	SQ FT
<u>13.4</u>		SQ FT PROVIDED

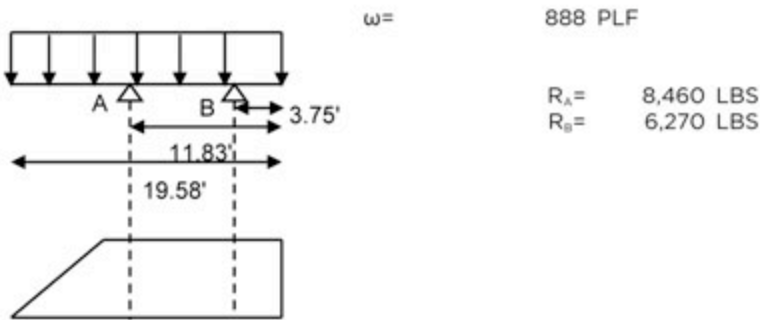
27	TOTAL SQ FT PROVIDED
1277	PSF PER FOOTING

FOUNDATIONS

MODULE C

Cantilever Load

	D (psf)	L (psf)	Total (psf)	Trib B (ft)	ω (plf)
Roof	27	20	47	6	282
Floor	15	50	65	6	390
Walls	18	0	18	12	216
Total					888



AT 1500_{psf} BEARING PRESSURE THIS REQUIRES: 5.6 SQ FT FOR FOOTINGS

A:	SEISMIC PIERS	QTY	AREA	
	STANDARD PIERS	3	4	SQ FT
		0	1.8	SQ FT
		<hr/>		
		12	SQ FT	PROVIDED
		705 PSF PER FOOTING		

AT 1500_{psf} BEARING PRESSURE THIS REQUIRES: 4.2 SQ FT FOR FOOTINGS

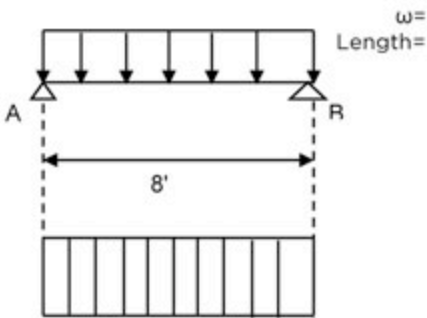
B:	SEISMIC PIERS	QTY	AREA	
	STANDARD PIERS	3	4	SQ FT
		0	1.8	SQ FT
		<hr/>		
		12	SQ FT	PROVIDED
		523 PSF PER FOOTING		

FOUNDATIONS

DECK

Deck Loading

	D (psf)	L (psf)	Total (psf)	Trib B (ft)	w (plf)
Floor	20	100	120	4	480
Total					480



480 plf
8 ft
R_A= 1,920 LBS
R_B= 1,920 LBS

AT 1500_{PSF} BEARING PRESSURE THIS REQUIRES: 1.3 SQ FT FOR FOOTINGS

A: SEISMIC PIERS
STANDARD PIERS

QTY	AREA	
0	4	SQ FT
2	1.8	SQ FT
3.6		SQ FT PROVIDED
533		PSF PER FOOTING

AT 1500_{PSF} BEARING PRESSURE THIS REQUIRES: 1.3 SQ FT FOR FOOTINGS

B: SEISMIC PIERS
STANDARD PIERS

QTY	AREA	
0	4	SQ FT
2	1.8	SQ FT
3.6		SQ FT PROVIDED
533		PSF PER FOOTING

GRADE VARIABILITY

Standard Piers, fabricated by Central Piers Inc., serve as the footings required to comply with the 1500 psf allowable bearing capacity. See S-101 and S-102 for the foundation plan and bearing plan, respectively. Central Piers Inc. supplies various sized piers for varying ground heights. Central Piers Inc. stocks piers that range from 12"-14" up to 34"-36". Each Standard Pier has a height adjustment of 2". Team California plans to bring a set of all of the available sized piers listed on the Footing Availability Schedule on A3/S-601 if shimming is needed. Therefore, no additional structural calculations are needed for our method of pier adjustability because an appropriately sized pier will be used where piers are needed.

DECK CALCULATIONS

Deck Joist

2 x 6 Redwood No. 2

Spacing = 16 in o.c.

Properties:

$$\begin{aligned}
 d &= 5.5 \text{ in} \\
 b &= 1.5 \text{ in} \\
 A &= 8.25 \text{ in}^2 \\
 S_x &= 7.56 \text{ in}^3 \\
 I_x &= 20.80 \text{ in}^4 \\
 E &= 1200000 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 L &= 6.0 \text{ ft} \\
 CF &= 1.11 \\
 Cr &= 1.15
 \end{aligned}$$

Loads:

$$\begin{aligned}
 D &= 10 \text{ psf} \\
 L &= 100 \text{ psf} \\
 D+L &= 110 \text{ psf}
 \end{aligned}$$

$$\begin{aligned}
 wD &= 13.3 \text{ plf} \\
 wL &= 133.3 \text{ plf} \\
 wD+L &= 146.7 \text{ plf}
 \end{aligned}$$

Check Bending:

$$\begin{aligned}
 M &= 660 \text{ lb-ft} = 7920 \text{ lb-in} \\
 f_b &= 1047 \text{ psi} \\
 F_b &= 925 \text{ psi} \\
 CL &= 1.0 \\
 F'b &= 1183 \text{ psi}
 \end{aligned}$$

OK

Check Shear:

$$\begin{aligned}
 V &= 440 \text{ lbs} \\
 f_v &= 80 \text{ psi} \\
 F_v &= 160 \text{ psi} \\
 F'v &= 160 \text{ psi}
 \end{aligned}$$

OK

Check Deflection:

$$\begin{aligned}
 DL &= 0.16 \text{ in} & \text{or} & \frac{L}{462} \text{ OK} \\
 DD+L &= 0.17 \text{ in} & \text{or} & \frac{L}{420} \text{ OK}
 \end{aligned}$$

Deck Girder

3 x 10 Redwood No. 2

Spacing = 36 in o.c.

Properties:

$$\begin{aligned}
 d &= 9.25 \text{ in} \\
 b &= 2.5 \text{ in} \\
 A &= 23.13 \text{ in}^2 \\
 S_x &= 35.65 \text{ in}^3 \\
 I_x &= 164.89 \text{ in}^4 \\
 E &= 1200000 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 L &= 8.5 \text{ ft} \\
 CF &= 1.04 \\
 Cr &= 1.15
 \end{aligned}$$

Loads:

$$\begin{aligned}
 D &= 10 \text{ psf} \\
 L &= 100 \text{ psf} \\
 D+L &= 110 \text{ psf}
 \end{aligned}$$

$$\begin{aligned}
 wD &= 30.0 \text{ plf} \\
 wL &= 300.0 \text{ plf} \\
 wD+L &= 330.0 \text{ plf}
 \end{aligned}$$

Check Bending:

$$\begin{aligned}
 M &= 2980 \text{ lb-ft} = 35764 \text{ lb-in} \\
 f_b &= 1003 \text{ psi} \\
 F_b &= 925 \text{ psi} \\
 CL &= 1.0 \\
 F'b &= 1102 \text{ psi}
 \end{aligned}$$

OK

Check Shear:

$$\begin{aligned}
 V &= 1403 \text{ lbs} \\
 f_v &= 91 \text{ psi} \\
 F_v &= 160 \text{ psi} \\
 F'v &= 160 \text{ psi}
 \end{aligned}$$

OK

Check Deflection:

$$\begin{aligned}
 DL &= 0.18 \text{ in} & \text{or} & \frac{L}{573} \text{ OK} \\
 DD+L &= 0.20 \text{ in} & \text{or} & \frac{L}{521} \text{ OK}
 \end{aligned}$$

Deck Slat

1x6 Cottonwood

Spacing = 6 in o.c.

Properties:

$$\begin{aligned}
 d &= 0.75 \text{ in} \\
 b &= 5.25 \text{ in} \\
 A &= 3.94 \text{ in}^2 \\
 S_x &= 0.49 \text{ in}^3 \\
 I_x &= 0.18 \text{ in}^4 \\
 E &= 1200000 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 L &= 1.3 \text{ ft} \\
 CF &= 1.46 \\
 Cr &= 1.15
 \end{aligned}$$

Loads:

$$\begin{aligned}
 D &= 10 \text{ psf} \\
 L &= 100 \text{ psf} \\
 D+L &= 110 \text{ psf}
 \end{aligned}$$

$$\begin{aligned}
 wD &= 5.0 \text{ plf} \\
 wL &= 50.0 \text{ plf} \\
 wD+L &= 55.0 \text{ plf}
 \end{aligned}$$

Check Bending:

$$\begin{aligned}
 M &= 12 \text{ lb-ft} = 147 \text{ lb-in} \\
 f_b &= 298 \text{ psi} \\
 F_b &= 625 \text{ psi} \\
 CL &= 1.0 \\
 F'b &= 1048 \text{ psi}
 \end{aligned}$$

OK

Check Shear:

$$\begin{aligned}
 V &= 37 \text{ lbs} \\
 f_v &= 14 \text{ psi} \\
 F_v &= 125 \text{ psi} \\
 F'v &= 125 \text{ psi}
 \end{aligned}$$

OK

Check Deflection:

$$\begin{aligned}
 DL &= 0.02 \text{ in} & \text{or} & \frac{L}{997} \text{ OK} \\
 DD+L &= 0.02 \text{ in} & \text{or} & \frac{L}{906} \text{ OK}
 \end{aligned}$$

SOLAR PANEL RACKING*Componentes and Cladding*

(Simplified Method 1 ASCE 7-05)

Basic Wind Speed	V_{3s}	=	85.00 mph	(Figure 6-1)
Importance Factor	I	=	1.0	(Table 6-1)
Exposure Category		=	C	
Topographic Factor	K_{zt}	=	1.0	(Section 6.5.7.2)
Gust Effect Factor	G	=	0.85	
Adjustment Factor	λ	=	1.21	(Figure 6-2)
Wind Load for Exp. B	p_{net30}	=	30.6	(Figure 6-3)
Design Wind Load	$p_{net(psf)} = \lambda K_{zt} I p_{net30}$	=	37.03 psf	

