Project Name:	**CASH – Caribbean Affordable Solar House**
	Team Puerto Rico
	University of Puerto Rico
	2009 Solar Decathlon Competition
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Deliverable Date:	**Updated May 31, 2009**

CASH
CARIBBEAN AFFORDABLE SOLAR HOUSE

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SUMMARY OF CHANGES

All parts of the Project Manual Document and the Construction Drawings Documents must be reviewed.

Changes have been performed to all parts of both documents from its last vesion of April 16, 2009.

This new version has been summited on June 2, 2009.

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	O-101 To O-106	
4-2	Construction Equipment	Specs for heavy machinery	O-101,O-601 To O-604	
4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	C-103 S-101 to S-102 S-501	
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	C-103 S-101 to S-102 S-501	
4-5	Generators	Specifications for generators	See Construction Specs. Section 481100	
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	See Construction Specs. Section 481100	
4-6	Spill Containment	Specifications for all equipment, tanks, and pipes that will contain fluids at any point during the event	See Construction Specs. Section 481100	
4-7	Lot Conditions	Calculations showing that structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	See Project Manual Section : Structural Calculation	
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	C-103 A-203 to A-204 A-301	
5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	A-201 A-202	
5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	Not applicable See A-201 to A-202	

Rule #	Rule Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
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	See Project Manual Section: Structural Calculation S-001, S-101, S-102, S-103, S-104, S-105, S-201, S-202, S-203, S-301, S-501, S-502, S-503, S-504, S-505, S-506, S-701, S-702, S-703, S-704,S-705	
6-2	Maximum Architectural Footprint	Drawing(s) showing all information needed by the Rules Officials to measure the architectural footprint electronically	A-602	
6-2	Maximum Architectural Footprint	Drawing(s) showing all movable components that may increase the footprint if operated during contest week	Not applicable	
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)	Not applicable	
6-3	Minimum Conditioned Space	Drawing(s) showing space conditioning means in primary living spaces	A-602 A-603	
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	C-102 X-601	
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	A-103	
7-2	Watering Restrictions	Drawings showing the layout and operation of greywater irrigation systems	Not applicable	

Rule #	Rule Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
8-1	PV Technology Limitations	Specifications for photovoltaic components	See Construction Specs. Section 263100 A-107 to A-108, E-106, E-601, E-602	
8-1	PV Technology Limitations	Retail price quote for photovoltaic components	See Project Manual Section: PV Prices Quotes	
8-3	Thermal Energy Storage	Drawing(s) showing the location of thermal energy storage components	Not applicable	
8-3	Thermal Energy Storage	Specifications for thermal energy storage components	Not applicable	
8-3	Thermal Energy Storage	Shading calculations and/or diagrams for thermal energy storage components (if necessary)	Not applicable	
8-4	Batteries	Drawing(s) showing the location(s) and quantity of stand-alone, PV-powered devices	Not applicable	
8-4	Batteries	Specifications for all stand-alone, PV-powered devices	Not applicable	
8-5	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	Not applicable	
8-5	Desiccant Systems	Specifications for desiccant system components	Not applicable	
8-6	Village Grid	Completed Interconnection Application form.	See Project Manual Section: Interconnection Application form	
8-6	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	E-001,E-101,E-104, E-106	
8-6	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	See Construction Specs. Section 263100, 260526 E-001, E-101, E-104, E-106	
8-6	Village Grid	One-line electrical diagram	E-602	
8-6	Village Grid	Calculation of service/feeder net computed load per NEC 220	See Project Manual Section: Interconnection Application form E-001, E-602	