Dead Load		
Photo-Voltaics	=	3 psf
Racking	=	5 psf
Total	=	8 psf

Downforce Load

Governing Load Combination	=	$1.0D + 1.0p_{net}$
Design Load	=	45.03 psf

Uplift Load

Governing Load Combination	=	$0.6D - 1.0p_{net}$
Design Load	=	32.23 psf

Check Downforce

Spacing	=	5.5 ft
w	=	247.64 plf
Rail Span	=	3.00 ft
Point Load	=	371.46 lb

OK BY INSPECTION

Appendix A – Visual Analysis Models

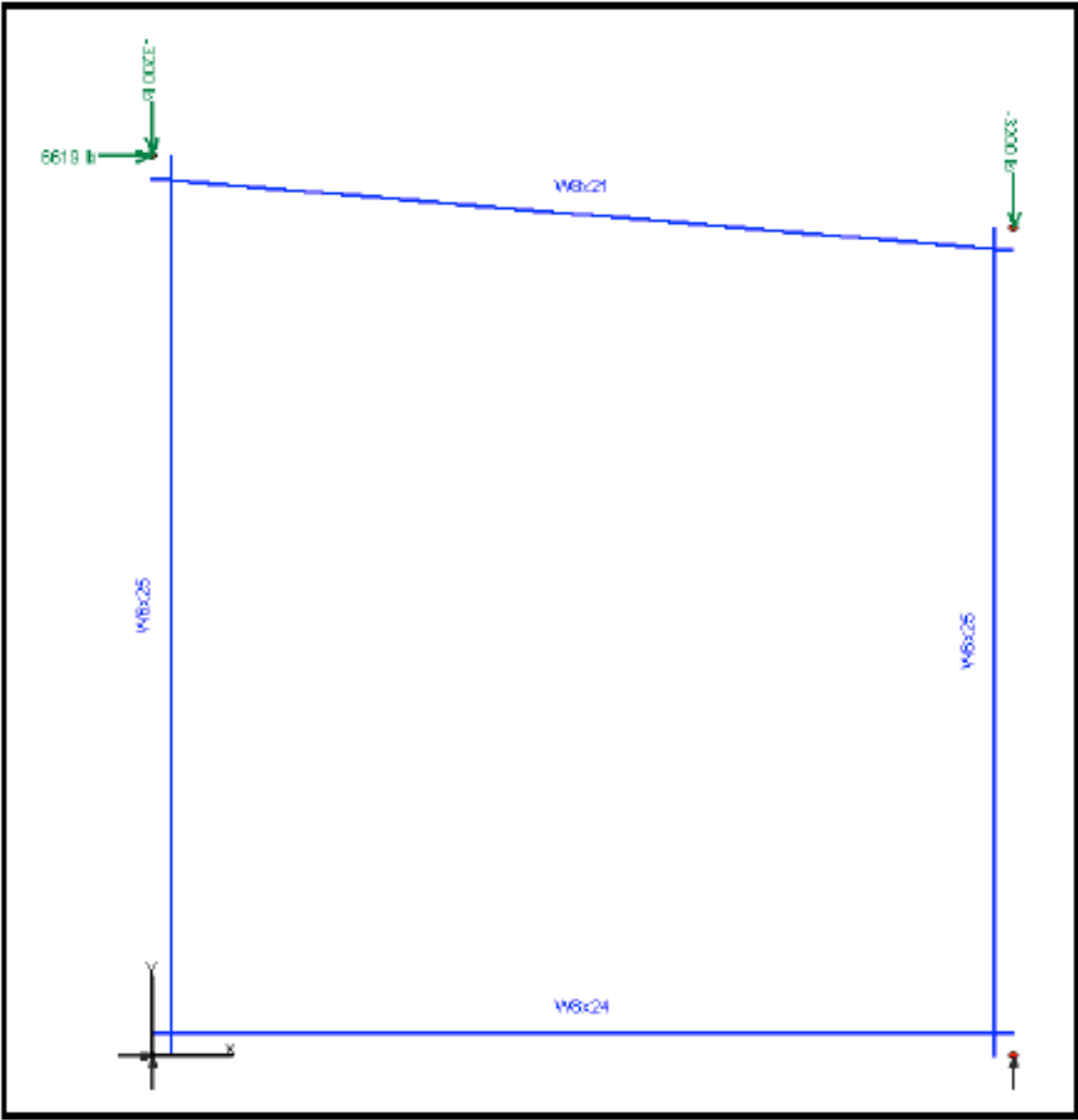


Figure 1: Moment Frame Free Body Diagram

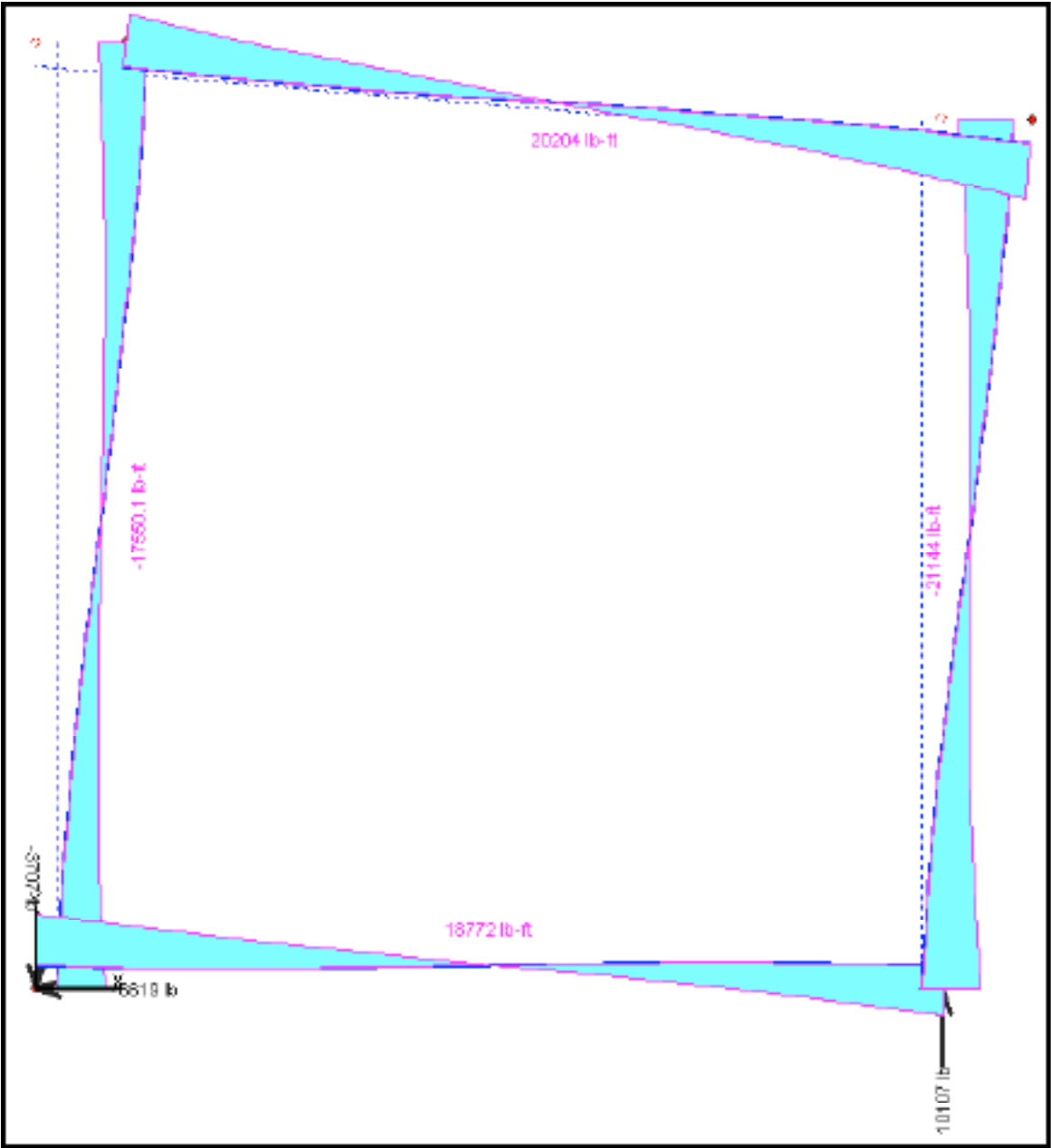


Figure 2: Moment Diagram of Moment Frame # 1

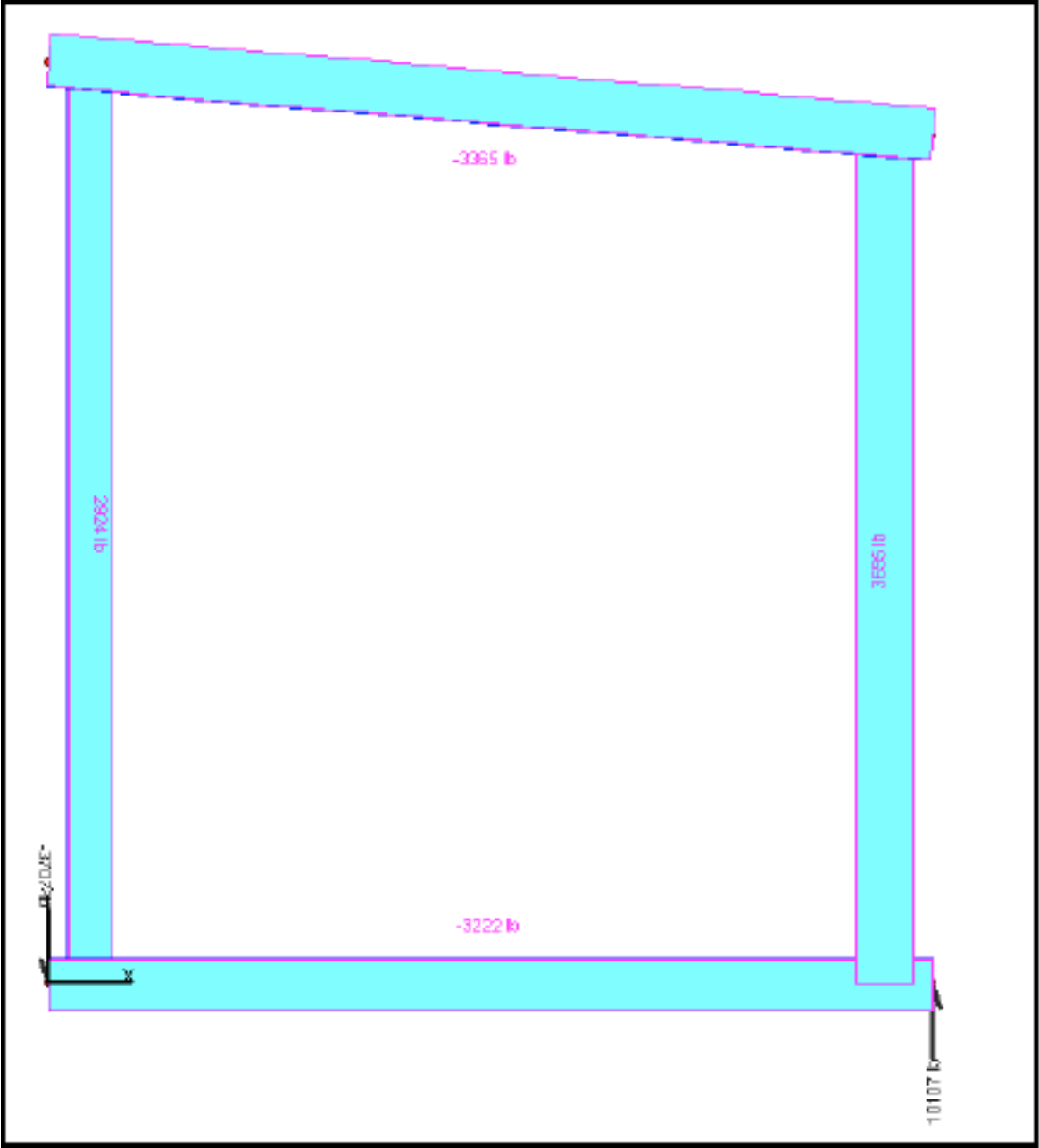


Figure 3: Shear Diagram of Moment Frame #1

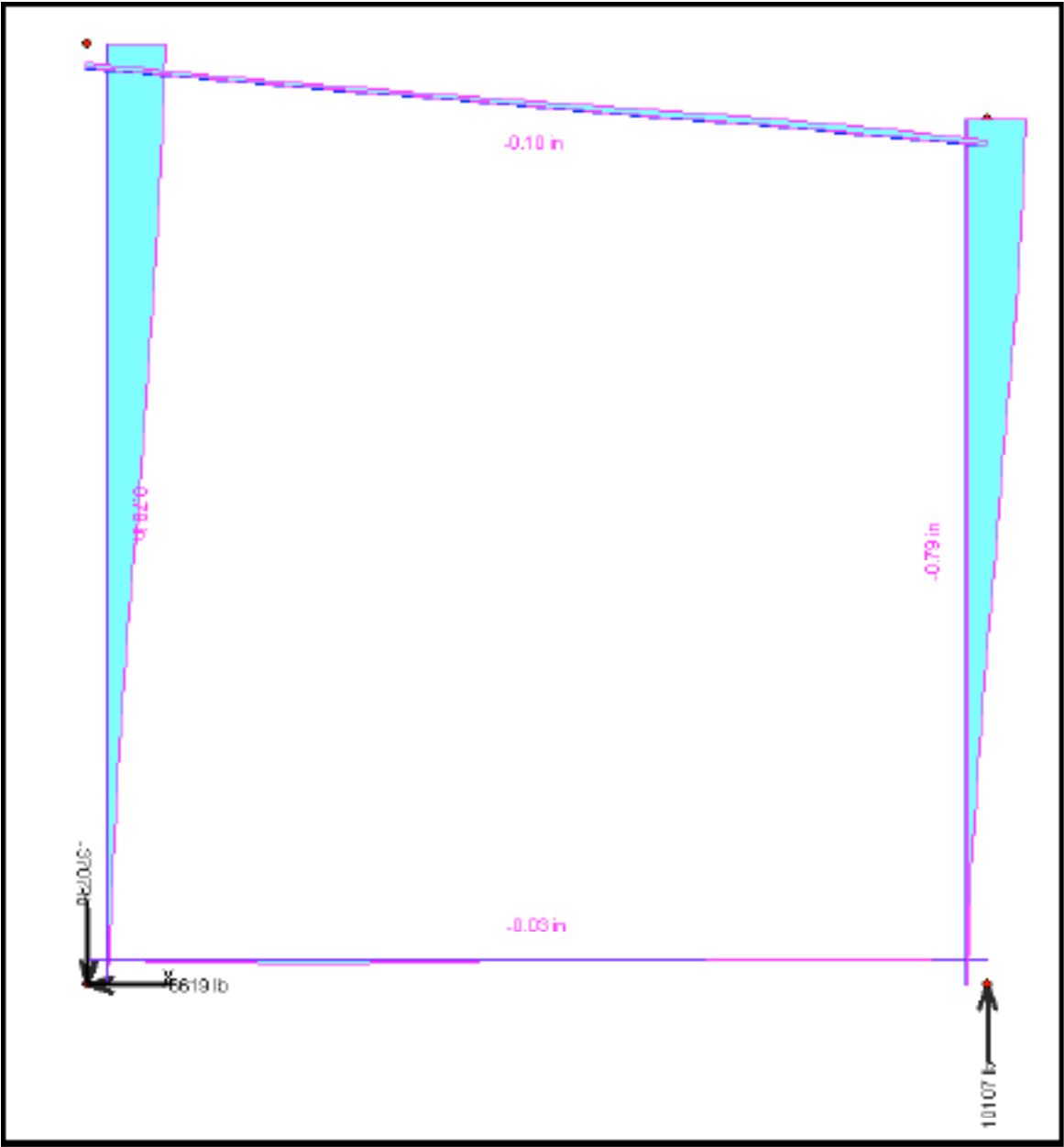


Figure 4: Drift Diagram of Moment Frame #1

DETAILED WATER BUDGET



Competition Water Usage		
Day	Competition	Water Usage (gal)
8	Dishwasher	6.5
	Clothes washer	14.2
	Cooking	1
	Hot Water (2 draws)	30
	Total per Day	51.7
9	Hot water (3 draws)	45
	Clothes washer (2)	28.4
	Dining	5
	Total per Day	78.4
10	Hot water (2 draws)	30
	Dishwasher	6.5
	Cooking	1
	Total per Day	37.5
11	Hot water (3 draws)	45
	Total per Day	45
12	Cooking	1
	Hot water (2)	30
	Clothes washer (2)	28.4
	Dining	5
	Total per Day	64.4
13	Clothes washer	14.2
	Hot water (3 draws)	45
	Dishwasher	6.5
	Total per Day	65.7
14	Clothes washer (2)	28.4
	Hot water (2 draws)	30
	Dishwasher	6.5
	Cooking	1
	Total per Day	65.9
15	Hot water (3 draws)	30
	Clothes washer (2)	28.4
	Dishwasher	6.5
	Total per Day	64.9
	COMPETITION TOTAL	473.5

Water Budget Totals	
Tanks and Pipes	600
Pond	1103
House Usage	473.5
Contingency	200
TOTAL	2376.5

Initial Filling Summary	
<i>Remainder of Budget will be met by top-off</i>	
Thermal Storage Tank	350
Water Supply Tank	800
Pond	1103
TOTAL	2253

UNLISTED ELECTRICAL COMPONENTS



SUMMARY OF UNLISTED ELECTRICAL COMPONENTS

Summary

Refract House has only two electrical components that are not listed by Underwriters Laboratories: our indirect-fire absorption chiller and its associated open-circuit forced-draft cooling tower. Both are CE-certified for sale and use in Germany, and this should prove equivalence with UL standards. Any additional documentation required to prove compliance will be provided to Tom Meyers as requested, but at this time we have not received confirmation of what is required. He has indicated that approval would be likely, given the specific equipment involved, and we will work closely with him in the coming weeks to ensure that the components will operate safely and are properly documented.

Both units require 230V single phase 50Hz power, which will be provided by a small frequency converter. Peak power consumption of the two units combined is less than 600W.

Sonnenklima wct23kw Open-Circuit Forced-Draft Cooling Tower

European Certification: CE-certified

Construction Specification: 23 65 13

Manufacturer Data Sheet available at:

<http://scu-cca-solar.org/submittals/SunInverseCHILLERandCOOLINGTOWER.pdf>

Sonnenklima SunInverse10kw Indirect-Fired Absorption Chiller

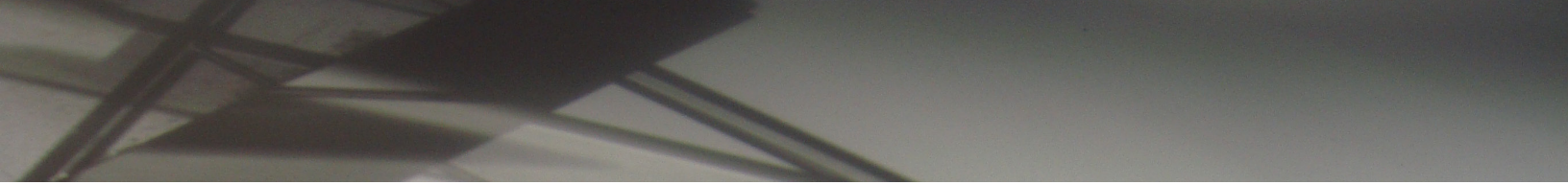
European Certification: CE-certified

Construction Specification: 23 64 13

Manufacturer Data Sheet available at:

<http://scu-cca-solar.org/submittals/SunInverseCHILLERandCOOLINGTOWER.pdf>

PV PRICE QUOTES



Price Quote For Photovoltaic Panels

The price quote for the Sunpower SPR-225 is \$4.22 per watt. Module price is \$949.50.

Modules	Price (\$/Watt)	Price (\$/unit)
SPR-225-BLK-U	\$4.22	\$949.50

RECONFIGURABLE FEATURES



Summary of Reconfigurable Features:

Per Appendix B2-b of the Solar Decathlon 2009 Rules v1.1, the only major reconfigurable feature of Refract House is our operable external blinds.

Operable External Horizontal Blinds:

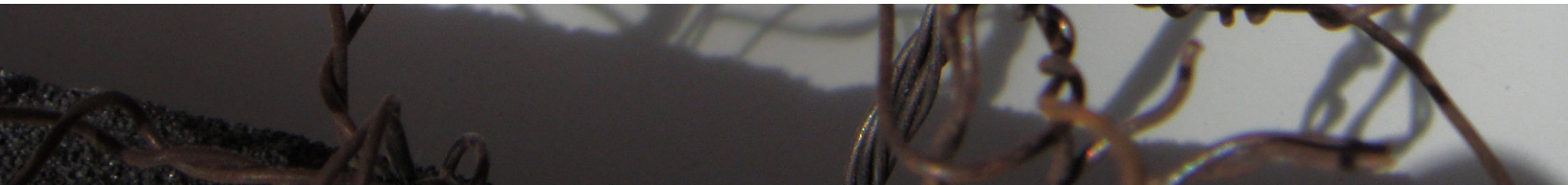
All three of Refract House's southern doors, as well as the two end cap doors, are fitted with external shading devices. These are commercially-available horizontal external operable blinds manufactured by Nysan. Refer to construction specifications and architectural sheets for details.

The blinds are electronically controllable by the resident, and can be used to modulate daylighting as well as solar gain. They can be fully deployed or completely retracted, as well as tilted at different angles.

We will use the blinds in the competition to demonstrate the flexibility of the southern facades. As in real operation, they will be in different positions during the course of the day and the week, depending on weather. Public tours will see different configurations depending on their timing.

During the jury visit, the blinds will be shown in an appropriately representative number of configurations. The competition organizers are free to suggest the degree to which different configurations will be demonstrated, but certainly all blinds will be shown raised and lowered, and at least one will demonstrate the effects of different tilts.

INTERCONNECTION APPLICATION FORM



Solar Decathlon 2009
INTERCONNECTION APPLICATION FORM

Team California Lot #119

1.0 PV SYSTEMS

Module Manufacturer	Short Description of Array	DC Rating of Array
SunPower	We will have 4 strings. There will be two strings of 10 panels in series both are connected in parallel and will filter into an Amtec combiner box. There will also be two strings of 9 panels in series connected in parallel, which will also connect to an Amtec combiner box. This will then go to the inverter.	38 panels rated at 225 Watts each 8.55kW

Total DC power of all arrays is 8.55 kW.

2.0 INVERTERS

Inverter Manufacturer	Model Number	Voltage	Output Rating (kW)	Quantity
Sunny Boy	5000	600 V	5 kW	2

Total AC power of all inverters is 10 kW.

3.0 NEC 220: CALCULATION OF SERVICE/FEEDER NET COMPUTED LOAD**3.1 Wire Sizes and Breakers Calculations:**

Assumptions:

- Outdoor temperature correction factor is 0.58 (141-158 F)
- Mechanical room correction factor is 0.82 (114-122 F)
- Conduit fill calculations are determined in accordance with NEC Annex C Table C.1 (a)

3.2 PV Open Circuit Voltage

The record low temperature for Washington DC is -7 degrees C. The open circuit voltage for the Sunpower 225 solar panel is 48.5 V. A correction factor of 1.14 is necessary, because the rise in open-circuit voltage at lower temperatures.

3.2.1 Calculations:

(Correction Factor)*(Manufacturers Open-Circuit Voltage)= Corrected Open-Circuit Voltage

$$1.14 * 48.5 = 55.29$$

Since our largest string is at 10 panels in series, the most voltage that will run will 552.9 V, which is still below the required 600V.

3.3 Solar Array to Amtec Combiner Box

3.3.1 Ampacity Calculations:

The necessary calculations for NEC required Ampacity is given by:

$$\text{Panel Isc} \times \# \text{ of Parallel Strings} \times 1.25^2 = \text{NEC required Ampacity}$$

And for our given system:

$$5.87\text{A} \times 2 \times 1.25^2 = 18.34 \text{ A}$$

Since the ampacity of each line will not exceed 18.34 A, we will be using AWG #10 USE-2, which is rated up to $(40\text{A}) \times (0.58) = 23.2\text{A}$

3.4 Amtec Combiner Box to Sunny Boy DC Disconnect

3.4.1 Ampacity Calculations

From necessary calculations for NEC required Ampacity given above applied for our system:

$$5.87\text{A} \times 2 \times 1.25^2 = 18.34 \text{ A}$$

Since the ampacity of each line will not exceed 18.34 A, we will be using AWG#8 THWN-2, which is rated up to $40\text{A} \times 0.58 = 23.2\text{A}$

3.4.2 Conduit Fill:

1" EMT will be used and it can hold 6 #8 THWN-2 conductors. The 1" EMT is slightly oversized, but will be better for installation purposes. Each inverter has its own conduit run to the AC load center. The conduit fill will be three conductors plus ground.

Since the conductors will be held in conduit an extra correction factor is necessary to be included in the equation. Since there will be 6 conductors a Conduit Correction Factor of 0.8 will be factored into the rating of the wire under these conditions.

The NEC rating is found through:

Wire Rating x Temp. Correction Factor x Conduit Correction Factor = NEC RATING

$$55A \times 0.58 \times 0.80 = 25.52A$$

The current running through the wire is expected to be no more than 18.34A, the new rating of the THWN-2 is at 25.52A and is suffice for use.

The DC disconnects are built-into the SunnyBoy5000US inverter, and they are rated for a Max Input Current of 21A.

3.5 Sunny Boy DC Disconnect to Subpanel AC Load Center

3.5.1 Ampacity Calculations:

The inverter ampacity calculation is found through:

$$W_{out}/V_{out} \times 1.25 = \text{Amps}$$

For the Sunny Boy 5000 with 240V:

$$5000W/240V \times 1.25 = 26.04 \text{ A}$$

Since we will be producing no more than 26.04 A, we will have an AC load center with 100A Mains Rating using the Square D HOM612L100RB with 2 independent 30 A double pole breakers and a mains rating of 100A.

#10 THWN-2 wiring will be used to feed into the load center because of the de-rating factor, $40A \times 0.82 = 32.8A$ it will still be able to handle the current.

3.5.2 Conduit Fill:

1/2" EMT will be used and it can accommodate the 4 #10 THWN-2 conductors. Each inverter has its own conduit run to the AC load center. The conduit fill will be three conductors plus ground.

3.6 Load Center to Main Circuit Breaker

This is based on the 120% rule of the NEC. We will be utilizing a Square D Power Link G3 300 Level NF Panel Board with a 250A mains and a 150A Main disconnect. Based on the 120% rule of the NEC we take our mains rating and multiply it by 120% and subtract it by our main disconnect rating. Calculations are shown below:

$$(250 \times 1.2) - 150 = 150A.$$

The backfeed into the main panel will be 150A, however our 60A solar breaker will limit the backfeeding.