Rule #	Rule Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
8-6	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box	C-102 E-101	
8-6	Village Grid	Elevation(s) showing the terminal box, meter housing, main utility disconnect, and other service equipment	E-101 E-601 E-602	
9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems	A-106 P-905	
9-6	Thermal Mass	Drawing(s) showing the locations of water-based thermal mass systems	Not applicable	
9-6	Thermal Mass	Specifications for components of water-based thermal mass systems	Not applicable	
10-2	Event Sponsor Recognition	Drawing(s) showing the dimensions, materials, artwork, and content of all communications materials, including signage	See Communications Plan X-603 X-602	
10-3	Team Sponsor Recognition	Drawing(s) showing the dimensions, materials, artwork, and content of all communications materials, including signage	See Communications Plan	
11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route	X-101 X-601	
11-4	Public Exhibit	Drawing(s) showing the dimensions, materials, artwork, and content of the handout	See Communications Plan	
11-4	Public Exhibit	Drawing(s) showing the artwork and content of the team uniform	See Project Manual Section: Team Uniform	

Code Section	Code Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
3-1	Fire Protection and Prevention	a. Fire Protection Plan b. Smoke alarms per IRC requirements and fire extinguisher with a minimum UL rating of 2A-10BC. (IRC, Sec. R313)	E-105	D4
3-2	Means of Egress	a. Stairs (IBC, Sec. 1009.3 and IRC, Sec. R311.5) b. Handrails (IBC, 1009.11)	A-408 A-409	
3-3	Interior Finishes	Interior finishes must comply with IRC Section R315	A-601	
3-4	Glazing	IRC Section 308 Hazardous locations are subject to human impact and require safety glazing	A-605	
3-5	Roofing	Provide details on the proposed roofing system. All roofing materials shall comply with IRC Chapter 9	A-501 - , A-507	
3-6	Foam Plastic	Foam plastics for building construction. Must comply with IRC Section R314	A-501 - , A-507	
3-7	Exterior Envelope	Provide section detail of proposed wall assembly. Shall comply with IRC Section R703	A-501 - , A-507	
3-8	Ceiling Height	Ceiling height shall provide a minimum of 7 ft. of headroom. Shall comply with IRC Section R305	A-303	C5, D3
4-1	Accessible Route – Interior	To all spaces available to the public, shall be accessible in accordance with 2006 IBC Chapter 11 and ICC/ANSI A117.1-2003	X-601	C6
4-3	Accessibility - Ramps	A landing 60 in. long is required. Handrails are required. Shall comply with ADAAG Section 4.8 and ANSI A117.1-2003 Section 405	A-601	C6, E6
4-4	Changes in Elevation	To be considered along an accessible route.	A-502 A-504 A-505 A-507	D6 D6 D6 D5
4-5	Doors and Door Approaches	All doors shall comply with ADAAG Section 4.13 and ANSI A117.1-2003 Section 404	A-605	

Code Section	Code Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
5-1	Prescriptive Requirements	Structural systems shall be designed in accordance with the IRC Section CC2.6. Complete drawings of the structural framing shall be done. Hangers and other mechanical connections shall be provided in accordance with the IRC Section 301.1.	S-101 – S-705	
5-2	Design Loads	Minimum loads are used in the structural design for wind, railings, interior floor, decks, ramps, roof, soil… Structural plans indicate the design loads and the locations, size, and weight of special loads.	S-001 Project Manual (Structural Calculations)	
5-3	Exterior Construction	Structural plans include design details for the deck, stairs and ramps in accordance with the IRC Section 301.1.	S-101, S-103, S-701 – S-705	
5-4	Specific Point Loads	Calculations are provided for point-load connections demonstrating the ability to withstand 60-mph winds. Details are provided for connection details of all solar panel connections demonstrating their ability to resist uplift in accordance with the IRC Section R301.1	S-501	F8
5-5	Foundation	Foundation plan for temporary setup on the competition site is provided, including all details on pad footings and tie-down anchors according to the IRC Section R401.1 and R401.2	S-101, S-102, S-501	
5-6	Alternate Materials		Not applicable	
5-7	Structural Steel	Structural details for steel assemblies are provided, including welded or bolted connections within the assembly in accordance with IRC Section R301.1.3	S-502 -, S-506 E-102, E-601	

Code Section	Code Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
6-2	Electrical Drawing Requirements	a. Electrical plans include layouts of all fixtures. b. Details are provided for the proposed PV system according to the IRC Section R106.1.1 c. Key for electrical symbols provided in accordance to IRC Section R106.1.1	E-102 - E-106, E-201, E-202	
6-3	Tamper-Resistant Receptacles	In all areas specified in NEC Article 210.52, all 125-volt, 15 and 20-ampere receptacles shall be listed tamper-resistant receptacles.	E-104	
6-4	Outdoor Receptacles	Receptacles used on the exterior of the building are protected with GFCI. Enclosures must be suitable for damp locations in accordance with IRC Section E3802.3	E-104	
6-5	Arc-Fault Circuit Protection	AFCI are code compliant with NEC, NFC and all local ordinances with jurisdiction.		
6-6	Ground-Fault Circuit Protection	AC receptacles in the kitchen and bathroom shall be GFCI protected in accordance to IRC Section 3802.1 and 3802.6	E-601 E-602	A8 B4
6-7	Equipment Listings	Electrical equipment shall carry an approved testing agency's listing or shall have been approved by the Solar Decathlon building official and Solar Decathlon electrical inspectors for temporary use on the National Mall during the event in accordance with Section 104.11 of the IRC and Section 110.2 of the NEC or Section E3303.3 of the IRC		
6-8	Photovoltaics	In accordance with Articles 690, 480, 445, 250, 310, 400, and 240 of the NEC	E-106 E-601 – E-602	
7-1	Mechanical Drawing Requirements	Key for symbols provided in accordance to the IRC Section R106.1.1		

Code Section	Code Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
7-2	Return Air	Return air shall not be taken from a bathroom, kitchen, mechanical, or furnace rooms. It shall not be taken where there is presence of flammable vapors in accordance to the IRC Section M1602.2 Items 2 and 4	M-101 M-601	D3 C4
7-3	Outside Air	a. Outside air shall comply with IRC Section M1602.2.3 b. Screens shall comply with IRC Section M1602.3	M-601	D2
7-4	Bathroom Ventilation	Bathrooms shall be provided with mechanical ventilation systems in accordance with IRC Section R303.3	M-601	C7
8-1	Solar Mechanical Drawing Requirements	Plan details are provided for the solar mechanical system. Must comply with IRC Section 106.1.1	E-106 P-104	
8-2	Cross Connection	Details for the solar hot-water system are provided in compliance with IRC Section R106.1.1	P-104 P-904	
8-3	Access	Solar collectors, controls, dampers, fans, and pumps shall be accessible for inspection, maintenance, repair, and replacement in compliance with IRC Section M2301.2.1	A-301 E-106	
8-4	Roof-Mounted Collectors	The roof shall be constructed to support all loads imposed by the collectors in compliance with IRC Section M2301.2.2	A-501 A-504	
8-5	Pressure and Temperature Relief	Pressure- and temperature-relief valves shall be provided for components under pressure in compliance with IRC Section M2301.2.3	Construction Specifications 26 31 00	
8-6	Vacuum Relief	Shall protect system components that might be subject to pressure drops below atmospheric pressure during operation or shutdown.	Construction Specifications 26 31 00	
8-7	Expansion Tanks	In solar systems, in accordance with IRC, Section M2301	Construction Specifications 26 31 00	

Code Section	Code Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
8-8	Solar Loop Isolation	Valves shall be installed to allow isolation of the solar collectors from the remainder of the system in compliance with IRC Section M2301.2.8	Construction Specifications 26 31 00	
8-9	Maximum Temperature Limitation	System shall be equipped with means to limit the maximum water temperature of the system fluid in compliance with IRC Section M2301.2.9	P-904	
8-10	Collector and Thermal Storage Unit Labeling	Collectors and storage units shall be listed and labeled in compliance with IRC Section 2301.3		
8-11	Prohibited Heat-Transfer Media	Flammable gasses and liquids shall not be used as heat transfer-fluids in compliance with IRC Section M2301.4	Not applicable	
8-12	Backflow Prevention	All connections from the potable water supply to solar systems shall comply with IRC Section P2902.4.5	P-001 – P-003	
8-13	Pressure Test	All solar hydronic piping shall be tested hydrostically	P-001	
9-1	Plumbing Drawing Requirements	a. Labeled isometric diagram of the proposed plumbing system is provided b. Key for symbols are provided	P-901 – P-905	
9-2	Water Closet Demonstration	Water closets are installed for demonstration only and shall not be connected to any portion of the sewage disposal system	P-105	D4
9-3	Plumbing Wall-Structural	Create a dedicated plumbing wall	A-508 P-101 – P-105	E5
9-4	Shower Mixing Valves	Shower mixing valves shall be pressure balanced, thermostatic mixing, or a combination of the two in accordance to the IRC Section P2802.3 and P2708.3	See Plumbing Specifications	
9-5	Backflow Prevention	Backflow prevention is required to isolate the potable water supply from the solar systems in accordance with the IRC Section P2902.2		