3.6.1 Ampacity Calculations:

From the inverter power ampacity calculations above:

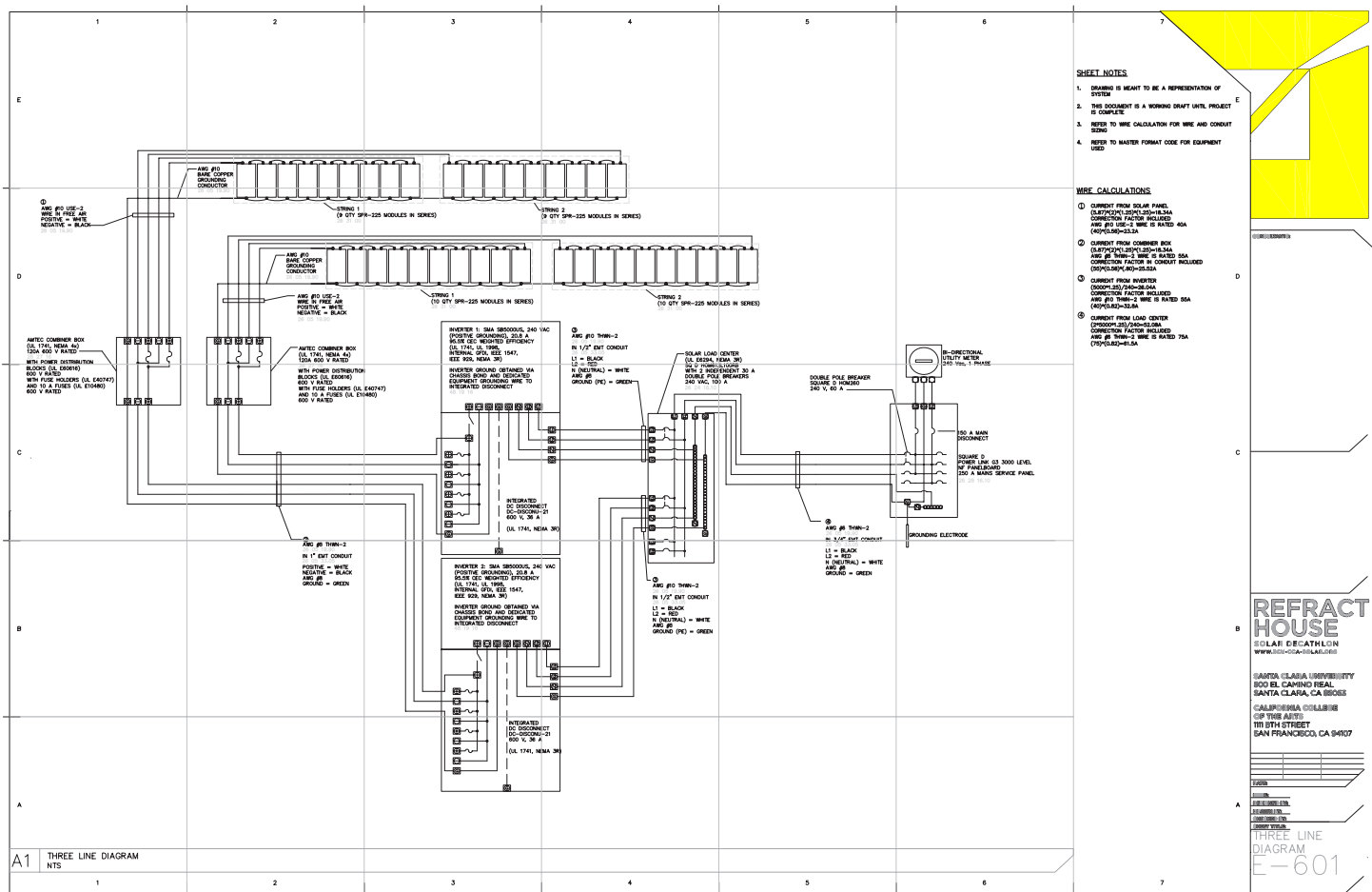
$$W_{\text{OutMax}} / V_{\text{AC}} \times 1.25 = \text{Amps}$$

$$(2 \times 5000\text{W}) / 240\text{V} \times 1.25 = 52.08\text{A}$$

Since there is going to be a maximum of 100A between the load center and the main circuit breaker, an AWG #6 THWN-2 wire will suffice as we expect no more than 52.08A coming from our load center. AWG #6 THWN-2 is rated for 75A, with the de-rating factor of $75 \times 0.82 = 61.5\text{A}$.

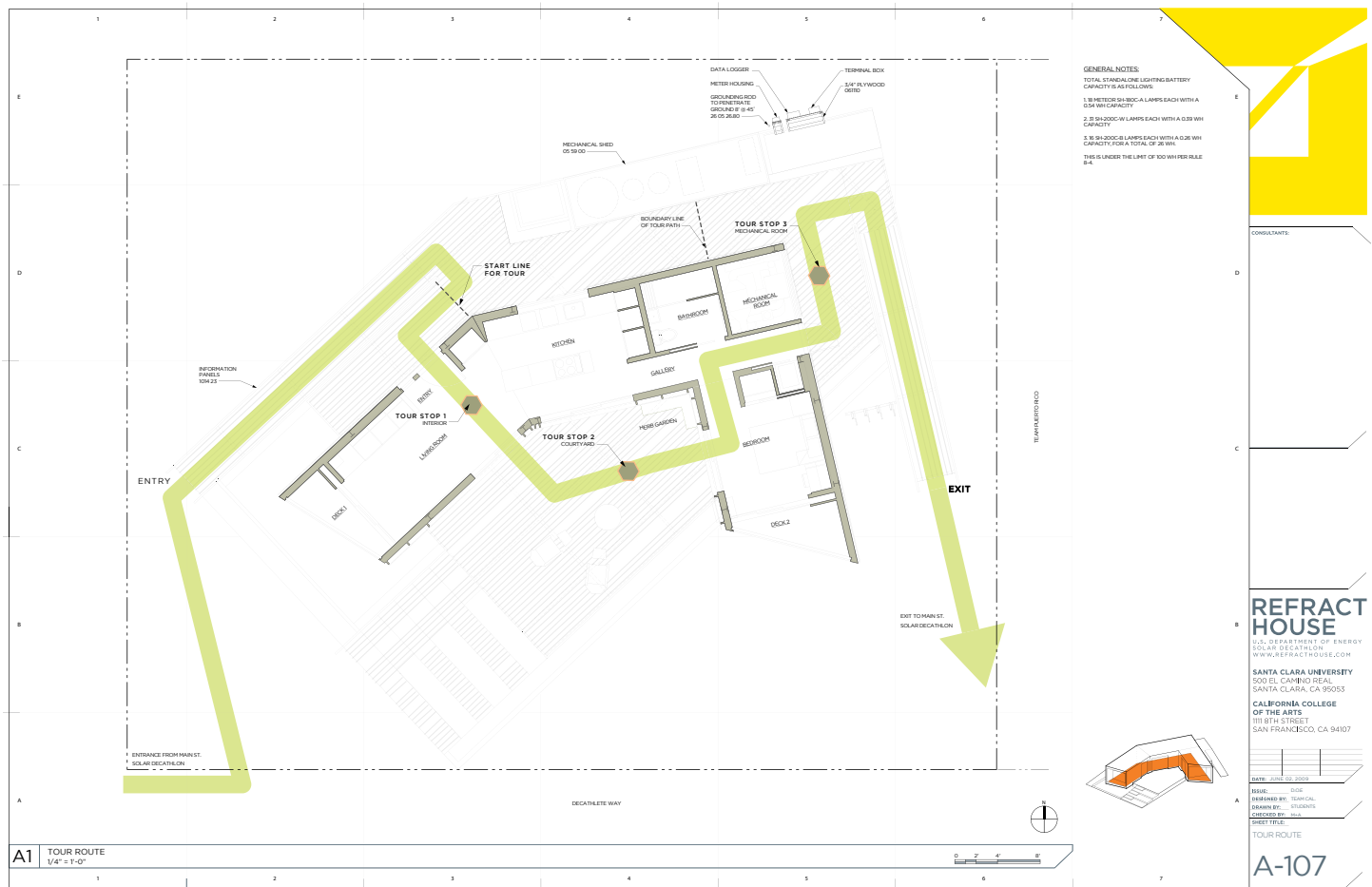
4.0 Three-Line Electrical Schematic

Reference: Construction Drawings sheet E-601



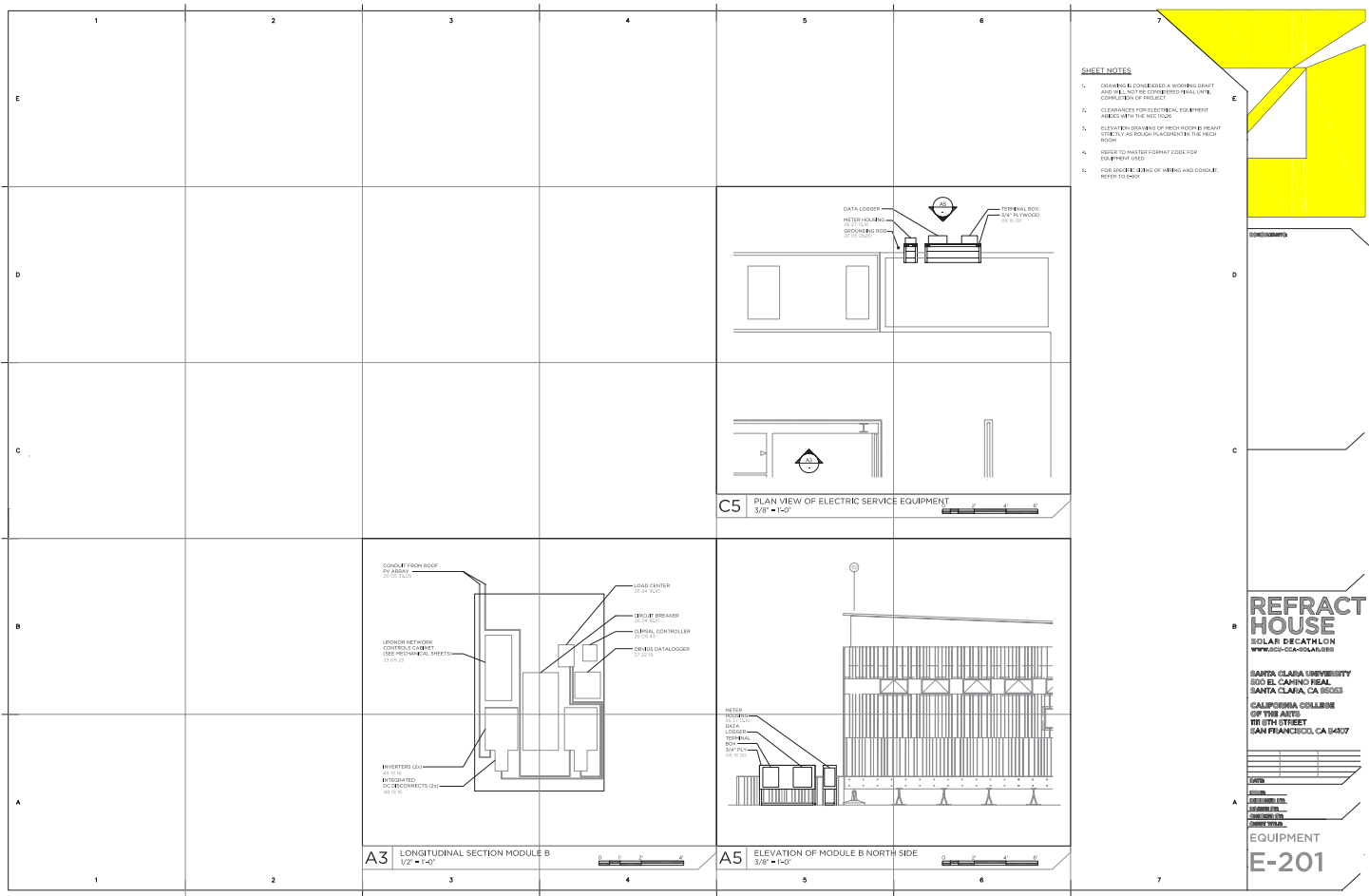
5.0 SERVICE POINT AND TOUR ROUTE PLAN

Reference: Construction Drawings sheet A-107



6.0 TERMINAL BOX ELEVATION

Reference: Construction Drawings sheet E-201



7.0 CONTACT INFORMATION

For information regarding electrical calculations, drawings, and rules compliance, contact Team California Electrical Engineer:

Richard Navarro
951-533-1215
rnavarro@scu.edu

ENERGY ANALYSIS REPORT

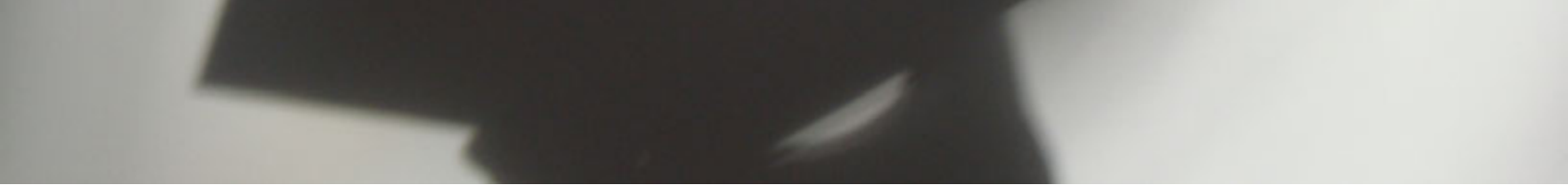


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- 4.3. Homeowner effects

1.0 – Executive Summary

1.1 – Introduction

Team California's Energy Analysis Report presents comprehensive information about our energy systems: mechanical, electrical, and monitoring. It explains their operation in detail, as well as their development and the modeling tools we have employed to optimize them and predict their performance.

The report is lengthy. The reader is advised to digest this executive summary and to skim the introductions of each major section before attending to the detailed content.

We hope to use this report to demonstrate how carefully we have engineered our systems. Specifically, we will emphasize the following: our efforts to seamlessly integrate technology with the house's architecture and living experience; our innovative approaches to solving design challenges; the efficiency of our systems; and the functionality and reliability of our design.

1.2 – Integration

All of our engineering for Refract House has had one unifying goal: to enable the house to be as beautiful, as functional, and as un-compromising for the homeowner as possible.

We have designed our solar thermal and photovoltaic arrays to be a single low-angle plane that appears as part of the house while still producing ample energy. We have also carefully engineered the house's envelope, windows, and shading to keep thermal loads low while still allowing for the architectural intent of a home that embraces the outdoors. And our energy monitoring systems allow residents and visitors to easily access information on system performance, helping them establish better habits and getting them excited about all the technology hidden from plain view.

1.3 – Innovation

Whenever possible, we have strived to push the envelope of efficient and creative design. Our approach to thermal systems and building envelope has been to re-examine everything, leading to a completely unique system: solar thermal radiant cooling, heat recovery to preheat domestic hot water and intelligently disabling energy recovery when it isn't efficient.

Similarly, our electrical design recognizes that the largest contributor to its efficiency is the homeowner. So we have designed energy usage to be easily monitored and controlled. Residents can turn off lights, appliances, or whole circuits from a home touch screen or their iPhone on the go. And the system is designed to make learning about energy and water fun and easy, so they and their friends can become educated citizens for tomorrow's sustainable future.

1.4 – Efficiency

Our electrical and mechanical systems, as well as our building envelope, have been extensively modeled and optimized to use as little energy as possible.

Our mechanical systems should use less than 1 MWh per year, saving at least 4 MWh over a conventional system, nearly \$350 and 3 tons of CO₂ emissions annually.

Our lighting and appliance selections make the house much more efficient regardless of homeowner usage, but it is difficult to say exactly how much without a definite benchmark. It likely uses at least 30% less energy than similar homes, saving more than 3 MWh annually.

And our monitoring and control systems have the potential to drastically improve homeowner habits, saving a great deal of energy. Again, this depends entirely on the basis of comparison, but our modeling suggests that at least 1.5 MWh could be saved by turning an “average” user into an “eco-friendly” user.

1.5 – Functionality and Reliability

Every system in Refract House has been designed not only to meet and exceed its required function, but to perform reliably for years to come.

Our thermal systems have been designed with long life in mind. We have used the highest-quality materials, like stainless steel pumps, and employed good design practices, like properly sizing valves and employing air eliminators for long-term dissolved gas control. We have also designed for minimal equipment cycling by using buffer tanks and intelligent control logic.

Our electrical and control systems are also designed for long term life. We have used high quality components that are sized for maximum foreseeable load. We have also designed the house to be as expandable as possible, using lots of extra conduit and faceplates for running new data or power interfaces in the future as technology or homeowner needs arise.

2.0 – Mechanical

2.1 – Introduction

In this section we describe the thermal analysis of Refract House and the mechanical systems we have designed to condition the house.

We begin by defining the design markets and briefly summarizing the predicted loads, and then describe the actual system design. We conclude by discussing our thermal analysis in more detail, and its implications on the design process.

2.2 – Design Markets

Refract House is engineered to perform optimally in Washington, D.C. during the contest month. The house also performs exceptionally all year in our design market – Los Gatos, California – but when optimization decisions come down to very specific weather situations, we have given priority to optimal performance during the contest. These decisions, such as ratio of solar thermal to photovoltaic area, could be customized easily to adapt the house to different markets. For example, the competition design includes 6 solar thermal collectors, but 4 or 5 would suffice in Santa Clara due to the shorter cooling season and the higher summer insolation. Even fewer collectors might be required in a climate with very little cooling, because the passive solar design of the house nearly eliminates heating demand.

All weather data for simulations are based on TMY3 data. Baltimore International Airport data is used for Washington, D.C., and San Jose International Airport data is used for Los Gatos, CA.

2.3 – Building Simulation and Loads

The thermal loads of the building were modeled using DesignBuilder™ software, a graphical program built on the Department of Energy's EnergyPlus engine. Greater discussion of these simulations is offered in Section 2.5, but the basic parameters of the simulation for the present house design are summarized in Table 1.