Code Section	Code Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
9-6	Supply	No additive of any kind may be added to the water in the team's supply tank. This water is not for consumption at any time. Teams will be required to provide the tank and support this tank so that it does not damage the competition site turf.	A-411	
9-7	Waste	All substances used in combination with water to clean the house, dishes, utensils, etc., must be nontoxic and preferably biodegradable.		
9-8	Water Feature Safety	a. Water features shall not exceed a depth of 2 ft. b. There shall be a representative from the team positioned at the water feature when open to the public to monitor the area and act as a lifeguard if necessary. During times when the area is not open to the public, the water feature shall be covered or guarded in a manner to prevent access. c. To ensure a safe access, a 44 in. accessible surface shall be maintained all around the water feature.	Not applicable	
10-1	Thermal Storage	All thermal storage devices ("mass") must be made of stable, nontoxic materials.	Not applicable	
10-2	Paint Disposal	Teams are not permitted to dispose of paint on the competition site.		
10-3	MSDS	MSDS are required for all potentially hazardous materials to be used at the event, such as cleaning solvent, glycol, rubber cement, rubbing alcohol, etc.		
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SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. References.

B. Quality assurance.

C. Format.

D. Schedules.

E. Submittals.

F. Review and evaluation.

G. Updating schedules.

H. Distribution.

1.2 REFERENCES

A. AGC's "The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry".

1.3 QUALITY ASSURANCE

A. Scheduler: Specialist Consultant specializing in CPM scheduling with Architectural Students in a Project Management Elective Course. Specialist Consultant specializing in CPM, have two years minimum experience in scheduling construction work of complexity comparable to this Project, and having use of computer facilities capable of delivering detailed graphic printout.

B. Contractor's Administrative Personnel: Project Management Elective Course and experience in using and monitoring CPM schedules on comparable projects is required.

1.4 FORMAT

A. Listings: Reading from left to right, in ascending order for each activity. Identify each activity with applicable specification section number.

B. Diagram Sheet Size: 11 inches (279.4 mm) high x 17 inches (431.8 mm) wide.

C. Scale and Spacing: To allow for notations and revisions.

1.5 SCHEDULES

A. Prepare network analysis diagrams and supporting mathematical analyses using Critical Path Method, under concepts and methods outlined in AGC's "The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry".

B. Illustrate order and interdependence of activities and sequence of work; how start of given activity depends on completion of preceding activities, and how completion of activity may restrain start of subsequent activities.

C. Illustrate complete sequence of construction by activity, identifying work of separate stages. Indicate dates for procurement and delivery of critical products; and dates for installation and provision for testing. Include legend for symbols and abbreviations used.

D. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
1. Preceding and following event numbers.
2. Activity description.
3. Estimated duration of activity, in maximum 150 day intervals.
4. Earliest start date.
5. Earliest finish date.
6. Actual start date.
7. Actual finish date.
8. Latest start date.
9. Latest finish date.
10. Total and free float; accrue float time to Owner and to Owner's benefit.
11. Percentage of activity completed.
12. Responsibility.

E. Analysis Program: Capable of accepting revised completion dates, and recomputation of scheduled dates and float.

F. Required Sorts: List activities in sorts or groups:
1. By preceding work item or event number from lowest to highest.
2. By longest float, then in order of early start.
3. By responsibility in order of earliest possible start date.

4. In order of latest allowable start dates.
5. In order of latest allowable finish dates.
6. Contractor's periodic payment request sorted by specifications sections.
7. Listing of basic input data generating report.
8. Listing of activities on critical path.

G. Prepare sub-schedules for each stage of Work.

H. Coordinate contents with schedule of values in Section 01 33 00 - Submittal Procedures.

1.6 SUBMITTALS

A. Within 10 days after date established in Notice to Proceed, submit proposed preliminary network diagram defining planned operations for first 60 days of Work, with general outline for remainder of Work.

B. Participate in review of preliminary and complete network diagrams jointly with Architect/Engineer and Students.

C. Within 20 days after joint review of proposed preliminary network diagram, submit draft of proposed complete network diagram for review. Include written certification that mechanical and electrical Subcontractors have reviewed and accepted proposed schedule.

D. Within 10 days after joint review, submit complete network analysis consisting of network diagrams and mathematical analysis.

E. Submit updated network schedules 15 days.

F. Submit number of opaque reproductions Contractor requires, plus two copies Architect/Engineer will retain.

1.7 REVIEW AND EVALUATION

A. Participate in joint review and evaluation of network diagrams and analysis with Architect/Engineer and Students at each submittal.

B. Evaluate project status to determine work behind schedule and work ahead of schedule.

C. After review, revise network diagrams and analysis incorporating results of review, and resubmit within 10 days.

1.8 UPDATING SCHEDULES

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity. Update diagrams to graphically depict current status of Work.

C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

D. Indicate changes required to maintain Date of Total Completion.

E. Submit sorts required to support recommended changes.

F. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect including effects of changes on schedules of separate contractors.

1.9 DISTRIBUTION

A. Following joint review, distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, Architect/Engineer, and other concerned parties.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures.

B. Construction progress schedules.

C. Proposed products list.

D. Product data.

E. Shop drawings.

F. Samples.

G. Design data.

H. Test reports.

I. Certificates.

J. Manufacturer's instructions.

K. Erection drawings.

L. Construction photographs.

1.2 SUBMITTAL PROCEDURES

A. Transmit each submittal with AIA Form G810.

B. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.

C. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.

D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.

E. Schedule submittals to expedite Project, and deliver to Architect/Engineer. Coordinate submission of related items.

F. For each submittal for review, allow 15 days excluding delivery time to and from Contractor.

G. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed work.

H. When revised for resubmission, identify changes made since previous submission.

I. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

J. Submittals not requested will not be recognized or processed.

1.3 CONSTRUCTION PROGRESS SCHEDULES

A. Submit preliminary outline Schedules within 15 days after date established in Notice to Proceed for coordination with work of separate contracts. After review, submit detailed schedules within 15 days modified to accommodate revisions recommended by Architect/Engineer.

B. Submit revised Progress Schedules with each Application for Payment.

C. Distribute copies of reviewed schedules to Project site file, subcontractors, suppliers, and other concerned parties.

D. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

E. Submit computer generated horizontal bar chart with separate line for each section of Work, identifying first work day of each week.

F. Utilize Section 01 32 16 when critical path method analysis is required.

1.4 PROPOSED PRODUCTS LIST

A. Within 15 days after date of notice to proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.5 PRODUCT DATA

A. Product Data: Submit to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Submit number of copies Contractor requires, plus two copies Architect/Engineer will retain.

C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.6 SHOP DRAWINGS

A. Shop Drawings: Submit to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. When required by individual specification sections, provide shop drawings signed and sealed by professional engineer responsible for designing components shown on shop drawings.
   1. Include signed and sealed calculations to support design.
   2. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
   3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. Submit in form of one reproducible transparency and one opaque reproduction.