Table 1: Summary of critical design parameters for thermal model of Refract House design concept

Summary of Design Parameters for Commercial Building Design Envelope			
Building Envelope			
	Wall Insulation	R-25	ft^2*F*hr /BTU
	Floor/Ceiling Insulation	R-35	ft^2*F*hr /BTU
	Infiltration	0.1	ach
Windows			
	Description	Triple pane, low-e, solar control suspended film, 65% krypton fill (accounting for transit losses)	
	SHGC	0.226	
	U-value	0.786	W/m^2*K
	Shading	External horizontal louvers perpendicular to all south-facing windows	
HVAC			
	Description	Purchased heating and cooling (0.7 radiant fraction)	
	Ventilation	100-300 (mechanical)	CFM
	Distribution Efficiency	0.9	
Schedules			
	Occupants	4 people, moderate activity	
	Electrical gains (cont)	380	W
	Electical gains (scheduled)	520	W

The house as modeled is presented in Figure 1.

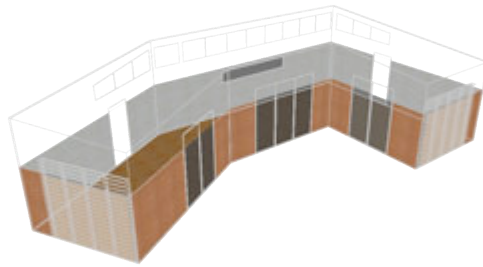


Figure 1: Renderings of Refract House as Modeled in DesignBuilder™

The heat balance, heating and cooling loads, and temperature data for the house as designed in Washington DC are presented in Figure 2.

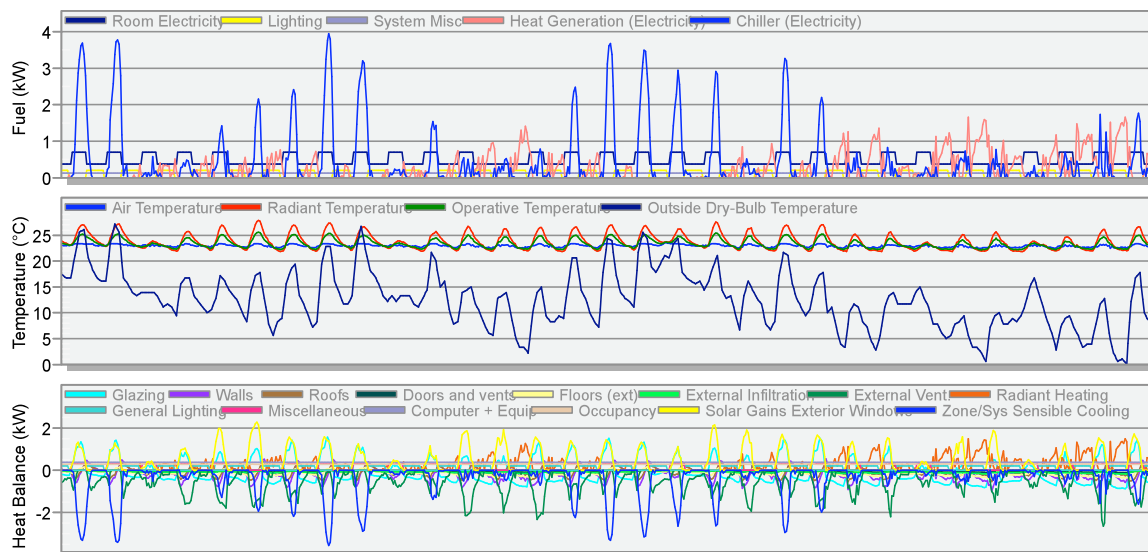


Figure 2: Heat balance, temperatures, and thermal loads for Refract House during October in Washington, D.C.

With a very tight design margin of 1.15, worst case design loads for both competition and annual performance in Los Gatos are 6.1kW in total cooling and 2.0kW in total heating.

2.4 – Mechanical System Design

2.4.1 – System Motivation

Refract House is designed to use solar thermal energy to meet almost all of our heating, cooling and hot water demands. In doing so, we have reduced our annual electrical consumption and thus the size of our expensive PV array. Additionally, the system is extremely stable, meaning that the system's average direct electrical backup load only varies from 0.5kWh to 1.6kWh per day, whether operating in Los Gatos or Washington D.C., in either Winter or Summer. Total operating energy, including pumps and fans, should not exceed 4 kWh per day.

Solar thermal collection is extremely effective, with instantaneous efficiencies several times greater than current PV systems. In heating, these systems are more effective - in both square footage and cost terms - than electric heat pump setups, the only other fully solar heating and cooling solution. In cooling mode - in this case employing an absorption chiller - the efficiency works out to be essentially comparable according to our analysis. Thus on an annual basis, we believe solar thermal heating and cooling to be more efficient given a limited roof area, in addition to the electrical load stability mentioned previously.

While the system design we will describe is highly complex and somewhat expensive, we believe that solar cooling - especially coupled with radiant systems - will be a major player in the future of efficient HVAC design. Thus this type of system should be economically feasible in the near future, and we hope this project will bring that day closer.

Considering the huge role that heating and cooling play in energy consumption across the country, meeting these demands with such an efficient alternative energy resource is an excellent way to start decreasing building electrical and gas consumption.

2.4.2 – System Overview

The thermal systems for Refract House reflect our desire to use solar thermal energy as completely and efficiently as possible. Solar collectors energize a storage tank that heats water for both domestic use and for space heating. This thermal energy is also used to drive a residential-sized water-fired absorption chiller that chills water for space cooling and dehumidification.

Because of the exceptional efficiency of radiant systems – both in not requiring fans and in allowing more moderate water temperatures – we employ radiant heating and cooling almost entirely, except when ventilation or dehumidification require the use of a blown-air system.

Beyond these large concepts, we have done our utmost to consider every detail in designing our system. Waste heat from the chiller is used to pre-heat domestic hot water; our efficient but energy-hungry Energy Recovery Ventilator is bypassed whenever its operation will use more energy than it would save; and our hydronic plumbing employs cutting edge “smart pumps” and has been designed to minimize head losses.

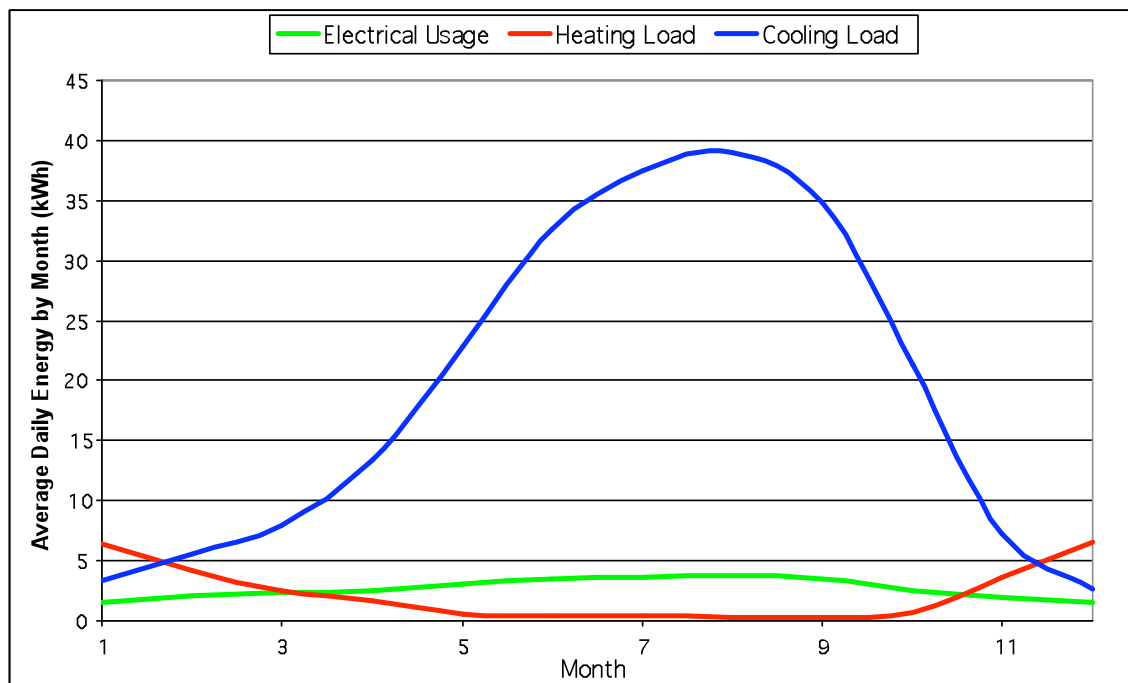


Figure 3: Annual heating and cooling loads in Los Gatos, and expected total electrical load from HVAC and hot water systems

The result of this extensive design is an extremely robust system that uses an average of less than 3.5 kWh per day, even in peak cooling season in Los Gatos. Figure 3 shows the annual heating and cooling loads for Refract House in Los Gatos, as well as the expected electrical consumption of the HVAC and hot water equipment.

Occupants stay comfortable year-round while the newest in HVAC technology quietly does its job.

2.4.3 – Solar Collection and Storage

2.4.3.1 – Description

The solar thermal array was designed using flat plate type collectors, based mostly on their aesthetic advantage over evacuated tube systems. The greater heat loss of this type of panel is partially made up for by their greater aperture area, and our particular panels – Schuco™ DG collectors – feature double-glazed covers that also help reduce these heat losses.

Thermal energy will be stored in an insulated water storage tank located outside the house on a custom enclosed mechanical skid. This tank was rigorously designed to optimize thermal stratification effects that increase collector efficiency and reduce heat pump runtimes and tank thermal losses.

The following sections will discuss the design in detail.

2.4.3.2 – Modeling of Thermal Collection and Storage

The solar thermal system was modeled using a custom Excel spreadsheet designed to perform energy balance on an hour-by-hour basis. The collector energy equations, tank losses, and hourly load data are used to determine hour-by-hour tank temperature over the course of the design period. A reversible air-to-water heat pump (RHP) backup engages in heating mode to keep the tank temperature high enough to heat water and provide space heating (125F). In cooling backup, the RHP drives the chilled water loop directly whenever the chiller cannot fully meet demands due to low storage tank temperature. The model is designed to track RHP backup energy usage and the utilized solar fraction in order to optimize the collector array. Figure 4 presents a block diagram of the model components and their interaction.

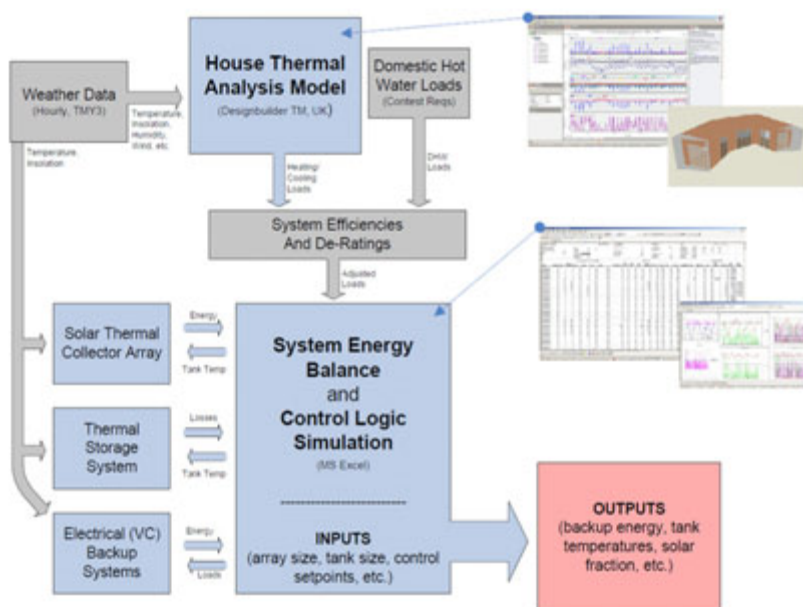


Figure 4: Block diagram of thermal analysis and mechanical system models

Total electrical energy production is the ultimate design parameter, and so our primary optimization goal is reducing the backup energy required for heating and cooling. However, designing the thermal array for near total load fulfillment is wasteful because the additional collectors provide diminishing returns. By using electrical backup to provide the last ~20% of the required energy, the system can be sized much more moderately. The extra PV panels

we can fit actually produce more electricity than needed for the backup – meaning that the house produces more net electricity while still meeting the thermal demands. Optimizing the system in this way ensures our roof space is utilized most effectively.

2.4.3.3 – Design of Collection and Storage

Optimum performance of the system is achieved when the backup energy required by adding a solar thermal collector is less than the energy that would be lost by the removal of the photovoltaic panels in that area. As noted previously, this optimum balance will vary in different locations in different seasons; our design optimizes for the competition month in Washington, D.C., but functions exceptionally all year in Los Gatos as well.

The relationship between the number of thermal collectors and the backup energy required October operation in D.C. is presented in Figure 5.

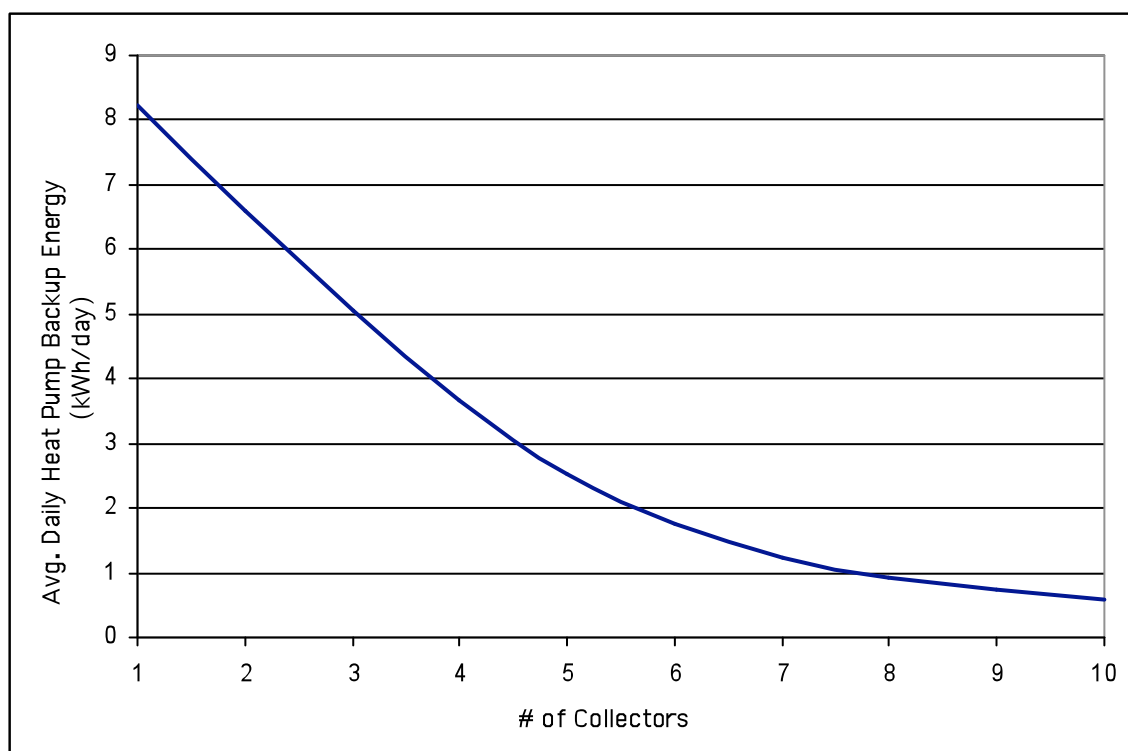


Figure 5: Average daily backup energy versus number of collectors in array for October, Washington D.C.

One may note the diminishing return of a larger array. The optimum size of six collectors was determined based on collector layout dynamics on our roof, and expected PV energy generation. This was an iterative process based on the various possible collector arrangements.

Tank size was determined in a similar way, minimizing backup energy. Larger tanks provide greater security against periods of low insolation or high demand, but also re-heat more slowly and have greater heat losses to the environment. Figure 6 presents backup energy requirements for various tank sizes, assuming two different insulation thicknesses of closed-cell blown foam.

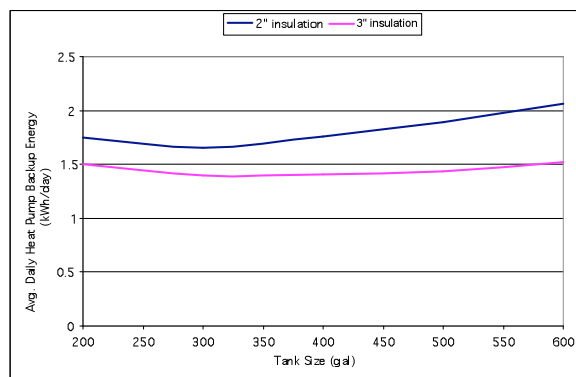


Figure 6: Average daily backup energy versus tank size for October, Washington, D.C.

Backup energy is minimized at a size that depends on the insulation of the tank, with greater insulation providing a larger optimum value for volume because heat losses are less of a concern. Assuming a reasonable 3" thickness of insulation, a storage volume of 350 gallons was chosen for the design. Of course, we will maximally insulate our tank given space constraints.

The tank was designed to optimize thermal stratification effects. Figure 6 shows the final design for the tank. At nearly 8 feet tall and only 3 feet in diameter, the geometry allows hot water to rise to the top of the tank, meaning the hottest water can be sent to loads while average temperatures - and thus losses - are considerably lower. We expect at least a 15°F difference top to bottom during operation. Return locations were based on the expected temperatures from each load, minimizing the disturbance of the stratification.

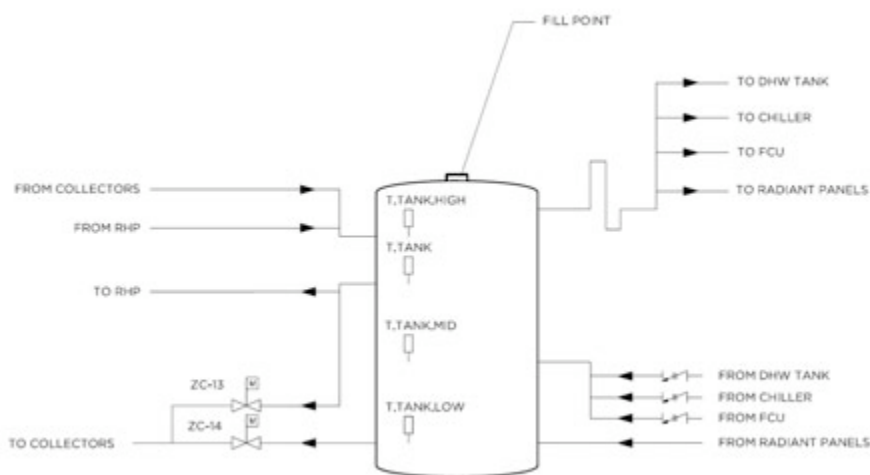


Figure 7: Tank design schematic optimizing thermal stratification and collector operation (not to scale)

More importantly, the heat inlets are designed to take advantage of stratification. The collector array can draw warmer water from the top of the tank during the morning, in order to quickly heat the top of the tank to efficient chiller operating temperature (150°F), and then switch to draw from either the bottom or a mix of the two, reducing average collector temperature and thus increasing array efficiency. Additionally, the heat pump backup only heats the very top of the tank, keeping its runtime at a minimum.