1.7 SAMPLES

A. Samples: Submit to Architect/Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Samples For Selection as Specified in Product Sections:
   1. Submit to Architect/Engineer for aesthetic, color, or finish selection.
   2. Submit samples of finishes from full range of manufacturers' standard colors, and in custom colors selected, textures, and patterns for Architect/Engineer selection.

C. Submit samples to illustrate functional and aesthetic characteristics of Products, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

D. Include identification on each sample, with full Project information.

E. Submit number of samples specified in individual specification sections; Architect/Engineer will retain one sample.

F. Reviewed samples which may be used in the Work are indicated in individual specification sections.

1.8 DESIGN DATA

A. Submit for Architect/Engineer's knowledge as contract administrator or for Owner.

B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.9 TEST REPORTS

A. Submit for Architect/Engineer's knowledge as contract administrator or for Owner.

B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.10 CERTIFICATES

A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to Architect/Engineer, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Architect/Engineer.

1.11 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Architect/Engineer for delivery to Owner in quantities specified for Product Data.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.12 MANUFACTURER'S FIELD REPORTS

A. Submit reports for Architect/Engineer's benefit as contract administrator or for Owner.

B. Submit report in duplicate within 5 of observation to Architect/Engineer for information.

C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.13 ERECTION DRAWINGS

A. Submit drawings for Architect/Engineer's benefit as contract administrator or for Owner.

B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

C. Data indicating inappropriate or unacceptable Work may be subject to action by Architect/Engineer or Owner.

1.14 CONSTRUCTION PHOTOGRAPHS

A. Provide photographs of site and construction throughout progress of Work produced by an experienced photographer, acceptable to Architect/Engineer.

B. Take site photographs from differing directions and interior photographs of indicating relative progress of the Work.

C. Take photographs as evidence of existing project conditions as follows:
1. Interior views.
2. Exterior views.

D. Identify each print on back. Identify name of Project, phase orientation of view, date and time of view, name and address of photographer, and photographer's numbered identification of exposure.

E. Deliver negatives to Owner with project record documents. Catalog and index negatives in chronological sequence; include typed table of contents.

PRODUCTS - Not Used

EXECUTION - Not Used

END OF SECTION

SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality control and control of installation.

B. Tolerances.

C. References.

D. Testing and inspection services.

E. Manufacturers' field services.

F. Examination.

G. Preparation.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. When manufacturers' instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.3 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Obtain copies of standards where required by product specification sections.

C. When specified reference standards conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

D. Neither contractual relationships, duties, nor responsibilities of parties in Contract nor those of Architect/Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.5 TESTING AND INSPECTION SERVICES

A. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing as required by Architect/Engineer or Owner.

B. Reports will be submitted to Architect/Engineer, Contractor, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
   1. Submit final report indicating correction of Work previously reported as non-compliant.

C. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same students on instructions by Architect/Engineer.

1.6 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment and as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify utility services are available, of correct characteristics, and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities:
1. Temporary electricity.
2. Temporary lighting for construction purposes.
3. Telephone service.
4. Temporary water service.
5. Temporary sanitary facilities.

B. Construction Facilities:
1. Field Offices and Sheds.
2. Vehicular access.
3. Parking.
4. Progress cleaning and waste removal.
5. Project identification.
6. Traffic regulation.
7. Fire prevention facilities.

C. Temporary Controls:
1. Barriers.
2. Enclosures and fencing.
3. Security.
4. Water control.
5. Dust control.
6. Noise control.
7. Pollution control.

D. Removal of utilities, facilities, and controls.

1.2 TEMPORARY ELECTRICITY

A. Provide temporary electric feeder from existing building electrical service at location as directed by Architect/Engineer.

B. Complement existing power service capacity and characteristics as required for construction operations.

C. Provide power outlets, with branch wiring and distribution boxes located as required for construction operations. Provide flexible power cords as required for portable construction tools and equipment.

D. Provide feeder switch at source distribution equipment at convenient location.

E. Permanent convenience receptacles may be utilized during construction.

1.3 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain fluorescent lighting for construction operations.

B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps for specified lighting levels.

C. Maintain lighting and provide routine repairs.

D. Permanent building lighting may be utilized during construction.

1.4 TELEPHONE SERVICE

A. Provide, maintain, and pay for telephone service to field office at time of project mobilization.

1.5 TEMPORARY WATER SERVICE

A. Provide suitable quality water service as needed to maintain specified conditions for construction operations. Connect to existing water source.

1.6 TEMPORARY SANITARY FACILITIES

A. Existing permanent facilities located at construction site may be used during construction operations. Maintain daily in clean and sanitary condition.

B. At end of construction, return existing facilities used for construction operations to same or better condition as original condition.

1.7 FIELD OFFICES AND SHEDS

A. Designated existing spaces may be used for field offices and for storage.

B. Office: Weather tight, with lighting, electrical outlets, heating, cooling and ventilating equipment, and equipped with sturdy furniture and drawing display table.

C. Provide space for Project meetings, with table and chairs to accommodate 6 persons.

D. Provide separate work station, similarly equipped and furnished, for use of Architect/Engineer, and students.

E. Locate offices and sheds minimum distance of 30 feet (10 m) from existing structures.

F. When permanent facilities are enclosed with operable utilities, relocate offices and storage into building, with written agreement of Owner, and remove temporary buildings.

G. Environmental Control:
   1. Storage Spaces: Heating and ventilation as needed to maintain products in accordance with Contract Documents; lighting for maintenance and inspection of products.

H. Storage Areas And Sheds: Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and for inspection of products to requirements of Section 01 60 00 - Product Requirements.

I. Preparation: Fill and grade sites for temporary structures sloped for drainage away from buildings.

J. Maintenance And Cleaning:
   1. Daily janitorial services for offices; periodic cleaning and maintenance for office and storage areas.
   2. Maintain approach walks free of mud, and water.

K. Removal: At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

1.8 VEHICULAR ACCESS

A. Construct temporary access roads from public thoroughfares to serve construction area, of width and load bearing capacity to accommodate unimpeded traffic for construction purposes.

B. Extend and relocate vehicular access as Work progress requires, provide detours as necessary for unimpeded traffic flow.

C. Location approved by Owner.

D. Provide unimpeded access for emergency vehicles.

E. Provide and maintain access to free of obstructions.

F. Provide means of removing mud from vehicle wheels before entering streets.

G. Use designated existing on-site roads for construction traffic.

1.9 PARKING

A. Provide temporary surface parking areas to accommodate construction personnel.

B. Locate as approved by Owner.

C. When site space is not adequate, provide additional off-site parking.

D. Use of designated existing on-site streets and driveways used for construction traffic is permitted.

E. Use of designated areas of existing parking facilities used by construction personnel is permitted.

F. Permanent Pavements And Parking Facilities:
1. Bases for permanent roads and parking areas may be used for construction traffic.
2. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.
3. Use of permanent parking structures is permitted.

G. Maintenance:
1. Maintain traffic and parking areas in sound condition.
2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

H. Removal, Repair:
1. Repair existing facilities damaged by use, to original condition.

I. Mud From Site Vehicles: Provide means of removing mud from vehicle wheels before entering streets.

1.10 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in clean and orderly condition.

B. Remove debris and rubbish prior to enclosing spaces.

C. Clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and rubbish from site periodically and dispose off-site.

1.11 PROJECT IDENTIFICATION

A. Project Identification Sign:
   1. One or two painted sign, dimensions selected by the architect above ground.
   2. Content:
      a. Project title, logo and name of Owner as indicated on Contract Documents.
      b. Names and titles of authorities.
      c. Names and titles of Architect/Engineer and Consultants.
      d. Name of Prime Contractor.
   3. Graphic Design, Colors, Style of Lettering: Designated by Architect/Engineer.

B. Sign Painter: Experienced as professional sign painter.

C. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.