The solar thermal HVAC and hot water system as designed requires an average of less than 1.6 kWh per day in backup energy during competition month, meeting 82% of the house load using solar thermal energy. In Los Gatos, winter operation requires almost no backup energy at all, and summer operation requires less than 1.0 kWh. This demonstrates the flexibility of the design – despite changing climates and locations. Backup energy remains low, even though cooling loads during the summer months in CA are more than double those during October in D.C. This is because in solar thermal cooling the load is nearly perfectly paired with the energy source.

2.4.4 – HVAC System

2.4.4.1 – Radiant System Description

The HVAC system is designed to be both efficient and comfortable by using radiant panels to deliver the majority of the heating and cooling load. Radiant heating and cooling are advantageous for several reasons. First, radiant systems provide good thermal comfort at more moderate air temperatures because of they affect *operative* temperature, which is a better metric of temperature as perceived by people. Second, they do not require high temperature differences to transfer energy, like air handler coils do. Thus radiant panels allow for more moderate water temperatures, increasing the efficiency of the generating equipment like heat pumps or chillers. Finally, our radiant system only uses enough blown air to ventilate and dehumidify, saving large amounts of energy in fan operation.

Radiant systems fall into two major categories: high-mass and low-mass. Well-designed high mass systems allow peak loads to be reduced and demand to be well-balanced throughout the day. However, they are also very slow to respond, and when conditions change quickly they can suffer in both efficiency and delivered performance. Because the house is expected to perform in different locations and climates, and because of the shipping height and weight limitations of the competition, Refract House employs a low-mass system.

The radiant solution we have chosen is a prefabricated panel-based system called Warmboard™, where PEX tubing is laid into pre-routed paths in an otherwise standard structural subfloor. The result is a system that performs as both a structural and mechanical system, reducing material and installation cost.

Both the floor and the ceiling of Refract House will be Warmboard™, allowing for radiant heating and radiant cooling to be done using the most efficient surface: ceiling for cooling, floor for heating. This also allows for both surfaces to be run simultaneously to meet large loads, such as peak summer cooling. We have opted for a single manifold and a single mix temperature to reduce plumbing complexity, although slightly increased performance could be achieved with different floor and ceiling temperatures.

2.4.4.2 – Blown-air system description

Ventilation is necessary to complement a radiant design, and a dedicated outdoor air system (DOAS) fills this role perfectly. Providing required ventilation for occupants, as well as meeting latent load by delivering air dried by chilled coils, the system allows the radiant panels to handle most of the sensible load in the house. It also allows for ventilation-based cooling when outside temperatures are low but the space is being warmed by solar gain, a significant concern for our highly-glazed house – especially in swing months like October.

An energy recovery ventilator (ERV) is included to pre-condition incoming air for both moisture and heat using

the exhausted room air. The ERV is designed to be bypassed with a controllable damper in cases where ventilation cooling is needed. Also, because ERV's consume a good deal of power (nearly 200W), we also bypass it whenever outdoor conditions make it not worth the energy. Using manufacturer data and our system simulation, we determined that the ERV is only economical when the temperature difference is greater than 15F between the inside and outside, or the humidity outside is greater than 90gr/lb (about 70% RH at 75F).

We also employ demand-controlled ventilation, where ventilation will occur based on air quality as measured by CO2 and VOC sensors, rather than assumed occupancy. This reduces both fan energy and the loads imparted by ventilation.

2.4.4.3 - Chiller description

The chosen absorption chiller is a residential-sized unit produced by Sonnenklima, the SunInverse 10kW. While it is nominally rated for 10kW at a driving temperature of 170F, the output can be scaled up or down - by varying the driving, rejection, and chilled water temperatures - from 40-140% of nominal, all without changing the COP by more than 10-15%. This means the operation is highly flexible, and more importantly, that driving temperatures as low as 130F can be used to run the machine, making it much more appropriate for lower-temperature residential solar applications than other chillers, which usually require at least 160F to engage.

Chiller control will be optimized using intelligent algorithms from Sonnenklima, as well as those developed at SCU, to pair it most elegantly with the solar thermal system and the house's requirements. The chiller itself modulates the cooling tower fan to optimize the tradeoff between load, COP, and electrical consumption. We are also using the chiller's rejected heat to preheat domestic hot water, further reducing cooling tower runtime.

2.4.4.4 - HVAC System Design and Sizing

Blown-air systems are sized according to their largest requirement, which can be ventilation, dehumidification, or heating/cooling, depending on the application. In the case of Refract House, the large radiant array and the need to operate in humid DC mean that the design constraint is the latent load.

We have chosen to employ our reversible heat pump (RHP) for our dehumidification needs in order to accomplish dehumidification quickly (with very low water temperatures) while allowing the chiller to be set at a more moderate water temperature to run the radiant panels. The RHP runs in series with the chiller to achieve very low temperatures and reduce backup runtime. A chilled water buffer tank serves as thermal mass to reduce cycling and absorb the extra cooling and redistribute it later.

The actual blown-air design process is iterative as different air flow rates and coil sizes are tested and ASHRAE sizing tools are employed. After the system is designed to meet the latent load, the maximum sensible contribution it can make in heating and in cooling is determined, and these must be large enough to assist the radiant system in providing an appropriate air temperature for comfort. In the case of our system, the contest measures only air temperature, so it is important that we are able to keep this within a specified range, not just the operative temperature. Thus our system would actually provide more economical operation in a real-world deployment, where comfort is measured rather than air temperature.

The system operates at a nominal 210 CFM, with a RenewAire EV200 as the ERV and a Rittling FCHP-04 (4/1-row heat/cool) as the fan coil unit (FCU). Maximum mechanical ventilation for natural cooling will be 300 CFM. Distribution is

handled by round flexible ductwork to four floor diffusers, located to provide the most even conditioning.

The radiant system is somewhat pre-sized because of the Warmboard™ panels, which are employed in all possible areas. The designer must simply verify that the panels will be able to meet the demand given the room temperature and floor/ceiling covering, and then determine water temperatures and flow rates. Again, the design condition is cooling, which is the more challenging operation mode because the panels must be maintained above the dewpoint to prevent condensation. Still, we are able to accomplish nearly 5kW of cooling, by modulating the temperature to keep the panel surface near dewpoint and driving the flow fast enough to keep the temperature drop across the array below 5F.

Together our fan coil unit and radiant system can produce over 6.5kW in cooling, which is more than enough to meet our design loads of 6.1kW.

2.4.5 - Heat Recovery Systems

All thermal energy used in a house, be it heating or cooling, is eventually lost to the environment. We sought to design Refract House to use as much waste heat or cooling as possible in order to save thermal energy and electricity. The challenge with this is that while thermal energy is abundant, it must be transferred to a useful source that is more moderate in temperature than itself. We identified several sources and sinks that would allow energy capture and re-capture, but only our plan for domestic hot water preheat will be implemented due to its low cost and complexity. Other sources we investigated included nocturnal radiative water chilling through our reflecting pool, and heat recovery from PV panels using hybrid PVT collectors instead of conventional PV.

Domestic hot water preheat will employ an indirect-fire hot water preheat tank to capture rejected heat from the chiller during the cooling season. Warm water at 95F from the chiller's heat rejection loop is passed through the preheat tank's heat exchanger, both pre-heating the domestic hot water and pre-cooling the water headed to the cooling tower, saving energy on both sides. The system was modeled using energy balances and expected water draws, and 80 gallon DHW and preheat tanks appear to be the optimum solution.

2.4.6 - Hydronic Piping Design

Having designed the components to be as efficient as possible, pumping energy becomes a major contributor to the HVAC system's total electrical consumption. Thus we have painstakingly designed each circuit to have as few fixtures as possible, and to operate with the lowest effective flow rates. Field optimization during commissioning will be extensive, and will tailor each loop's flow rate to run exactly as designed. Components such as the DHW preheat tank will also be bypassed whenever they are not in use.

For pumps, we have chosen to employ Grundfos' Alpha "smart pump" for each of our circuits. This type of permanent magnet, fractional-horsepower circulator is extremely efficient by design and also includes onboard circuitry to continuously maintain optimum performance. Some circuits will be allowed to "auto-adapt", a built-in power saving function that sets pump speed based on the system demands, while others will be tuned using onboard constant speed or constant pressure settings. Pumping energy will be cut by more than half by utilizing this type of circulator.

2.4.7 - Control System

All of the systems we have designed require detailed control and monitoring in order to function as intended. Control

of each system – solar collection, HVAC, and DHW and heat recovery – will be done using one control unit, the Uponor Climate Control Network DDC system. This will be independent of the rest of the house’s control systems for simplicity and to take advantage of existing off-the-shelf hydronic controls.

We have designed all control logic specifically for our system, and it will be implemented using BACnet. Initial programming will be done by Uponor engineers, using our sequence of operations, and subsequent field optimization and programming will be done by our team.

2.5 – Energy Modeling and Design Narrative

2.5.1 – Motivation for modeling

This section will detail more explicitly the evolution of the house's design and systems, and present the quantitative rationale to support our decisions. The most efficient systems always start with designing a house to have the smallest loads possible, and to this end we extensively modeled and engineered the house to require as little energy as possible before we began designing the systems to condition it.

Energy modeling of this detail is important in very large scale designs, and in energy efficiency development research, but is usually not employed for residences of this size. That being said, the Solar Decathlon is about pushing the design envelope, and also about gaining better insight into energy performance, and so this level of detailed analysis is practically requisite.

2.5.2 – House design philosophy

The thermal performance of the house is critical for both the contest and real-world operation. Not only are heating and cooling loads often the largest energy demands in buildings, but this house design requires special care. Because our architecture is designed to be extremely elegant and to emphasize the indoor-outdoor living environment of California, Refract House has greater thermal challenges to overcome than most similar-sized houses would.

In our design we strived to provide the necessary functionality while enabling great freedom in the house's architecture, proving that energy efficiency need not be boring or compromising. Specifically, several aspects of the house are made feasible by the excellent thermal design.

First, the very shape of the house is designed to marry the outdoor and indoor living environments, making the multiple decks and gardens a part of every room; the long, tube-like structure of the house connects every room to the outdoors on at least one side. But this also creates very large surface area to volume ratios and creates a long south wall, relying heavily on thermal engineering.

The indoor-outdoor concept also benefits from a large number of windows and sliding doors, which make the house very open and livable, but also pose challenges to thermal performance.

Finally, the cantilevering effect of the module endcaps and their all-glass nature also lend a very distinct feel to the house and create very pleasant isolated patio areas. Yet again, these features tend to make thermal efficiency more difficult, by reducing the insulation thickness in the end of the modules and necessitating steel moment frames which allow thermal bridging.

While all of these pose challenges, meeting those challenges while demonstrating exceptional energy performance in a house that is anything but compromising is our main design goal. The best result the thermal engineering can achieve is to enable Refract House to be maximally beautiful and functional while not compromising on efficiency.

2.5.3 – Window Studies

Because of the large area of predominantly south-facing windows, glazing defines the house's loads. Even with very efficient windows, the effect is pronounced. Figure 8 shows the effect of window area on average daily heating and cooling loads in Washington in October. Values for the house as ultimately designed are indicated with a heavy black datapoint in all studies.

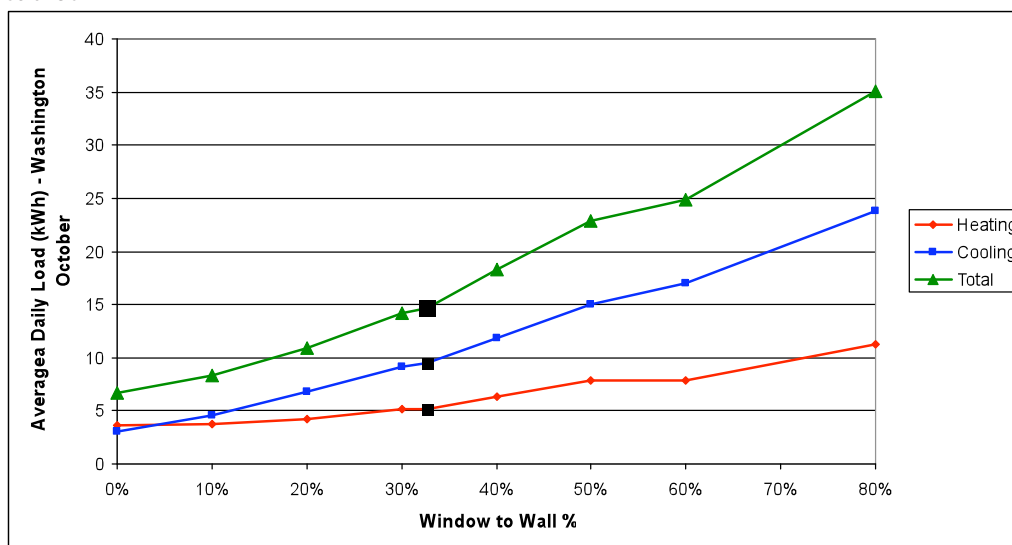


Figure 8: Average daily thermal load as a function of window area

Clearly cooling is the defining load – despite daytime temperatures generally below interior temperatures – because of the solar heat gain from large window area. However, heating load from heat losses during the evening also play a role. Thus both solar heat gain (SHGC) and heat transfer coefficient (U-Value) are important, but solar gain is the primary concern.

There are two ways to control solar gain, assuming window locations cannot be changed: shading and glass choice. Shading may be accomplished using trees, awnings, louvers, blinds, or any number of ways, but the context requirements and our desire to maximize our livable area leave us with only two viable options: louvers or blinds.

External blinds perform slightly better than internal ones because they dissipate any absorbed heat outside; in our model, similar geometries performed about 13% better. Figure 9 shows the effect of various external blind settings on house loads. Blinds were a conservative 4cm long and 4cm spaced, and were not scheduled, although the actual house blinds will be capable of being automatically raised, lowered and tilted depending on the time of day, season, or as the occupant desires.

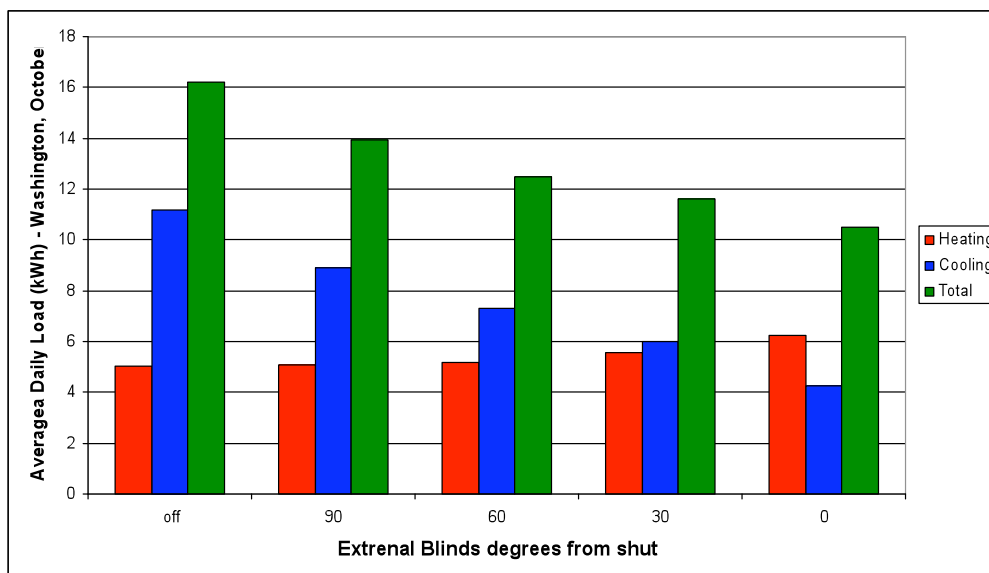


Figure 9: Average daily thermal load as a function of louver position

The data confirm that even moderate shading helps reduce cooling loads significantly, but also indicate that heavy shading can have the opposite effect on evening heating loads – likely because of the reduced carryover of thermal energy from the daytime gains on days where insolation is lower. This indicates that significant advantage could be gained by positioning the louvers intelligently depending on insolation and temperature.

Beyond shading, the other way to control solar gain is using glazing designed to have a low SHGC. While using aggressively-filmed windows can have a tremendous effect on gains, windows can become aesthetically unappealing (dark and shiny). Thus careful analysis is required to reach a compromise on this tradeoff. Figure 10 presents daily loads as a function of SHGC value.

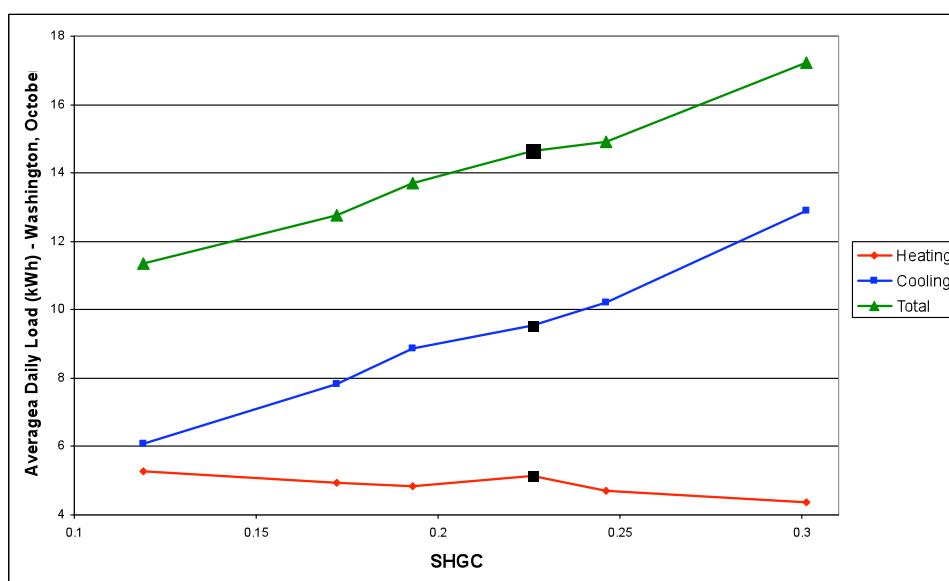


Figure 10: Average daily thermal load as a function of Solar Heat Gain Coefficient

As expected, the cooling load is heavily reduced by more aggressive SHGC values. The heating load is mostly unaffected, with a small increase similar to that observed in the shading effect. Thus the smallest SHGC with acceptable visual characteristics is optimal.

Beyond solar gain, windows also present another challenge: heat loss and gain to the outside. The effect of u-value on heating and cooling loads is presented in Figure 11.

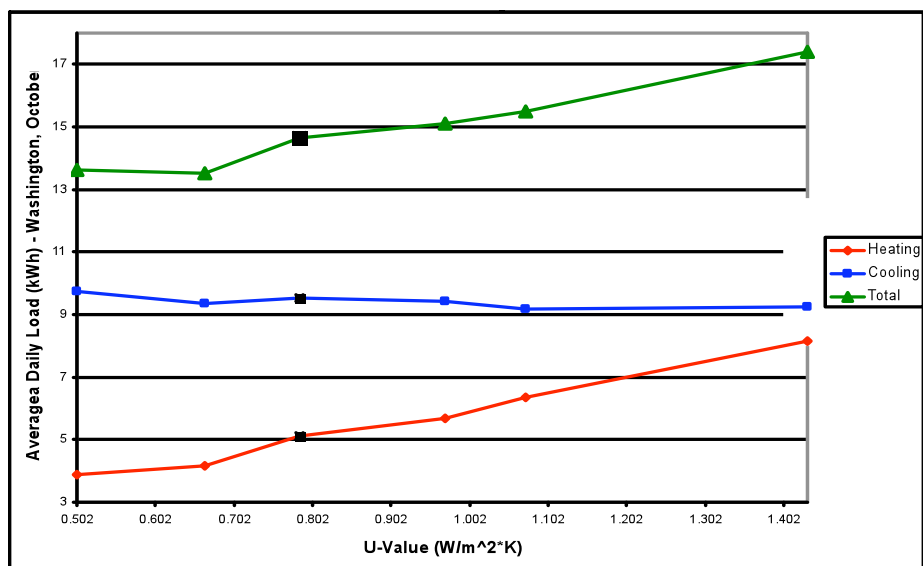


Figure 11: Average daily load as a function of U-Value

Here, the opposite trend is observed from solar heat gain: U-value primarily affects heating load because the design month has low evening temperatures, but has little effect on cooling load. Still, it is clear that more insulated windows are best.

Thus, window studies indicate that shading is important, and that intelligent shading is more useful than 'fixed' shading. It is also clear that very low SHGC values are best, and that U-value is important but less critical.

We have thus designed an insulated glass unit (IGU) that is triple-paned, with Cardinal366 Low-E glass on the outside, Southwall HM88 film as the center layer, and clear glass on the inside, with krypton as the gas fill. This unit will be employed in all windows that Southwall can fabricate. The tallest glass in the house will be double paned units with Argon and Cardinal366, which still perform admirably given that SHGC is our primary concern.

2.5.4 - Envelope studies

Heat is also lost and gained through the regular surfaces of the house: walls, ceilings and floors. In almost all design conditions, more insulated houses perform better, but we sought to examine the effect in more detail for the competition month. Heating and cooling loads are shown as a function of wall insulation in Figure 12.

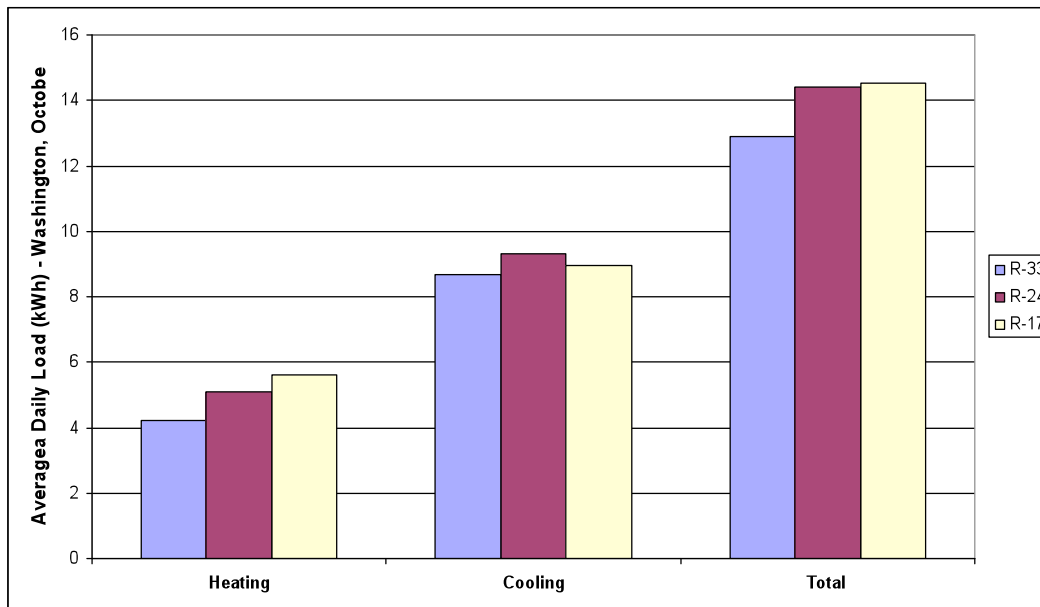


Figure 12: Average daily backup load as a function of R-Value

Again, we see that the swing month of October has created a curious situation: heating is reduced by greater insulation, but cooling is more complex because the heat loss helps fight solar gains. The optimum insulation value will vary depending on the exact specifications of the house and the exact weather it is designed for, but the general trend is unchanged: greater insulation means lower load. Thus, the house will be insulated maximally given the space constraints.

2.5.5- HVAC studies

The primary effect studied on the HVAC systems was the benefit of intelligent ventilation to counter solar gains on cool days. Ventilation cooling allows loads to be reduced or eliminated on many days. Figure 13 presents the effect of ventilation cooling on the house loads during October in Washington.

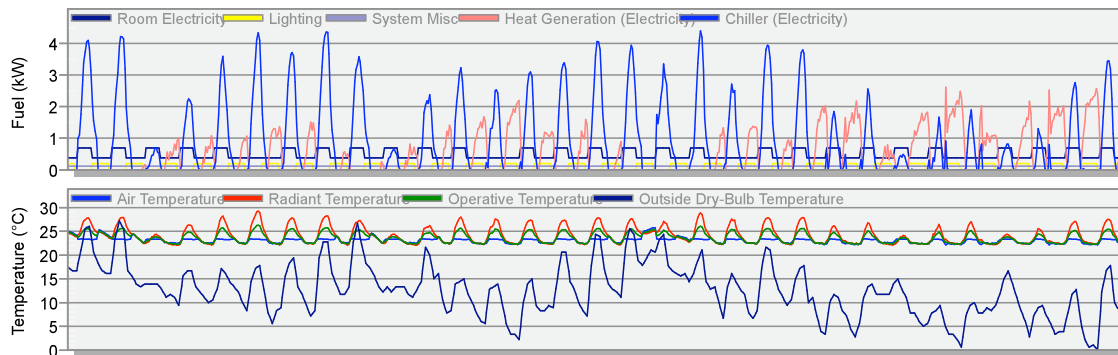


Figure 13a: Heating and cooling loads, no ventilation cooling, Washington, October

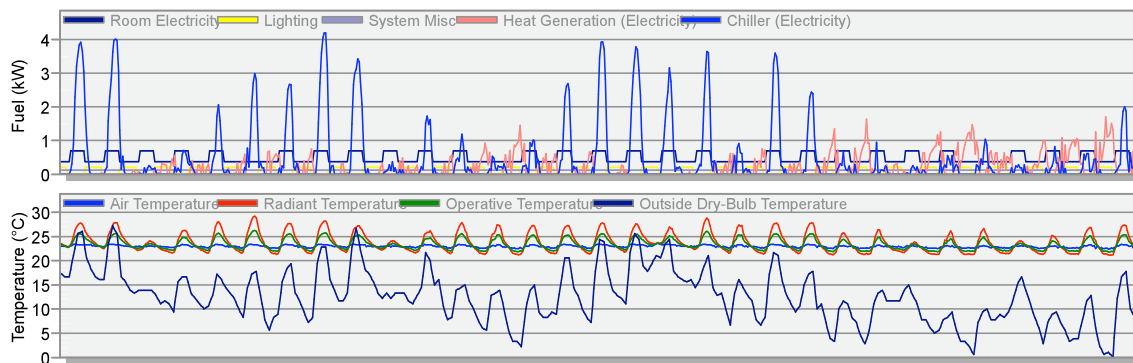


Figure 13b: Heating and cooling loads with ventilation cooling, Washington, October

It is apparent that the cooling load is reduced or eliminated on some days and totally unaffected on others, depending on outside conditions. The exact nature of this effect depends on the amount of ventilation. House loads as a function of ventilation rate for natural cooling are presented in Figure 14.

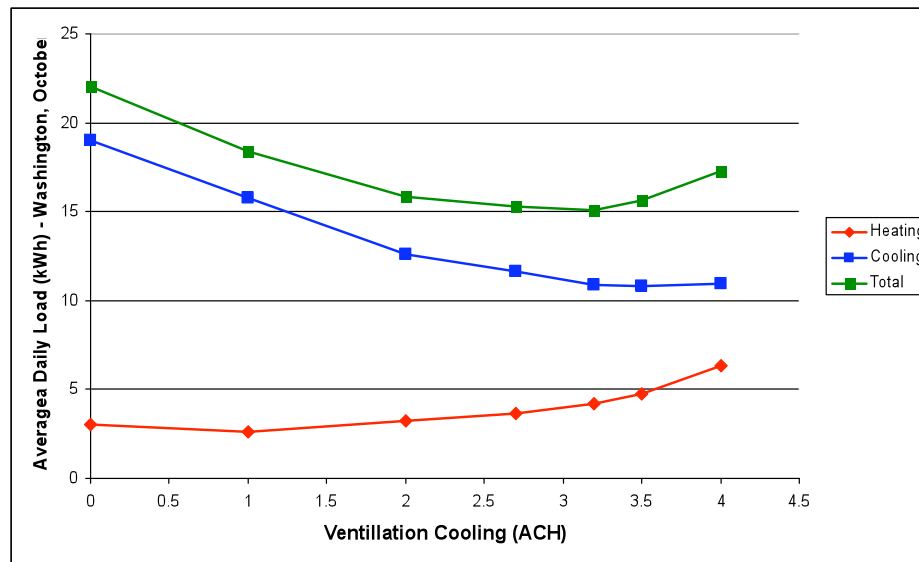


Figure 14: Heating and cooling loads as a function of cooling ventilation rate

Larger ventilation rates exhibit decreasing returns for cooling benefit, but negatively impact heating because of their effect on thermal carryover from the day, resulting in an optimal ventilation rate of about 3 ac/h, or about 300 CFM. Thus our blown-air system is designed to provide up to this flow rate.

3.0 – Electrical Systems

3.1 – Introduction

Electrical energy efficiency is one of the most important aspects of the competition. To make Refract House as electrically-efficient as possible, we had to both maximize the power delivery of our photovoltaic system and minimize the power consumption of the house itself. As with the thermal engineering, the best designs begin with load reduction, so this was our primary concern.

We have also sought to do more than just bolt a photovoltaic system on top of our house. Following our team's mission of integration, we constrained our photovoltaic array design to appear as part of the house. In doing so, we have shown that solar power can be beautiful, and can add more than just power to a home.

In this section, we present the house appliance and lighting selection, our photovoltaic system design, an analysis of the house's anticipated loads and production, and the role homeowner habits can play in the house's energy consumption.

3.2 – Loads and Production Summary

Refract House is designed first and foremost to reduce electrical loads in order to produce as much net power as possible, for both the competition and for the homeowner. Because we have designed a uniquely energy-efficient thermal system requiring much less power than most other HVAC systems, the selection of energy efficient appliances and lighting plays an even larger role in our total energy consumption than it might otherwise. Expected energy requirements for the house during competition are presented in Figure 15.

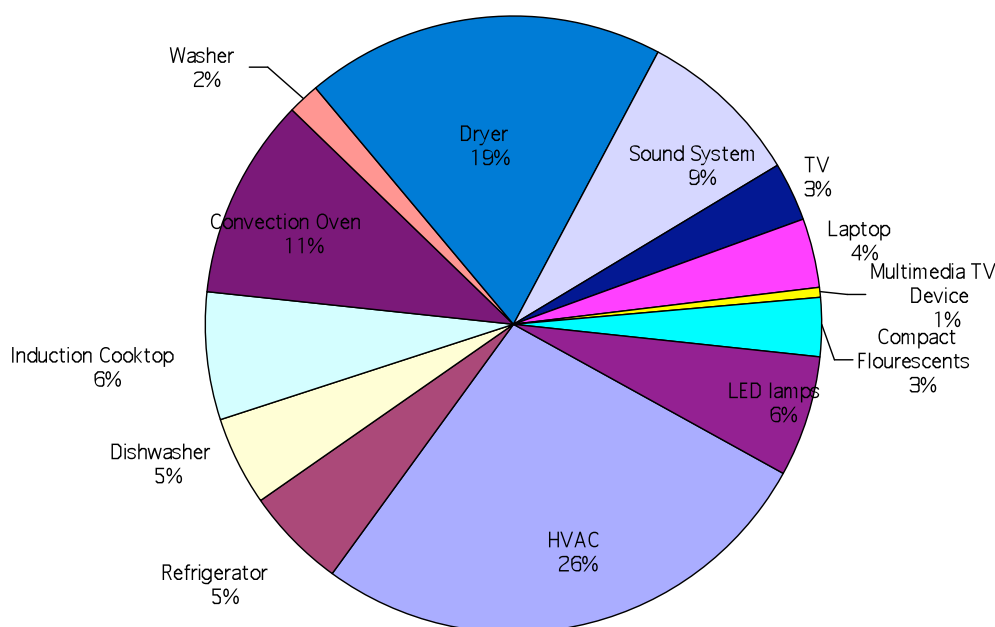


Figure 15: Average daily electrical consumption from various house loads

The appliances are the primary consumers, so great care was taken in selecting the most efficient ones available. Our appliance selection was influenced by Energy Star and Consortium for Energy Efficiency ratings, and each one was hand picked to meet not only our energy requirements but also the functional needs of the homeowner.

The house's lighting scheme was also designed to use as little power as possible. Using low-wattage high-efficacy LED fixtures for nearly every light, and CFL's for the rest, the house is comfortably lit with a minimum of energy.

Based on the competition schedule and our system modeling, we expect to consume an average of 18.5 kWh per day during the competition period, and to produce about 29 kWh. Thus we should be substantially net-energy-positive for the competition, assuming average historical insolation values.

Operating in our target market the house should annually consume between of 7-12 MWh, depending on resident habits, and produce 12.6 MWh. This means the house will be net-zero-energy for all but the most extravagant energy user.

3.3 – Design

3.3.1 – Goals and Challenges

Our design goal was to integrate maximum energy production with architectural aesthetics – we demanded that Refract House be a home above all, not a power plant.

Thus we set out to design the solar array to appear as an intentional part of the house rather than an afterthought. Most solar power systems are identifiably separate from the rest of the house - our design had to overcome this.

Furthermore, we wanted to maximize the power that the photovoltaic system would deliver to the house, reducing its dependence on externally-generated, carbon-heavy energy. This gives the resident the freedom to use all of the house amenities while still having the peace of mind of energy independence.

Yet the design of the house presented major challenges. The house shape is complex, creating difficult geometry for panel arrangement. Also, the large north-south footprint of the house, combined with the need for an integrated appearance and the competition height limitation, limits the roof slope to 10.5°. Additionally, the roof is shared with large solar thermal panels, making the layout and integration even more challenging.

3.3.2 – PV Array Design

Panel selection was the first stage in the design process. We needed a panel that was efficient, fit densely on our complex roof, and was aesthetically appealing. After much deliberation, SunPower's SPR-225 solar panel was chosen for its high efficiency, small size, and its all-black appearance.

After the selection of the panel was made, we used the panel efficiency to estimate the amount area that we needed to fulfill the required load of the house. We calculated that we would need approximately 31 panels to safely meet competition requirements.

To compensate for the decrease in efficiency due to our less-than-optimal panel tilt, we maximized the number of solar panels by packing them as efficiently as possible on the roof. After much experimentation, we were able to fit 38 panels on the roof by designing a custom racking system from modular Unirac components. The racking system also allows for back-clipping the panels and fitting flashing in array gaps, effectively achieving the desired appearance of a monolithic roof rather than a collection of panels.

Based on the design of our photovoltaic array, we will generate enough power to not only meet the tasks required by the competition, but also to produce a substantial amount of net contributed power.

3.3.3 – Inverters

For our inverter we chose SMA's Sunny Boy 5000US because its 97% CEC efficiency is the highest in its class. Additionally, it has an expected lifetime of at least 25 years, on par with our solar array and important for the long term value of the house.

3.3.4 – Maximum Power Point Tracking System

In order to harvest as much energy possible, we explored the possibility of using cutting-edge Maximum Power Point Tracking (MPPT) systems. While our inverters have MPPT functionality built in, we hoped to utilize new DC-to-DC boost systems that are coming to market here in Silicon Valley. These systems would increase our PV array efficiency by approximately 10% because they can compensate for power losses due to problematic or shaded solar panels by biasing unimpaired panels or strings. Furthermore, they would allow detailed monitoring that would be able to track the production of the strings or panels and update homeowners on the efficiency of their solar array, a function which appeals not only to the eco-friendly consumer but to tech-savvy Silicon Valley residents as well.

We investigated two types of systems through extensive collaboration with local manufacturers: a per-panel MPPT from Sympagis and a string-based MPPT from Act Solar.

Unfortunately, due to delays in the certification process, neither system will be ready in time for implementation in Refract House. However we still believe this technology has great promise, and would make an excellent addition for maximizing power delivery and innovation to customers in the future.

3.3.5 – Calculations

In order to determine the annual output power of our system, de-rating factors were calculated in detail. These were based on our system's expected performance during competition week. For example, we expect to keep our panels clean throughout the competition, which resulted in negligible losses due to soiling, and we resolved that the inverter was the limiting factor when determining the de-rating factor. Nevertheless, we expect our array to generate close to 90% of its potential power output, as detailed in Table 2.

Table 2: Summary of PV array de-rating assumptions

De-rating Type	Percentages
PV Name Plate Derating	0.9778
Inverter	0.9550
Module Mismatch	0.9950
Diodes/ Connection	0.9950
DC Wiring	0.9800
AC Wiring	0.9900
Soiling	0.9950
Total De-Rating Factor:	89.25%

The expected insolation for the competition period and location averages 3.8 sun-hours per day for our collector tilt. With our 8.55kW array we expect to produce a daily average energy of 29.0 kWh, an impressive figure.

Annual production for Los Gatos averages about 34.6 kWh per day, or about 12.6 MWh per year.

3.4 - Modeling

3.4.1 - Introduction

The following section describes the modeling in more detail, specifically major power consuming appliances, lighting, and the HVAC system.

3.4.2 - Competition Load Modeling

Accurate modeling of energy usage during the competition is critical to anticipating performance. Many of the appliances have specific prescribed run times, such as the TV and the lighting. Approximations of task-based loads, such as washing and drying towels, were made based on the manufacturer specifications. For the clothes washer, it is assumed that the wash cycle should run for less than thirty minutes. The clothes dryer should run for a maximum of ninety minutes.

HVAC, one of the larger energy loads, was challenging to estimate since the system is complex and exact performance and loads during the competition are uncertain. A robust model was developed by the thermal team, and this indicated the pumps, fans and backup heat pump would consume between 2 and 5 kWh per day, usually on the lower end of this.

Tabulating these estimates gave us a reasonable model of the likely energy demand for Refract House during the competition in Washington, D.C. Figure 16 shows a week of daily energy consumption based on our assumptions. As detailed in the chart, we are expecting our largest energy load on Monday and we can expect push the most energy back into the utility grid on Sunday, when only minimal loads will be running.

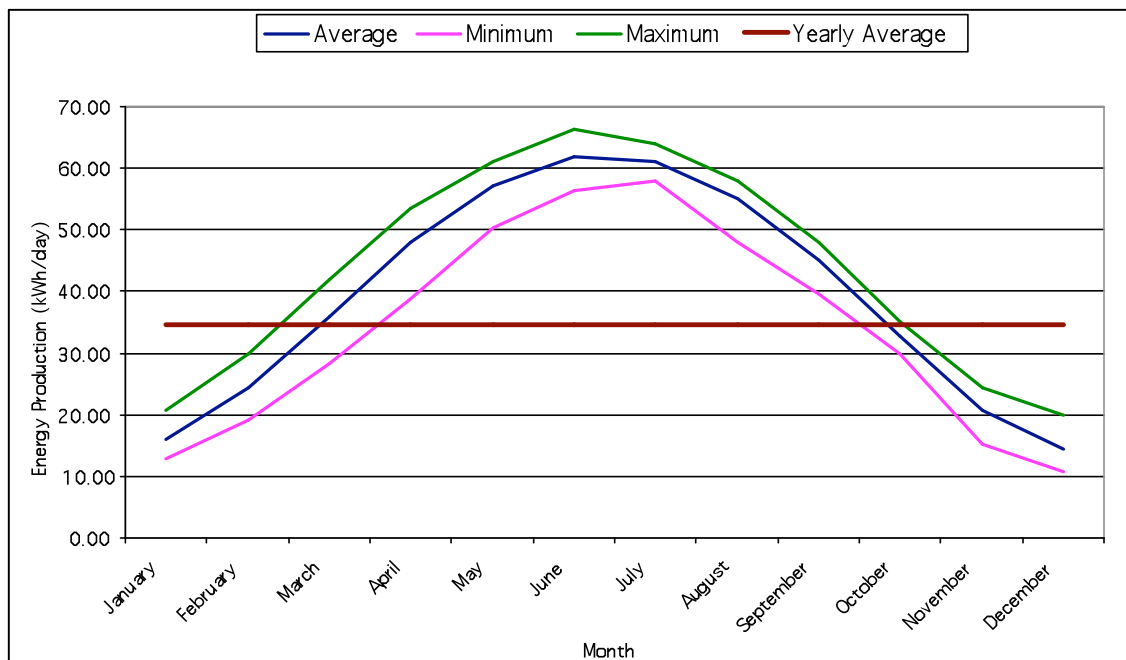


Figure 16: Expected house energy consumption and production during a competition week

We also compared our energy loads with those we might expect by using “conventional” appliances. Even with large consumers like the dryer not changing (most dryers have similar efficiencies), the house loads dropped by about 30%.

3.4.3 – Annual Performance Modeling

In addition to the contest performance, we also sought to investigate annual performance in our design market. Figure 17 presents the expected array production over the course of the year in Los Gatos, and exhibits the expected trends.

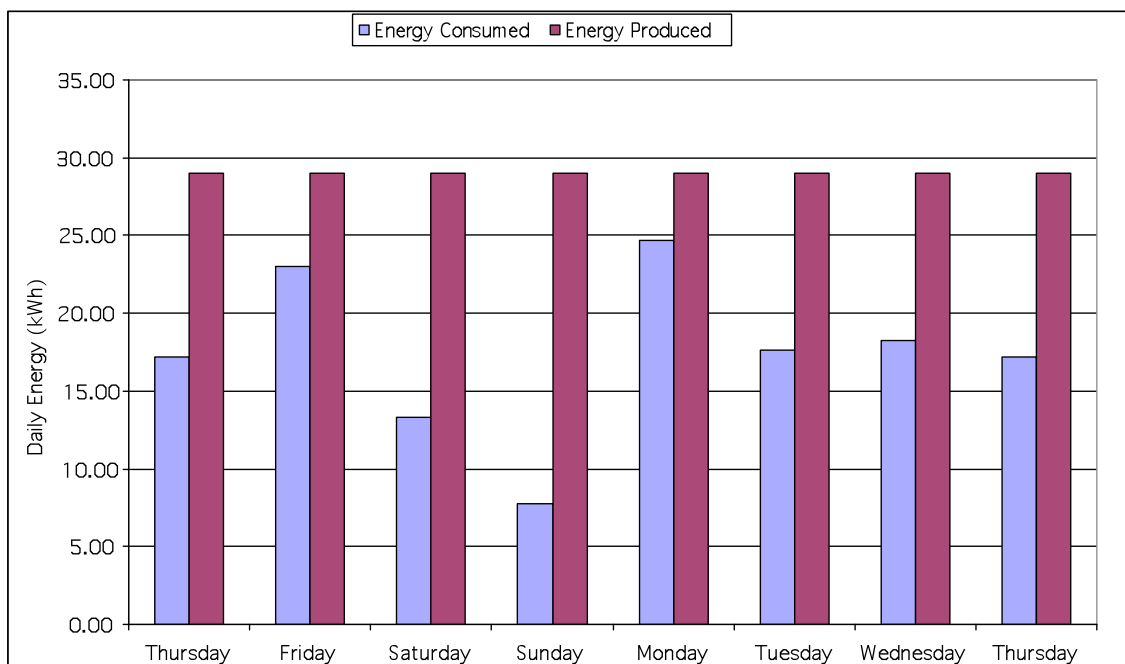


Figure 17: Expected house energy consumption and production during a competition week

The homeowner is the major unknown in annual performance. Thus we modeled possible usage patterns using a similar approach to our competition estimate and generated load scenarios for three hypothetical users: the eco-conscious user, the average user, and the luxury user.

The eco-friendly user is assumed to be very conscious of his energy usage and take reasonable measures to reduce his consumption, such as shutting off lights not in use, using moderate thermostat set points, using full laundry loads, and using electronics selectively.

The average user does not go out of his way to reduce energy, but is nonetheless generally aware of it and uses appliances only when necessary.

The luxury user, on the other hand, utilizes all of the amenities of the home to the fullest, using many appliances in parallel, occupying the house most of the time, and entertaining often.

Figure 18 presents the expected average annual electrical consumption of the three user types, and compares them to the PV array production.

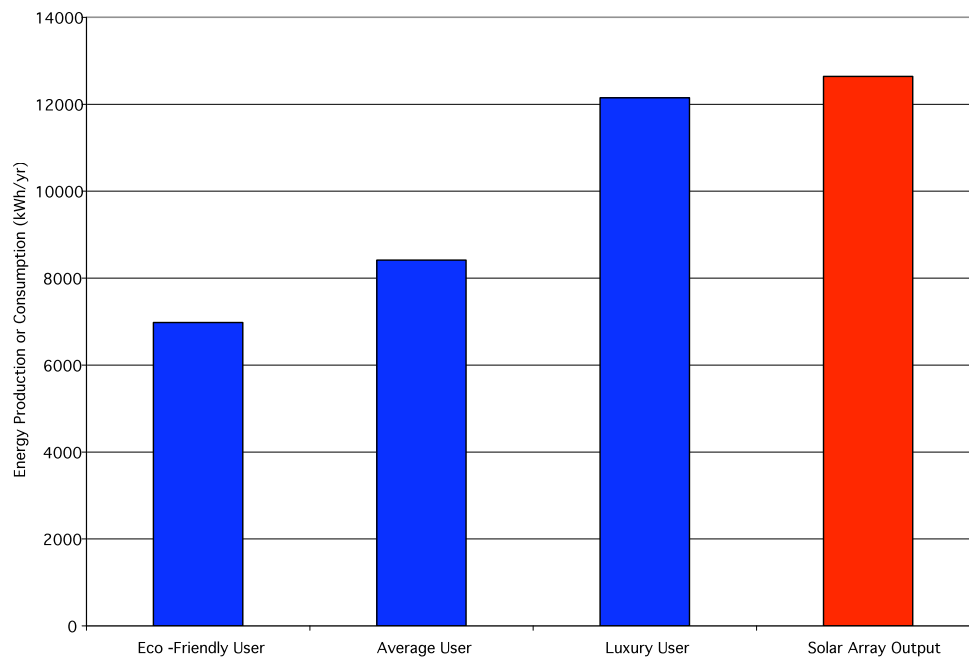


Figure 18: Expected annual energy consumption of different types of homeowners

From the results, it is obvious that homeowner behavior significantly affects the performance of the house. A conscious homeowner might be contributing nearly 6 MWh to the grid annually, while the extravagant homeowner might use all of the electricity produced.

Thus, in the next section, we shall discuss Refract House's home energy monitoring system, which is designed to make energy use and production transparent for the homeowner, encouraging intelligent habits.

4.0 – Home Energy Management

4.1 – Motivation

Traditional homes lack a method of informing residents about energy and water consumption until they receive their utility bill. By that time, homeowners are left puzzled as to why the bill is higher or lower than normal. In addition, many homeowners do not understand energy and are confused by the recorded consumption levels of kilowatt-hours of energy and cubic feet of water on their utility bills.

A truly energy-intelligent home would provide occupants with information on their energy and water usage in metrics they are familiar with, such as miles driven in a car or money spent on electricity. In addition, energy and water consumption need to be broken down into areas of the home, so the homeowner can learn which systems are most important to manage. For this information to be valuable, it needs to be available more often than once a month. An ideal system would provide real-time feedback, so homeowners can compare their habits with their consumption levels. A system such as this has the ability to help homeowners lower their energy and water usage considerably. Our own analysis indicates that occupant behavior can influence annual electrical consumption by nearly 6 MWh, even in a very small, ultra-efficient home like Refract House.

4.2 – Controls and Monitoring System Description

4.2.1 Monitoring Details

Refract House's Monitoring System provides real time feedback in clear measurements, allowing homeowners to become more conscious of their energy use. By seeing a direct correlation between their lifestyle and consumption levels, the homeowners will be enabled to adopt greener habits.

Refract House uses Lucid Design Group's Building Dashboard® to monitor and display the home's consumption levels. The system displays energy and water usage on a customized user-friendly website, which displays current and durational consumption levels. Data from sensors located about the house are sent to Lucid Design Group's servers every minute, where the information on consumption levels is posted to a website. Consumption measurements are presented in several units, allowing the user to select ones they best understand. Electrical consumption measurements include but are not limited to kilowatt-hours, currency, pounds of coal, pounds of carbon dioxide, and lightbulb-hours.

We have divided monitoring into certain systems and areas of the home. Lighting, plug loads, thermal systems, and photovoltaic systems are the main areas of electrical consumption or production, with lighting and plug loads additionally divided into sections of the home such as living room, kitchen, and bedroom. These decisions were made in conjunction with Lucid Design Group, who have determined through market research and experience that this amount of detail provides the best information for a general user. The water consumption is divided into cold and hot water consumption, as well as consumption from the shower and the amount of grey water recycled by the home.

We have also elected to include waste monitoring in the system. The homeowner will be able to weight their weekly trash and recycling outputs and enter them into the system, allowing them to track these metrics over time and aim to reduce them.

Figure 19 shows an example implementation of the Dashboard, showing how clearly information can be displayed to users, and the different forms monitoring can take, such as building to building competitions.

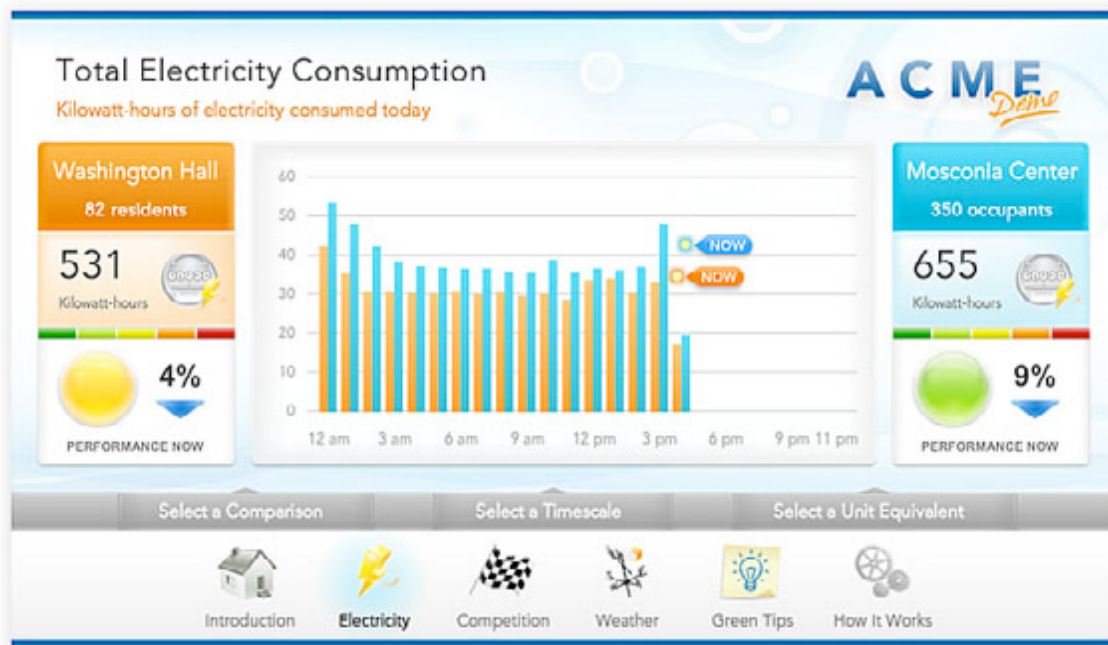


Figure 19: Building Dashboard® Demo Website www.luciddesiggroup.com

4.2.2 Highlighting Thermal Systems

Another feature of the monitoring system is to portray important aspects the home's thermal system. This intelligent and complex system runs in the background of the house with little user input, but can offer some exciting insight into the home's engineering. Highlighting this system excites residents and visitors about the home's sophisticated technologies and the energy they are saving. The monitoring system provides current information such as the thermal tank temperature, as well as energy and money saved over time.

4.2.3 Home Controls

The mechanical, lighting, entertainment, and monitoring systems were each designed independently to maximize performance and minimize energy consumption. Refract House's control system was created to provide a single user interface in order to access and control these different systems. Both an iPhone application and a touch-panel-accessible website control the temperature in the house, adjust the lighting, access the energy and water monitoring system, control the entertainment system, and check current weather conditions provided by a home weather station. With this system, Refract House can be controlled and monitored through a single interface.



Figure 20: Refract House Controls & Monitoring System

4.3 Home Owner Effect

Often termed the “Prius effect”, when drivers see how their car is performing in real time, they tend to adjust their driving to improve fuel consumption. The same effect happens when users see consumption levels from buildings or residences. A case study¹ of Oberlin College using Lucid Design Group’s first system, found that this “Prius effect” can have a substantial effect. The research discovered that electricity consumption was reduced by over 25% when dormitory residents could access their real-time consumption levels on a website.

The goal of Refract House’s monitoring system is to create this same effect by providing homeowners with the necessary information to make energy conscious decisions. The monitoring system merely provides the user the information; ultimately the homeowner has to make a choice to develop greener lifestyles. This change affects more than just their home’s utility bills. The homeowner begins to make greener decisions at work and introduces them to friends. The hope is that this one monitoring system provides an education not just to the homeowner, but also to all those that visit the house or interact with those who have.

¹ Peterson, John E, et al. “Dormitory Residents Reduce Electricity Consumption when Exposed to Real-Time Visual Feedback and Incentives.” *International Journal of Sustainability in Higher Education*. Vol 8 No. 1 (2007):16-33. <<http://www.luciddesigngroup.com/energycompetitions.php>>

ARCHITECTURE



ARCHITECTURE

1.0 Architecture

Refract House demonstrates that contemporary design and rigorous engineering can be united to create a home that is both beautiful and sustainable. Embracing the “California Lifestyle”, we have designed the interior spaces as much to complement the outdoors as to be sheltered from it.



Unlike so many high-efficiency homes, Refract House is not a box with minimal windows. Instead, we propose a new precedent for energy efficient homes that prioritizes visual, spatial and functional connection with the surrounding environment. We’ve used this strategy to transform an 800 square foot prefabricated house into an open and inviting home.

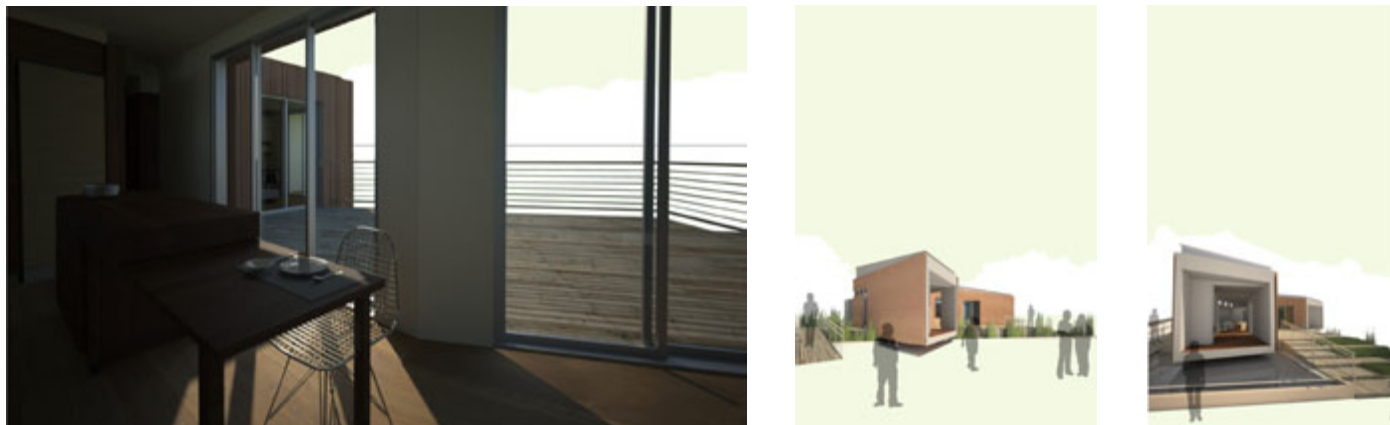
The bent form of the structure mimics the path of the sun from dawn to dusk. The southerly orientation of Refract House and its large expanses of glazing have informed our organization of interior zones. Light fills a room when people are most likely to be using it. Occupants will wake to the sun warming the easterly bedroom. Later in the day, people will move into the kitchen for cooking, socializing and dining. In the evening when the residents gather to relax and entertain guests they can watch as the sun sets and fills the living room.

Each of the three modules is set at a different angle in relation to the sun in order to control the entry of light and heat into the structure.

Two primary strategies increase the spaciousness and enjoyment of our small home. By elongating and bending the floor plan, spaces are differentiated and can take on an individual identity. The careful use of light and openings creates a strong visual and functional connection to the surrounding environment that makes the space feel larger than it actually is. The courtyard becomes the centerpiece of the house, a fourth room. All other spaces are connected to the courtyard both physically and visually.

2.0 Interiors

The interior design of the house preserves the visual and physical connection to the outdoors. Utilities, cabinetry and built-ins are embedded in the north walls. The walls adjacent to the courtyard are kept light and open in order to ensure an effortless transition between the interior and the exterior spaces.



Despite its advanced technology, Refract House is intended to be simple, modern and comfortable. The material pallet for the interior design was chosen from local California companies whose business practices reflect the sustainable ideals of Team California.

3.0 Landscape

The landscape is designed to encourage a sustainable lifestyle that complements California's climate and ecosystems. The reflecting pool is naturally filled by a rainwater catchment system, celebrating seasonal rainfall conditions and highlighting the western cantilever. The "Gplant" recycled water system alleviates the demand on California's over-taxed watersheds and responds to the sensitivity of local aquifers to the contents of our wastewater. The greywater filtered by the Gplant complies with California Title 22 standards to supply the reflecting pool. However, treated water will not fill the pool during the competition due to regulations.

Native wildlife, bird and insect species will all find shelter within a xeriscape garden that also provides fruits and vegetables for people living in the home. Plant choices are specific to their surroundings and will not include any non-native, invasive species.

We've sought to minimize the environmental footprint of the home, both metaphorically and literally. Both ends of the home are cantilevered off the ground and our permeable decking is intended to minimize stormwater runoff. At the same time, this increases the natural filtration of water through the soil and promotes groundwater recharge. The modular decking is intended to be flexible enough for a variety of different site conditions.

Refract house actively engages its surroundings, while minimizing its impact on them.

MARKET VIABILITY



1.0 Overview:

Refract House redefines the green housing market by designing for efficiency from the start without compromising luxury. Homeowners can now experience quality sustainable living without sacrificing their lifestyles.

2.0 Target Market:

Refract House was designed to meet the specific needs of affluent “empty-nesters.” Representing 25% of the U.S population, these pre-retirement baby boomers are looking to downsize their home without economizing their lifestyle. Our ideal homebuyers are an environmentally-conscious couple living in Los Gatos, California. Their children have moved out of their home and they are willing to spend a premium for a home that will satisfy their desires. Refract House appeals strongly to the environmental, aesthetic and lifestyle sensibilities of this demographic.

Target Market Identification

Occupant Demographic	Empty Nesters - late 40s to early 60s
Annual Combined Income	\$200,000
Location	Los Gatos, CA
Housing Type	Home for Couple
Occupancy	2
Number of Bedrooms	1

Los Gatos is a ripe market for Refract House. Nearly 40% of the city’s residents fall within our target demographic age and income levels.¹ Refract House will stand out to the market of empty nesters because of its integrated efficiency that doesn’t sacrifice aesthetics or the typical luxurious lifestyle. The advanced technical systems will stand out to a demographic where employment is dominated by the tech industry of local Silicon Valley. Refract House also takes advantage of the temperate climate through its indoor/outdoor design, letting homeowners enjoy the Californian lifestyle they expect.

3.0 Livability:

Our couple is now looking for a smaller yet tasteful house. Refract House is designed for entertaining and accommodating active outdoor lifestyles. The interior of the home includes built-in cabinetry and furniture that is designed for maximal style and minimal maintenance. Such design considerations include grout-free surfaces, self drying slate, and uncluttered floor areas. Low maintenance features allow our residents to enjoy more of their valuable free time.

Educating the homeowner about intelligent energy use is an important goal of Team California. Our home has an integrated control and monitoring system that provides easy access to real-time, system-specific energy usage data. Lighting and temperature systems can also be controlled remotely by the Apple iPhone. While high-tech, this system is also easy to use, truly empowering the homeowner to play an active and educated role in their energy usage. Additionally, as locals to Silicon Valley, our target homeowner is extremely comfortable using technology to complement his or her lifestyle.

Refract House was designed to capture and re-use water through a water re-circulation system that provides instant hot water in the shower and sinks. The radiant heating and cooling system maintains a steady indoor temperature and provides warm floors during cooler winter months. Radiant cooling allows the occupants to feel cool indoors

¹ <http://www.city-data.com/city/Los-Gatos-California.html>

even when the doors are open in the summer.

4.0 Buildability:

The documentation for Refract House has been prepared using National CAD Standards and includes complete CSI-compliant construction specifications. This allows any contractor to easily generate a cost analysis and construction drawings so they can replicate Refract House.

Refract House was designed using the Building Information Modeling (BIM) software Revit. We are coupling this model with other programs, such as Cadwork, to generate parametric designs of the house. This will allow developers to automatically compile a complete set of construction documents for custom, buyer-specific variations of Refract House. Ultimately, these models can be used to prefabricate components of the home. Combining this new technology with the existing idea of in-factory construction for modular homes would result in further reduced labor costs, less time on site, and minimal waste.

5.0 Marketability:

Potential Refract House owners are willing to accept higher upfront costs in order to be some of the first to have completely grid-friendly, zero-energy homes. For our market, cost isn't the largest factor. Rather, they are more interested in the quality of life they are buying. Our market is looking to enjoy an ecologically responsible lifestyle without being forced to sacrifice luxury. Refract House accommodates their lifestyles and discerning tastes, while exceeding their desires for a sustainable home. Moving into Refract House is about more than just saving money: it represents a conscious choice to reduce one's impact on the environment.

Though Refract House costs over \$800 per square foot compared to the \$585 average in Los Gatos, it concentrates the attributes typical to a luxurious 5,000 square foot home into its smaller footprint while still providing a very high quality of living. Our market is drawn to Refract House because it provides them with the option of an ecologically-responsible lifestyle without compromising value.

As the Washington Post recognized in an April 2007 article, value isn't provided solely by the cheapest price per square foot. The worth of a home is more directly related to the quality of life the house can provide.² As experienced homeowners, our target market understands this and can afford to pay for a home that satisfies their choice in lifestyle. Refract House has been designed to specifically address the needs and desires of this demographic.

2 <http://www.washingtonpost.com/wp-dyn/content/article/2007/04/06/AR2007040600934.html>

ENGINEERING



ENGINEERING

1.0 Intro

The Engineering design of Refract House has three major aspirations. Firstly, we have sought to engineer a house whose technology and design seamlessly enable sustainable living with no compromises – a home that feels like a home, and is maximally functional and luxurious. Secondly, we have attempted to optimize both our building and our systems to perform as efficiently as possible for contest and private operations alike. Finally, wherever possible, we have employed technologies and design practices that we see as the future of sustainable building, regardless of their direct measure in the contest.

2.0 Seamless integration, no compromise green living

Hopefully the first thing visitors will notice about Refract House is that it does not feel like a typical “green” home. Solar is not an afterthought, nor is energy efficiency – they are integral parts of the house’s design.

Outside the house our solar collectors appear as a single roof plane, our beautiful window louvers balance daylight and thermal demands, and our reclaimed water system shows itself in an elegant reflecting pool before being used to water the house’s landscaping.

Inside, energy monitoring, lighting controls and environmental controls are subtle and functional. The appliances run quietly and efficiently, and all the sophisticated systems that make the house operate are imperceptible underneath the surface of the home’s primary function – being a home.

Similarly, the house makes no concessions for its efficiency. Vast windows allow for beautiful views of the landscape and surroundings. Radiant cooling means that even during the summer the large glass entryways may be opened while the house stays cool, transforming the endcap porches and the courtyard into extensions of the living space – truly enabling the California outdoor lifestyle. The landscaping is expansive and beautiful, featuring an edible garden and a reflecting pool; both are emphasized by our dramatic cantilevered endcaps. Entertaining guests is easy with an open kitchen and living room, as well as the latest entertainment system technology.

3.0 Maximized efficiency in both building and system design

Not only must Refract House perform all the functions of a small but luxurious home, but it must do so efficiently, both for the contest and its permanent installation in California.

To this end, the house’s architecture and envelope have been extensively modeled and scrutinized for thermal performance. The result: highly engineered glazing for heat loss and solar gain control, sophisticated external shading for summer shading and winter passive solar gain, advanced soybean-based blown insulation for excellent thermal isolation and infiltration control, and aerogel-based thermal bridging prevention for critical building details. The house also features a “cool roof” design, where solar panels are racked high above the roof, and the walls are covered with a weather-stopping “skin”. Both of these systems allow airflow, prevent solar gain, and shield the house from the elements for a longer life.

Every system of the house has been optimized for efficiency, while still being sized to meet and exceed all foreseeable demands. The roof collector array was modeled to determine the best balance between solar thermal and solar electric panels, resulting in peak energy density for our target conditions. All electrical loads have been minimized, with circuits and displays configured to allow the user easy knowledge and control over what devices are on. Our mechanical systems were meticulously designed with the most efficient equipment, using

innovative features such as solar thermal radiant cooling, energy recovery ventilation, mechanical cooling, ERV bypass for mild weather, and waste heat recovery, to name a few.

4.0 Beyond the competition – the future of sustainable design

To us, this competition is about more than what happens in October. It is about making a house that we believe truly represents the future of sustainable design, a house that teaches not only us but also the public and industry about what is on the horizon.

Designing for the future is why we have employed radiant cooling even though the contest measurements do not favor it, and why we pursued direct current boost box technology until it was absolutely certain it would not be certified in time.

And of course, sustainability is about more than just energy independence. It is also choosing building materials carefully, minimizing water use, and designing a home which naturally encourages its occupants to be aware of their energy, water, and material use. So we have done our best to meet these high callings as well.

Nearly all our material choices have been evaluated in the broader context of sustainability, taking into account factors such as transportation, embodied energy, toxicity, durability, and reusability.

SCU students have also continued work on the bamboo joists that our team debuted in 2007 and we are excited to be bringing a new version to the competition in 2009. This year's joists are an open-web variety that allows for ductwork, conduit or piping to be easily run, reducing installation time and cost.

Refract House is also water conscious, an increasingly important part of green building, especially in California. It combines minimal water consumption – through low-flow fixtures and equipment, hot water recirculation, and a basin-style bathroom sink – with an irrigation system based on rainwater catchment and repurposed greywater.

Finally, we have designed our house not only to make energy, water, and waste sustainability easy for the homeowner, but to make information about their habits to be readily accessible. Our graphical monitoring system lets users track metrics for all three of these impacts, both in real time and historically. We thus enable the homeowner to actively understand and reduce their impact.

LIGHTING



1.0 Summary

The lighting design implements our architectural intent to tie the movement of the sun to the natural progression the residents would make through the house. We have focused on three things: maximizing the admittance of high quality sunlight, creating a strong spatial connection to the outdoors, and minimizing our electric load through the strategic use of daylight and our intelligent lighting control system.



As the sun moves across the sky, different portions of the home will receive varying levels of natural light. The program and design of each module is specific to the time and intensity of this exposure. For example, the bedroom is located at the east side of the home in order to receive light from the morning sun. Openings in the southern façade permit the entry of considerable light into the kitchen throughout the day, while providing indirect light to adjacent spaces. Late in the day, as the sun sinks towards the west, residents in the living room might catch a view of the sunset.

Spatially and functionally, the house seeks to create a strong connection between the indoor and outdoor environments.

2.0 Daylighting

We have taken advantage of the southerly orientation of the house and the amount of daylight that this provides. Our use of glazing on the end caps, glass doors, and clerestory along the northern and eastern walls allows in enough sunlight to nearly eliminate the need for electric lighting during the day. Mechanically operated louvers on the end caps and southern doors allow the residents to control the admission of daylight and heat with the changing seasons.



3.0 Indoor Electric Lighting

When designing our electric lighting plan, we considered how light affects the way people perceive and engage a space. To create a comfortable, domestic atmosphere we have used cove lights that wash the upper walls and ceiling with warm white light, and follow the clerestory band around the house. Supplementing the cove light are cool-temperature recessed cans for general-purpose lighting. Through even, ambient, and integrated illumination, electric light in our design guides residents through the house as one long, spacious form – much like the sun does during the day.

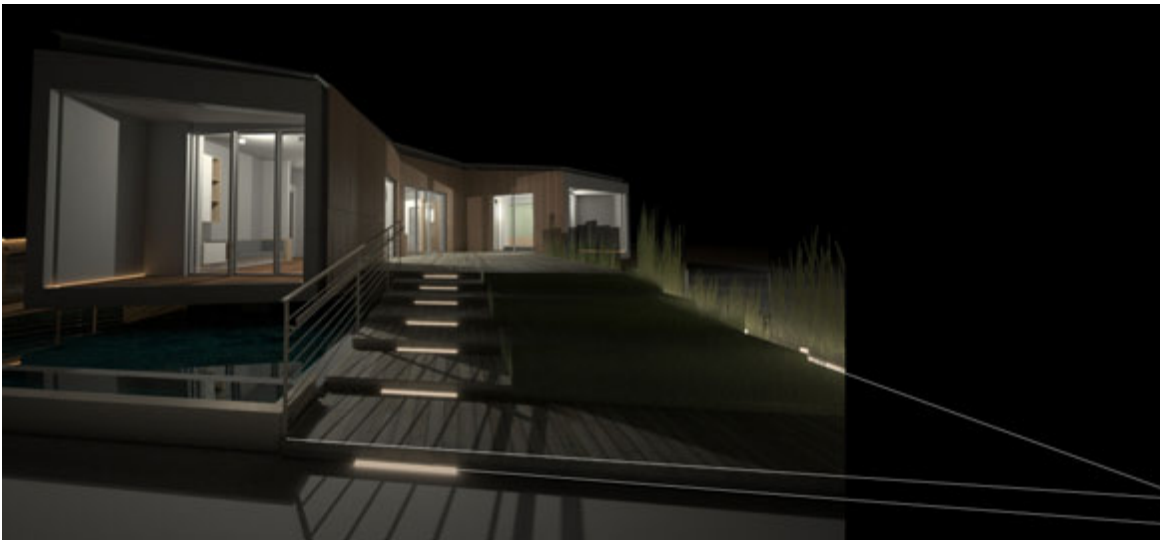


We have opted for LED lighting in nearly all of our fixtures. Their low energy consumption and extremely long life makes them an attractive energy-saving component of the house. Additionally, their mercury-free construction and our concern about the proper disposal of CFLs has guided our choices. Ultimately, we believe that LED technology is the healthier, sustainable future of electric lighting and thus we have chosen to showcase it in Refract House's lighting design.

We have created a layered lighting design by combining fixtures, temperatures, and daylight conditions. This allows users to control the illumination and ambiance of the room for a wide variety of moods and functions. The lighting control system gives the resident total flexibility in lighting the space. It allows for both individual fixture adjustment as well as house-wide or area-specific lighting control. Lights can be dimmed or turned on or off as needed through LED panels and two-way switches located in each of the three modules. Residents have the option of remotely changing the lighting through an iPhone application specifically developed for Refract House. This makes the Refract House a “smart house” but it also makes the residents smart consumers; having the ability to easily access and modify the lighting will ultimately help reduce energy consumption due to lighting throughout the year.

4.0 Outdoor Lighting

At night, light will pour out from the doors, clerestory windows, and cantilevered ends, illuminating the deck and surrounding landscape. The balcony walls are subtly uplit, providing just enough light for residents to relax overlooking the pool and landscape. To mark the entry points on the north and west sides, we have designed a custom fixture that replaces a vertical section of the rainscreen with a paraffin diffuser encasing LEDs. We will use self-contained photovoltaic lights for accent lighting along the ramp and deck areas. These lights use the



latest in solar cell and EDLC ultracapacitor technology, which means lower energy consumption, safer walking spaces, and minimal maintenance for residents. Due to competition regulations, we will use a conventional battery version that requires replacement every 3-4 years, though the ultracapacitor units last as long as 10 years.

5.0 Conclusion

Team California goes beyond the idea of a traditional modular home to fully integrate Refract House—and the life of its residents—into its environment. The balance of daylight and LED-based electric lighting reduces energy consumption and further blurs the distinction between the home’s interior and its surrounding environment. Through our controls and monitoring system, we give users the information they need to make smart decisions and to fully control the energy they are using to light their home. The lighting design, like the rest of the house, is an expression of the progressive Californian spirit that continues to lead the nation towards a more sustainable energy future.