D. Show content, layout, lettering, color, foundation, structure, sizes, and grades of members.

E. Sign Materials:
   1. Structure and Framing: New or used, structurally adequate.
   2. Sign Surfaces: Exterior grade plywood with medium density overlay, standard large sizes to minimize joints.
   3. Rough Hardware: Galvanized aluminum.
   4. Paint and Primers: Exterior quality, two coats; sign background of color as selected.
   5. Lettering: Exterior quality paint, colors as selected.

F. Installation:
   1. Install project identification sign within 15days after date fixed by notice to proceed.
   2. Erect at designated location.
   3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
   4. Install sign surface plumb and level, with butt joints. Anchor securely.
   5. Paint exposed surfaces of sign, supports, and framing.

G. Maintenance: Maintain signs and supports clean, repair deterioration and damage.

H. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.12 TRAFFIC REGULATION

A. Signs, Signals, And Devices:
   1. Post Mounted and Wall Mounted Traffic Control and Informational Signs: As approved by authority having jurisdiction.
   2. Traffic Control Signals: As approved by local jurisdictions.
   3. Traffic Cones and Drums, Flares and Lights: As approved by authority having jurisdiction.
   4. Flag person Equipment: As required by authority having jurisdiction.

B. Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.

C. Flares and Lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.

D. Haul Routes:
   1. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.

E. Traffic Signs And Signals:
   1. Provide signs at approaches to site and on site, at crossroads, detours, parking areas, and elsewhere as needed to direct construction and affected public traffic.
   2. Provide, operate, and maintain traffic control signals to direct and maintain orderly flow of traffic in areas under Contractor's control, and areas affected by Contractor's operations.
   3. Relocate as Work progresses, to maintain effective traffic control.

F. Removal:
   1. Remove equipment and devices when no longer required.
   2. Repair damage caused by installation.

1.13 FIRE PREVENTION FACILITIES

A. Prohibit smoking with buildings under construction. Designate area on site where smoking is permitted. Provide approved ashtrays in designated smoking areas.

B. Establish fire watch for cutting and welding and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.

C. Portable Fire Extinguishers: NFPA 10; 10 pound capacity, 4A-60B: C UL rating.
   1. Provide minimum one fire extinguisher in every construction trailer and storage shed.
   2. Provide minimum one fire extinguisher in construction site.

1.14 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, and to protect existing facilities and adjacent properties from damage from construction operations.

B. Provide barricades and covered walkways required by authorities having jurisdiction for public rights-of-way.

C. Provide protection for plants designated to remain. Replace damaged plants.

D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.15 ENCLOSURES AND FENCING

A. Temporary Construction: Commercial grade chain link fence.

B. Provide 6 feet (1.8m) high fence around construction site; equip with vehicular and pedestrian gates with locks.

C. Exterior Enclosures:
   1. Provide temporary weather tight closure of exterior openings to accommodate acceptable working conditions and protection for products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.
   2. Provide temporary roofing.

1.16 SECURITY

A. Security Program:
   1. Protect Work from theft, vandalism, and unauthorized entry.
   2. Initiate program in coordination with Owner's existing security system at project mobilization.

3. Maintain program throughout construction period until Owner acceptance precludes need for Contractor security.

B. Entry Control:
1. Restrict entrance of persons and vehicles into Project site and existing facilities.
2. Allow entrance only to authorized persons with proper identification.
3. Maintain log of workers and visitors, make available to Owner on request.
4. Control entrance of persons and vehicles related to Owner's operations.

C. Personnel Identification:
1. Provide identification badge to each person authorized to enter premises.
2. Badge To Include: Personal photograph, name and employer.
3. Maintain list of accredited persons, submit copy to Owner on request.
4. Require return of badges at expiration of their employment on the Work.

D. Security Service:
1. Employ uniformed guard service to provide watchpersons at site during non-working hours twenty four hours a day, seven days a week.

E. Restrictions:

1. Do not allow cameras on site or photographs taken except by written approval of Owner.
2. Do no work on days indicated in Owner-Contractor Agreement.

1.17 WATER CONTROL

A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

B. Protect site from puddling or running water. Provide water barriers as required to protect site.

1.18 DUST CONTROL

A. Execute Work by methods to minimize raising dust from construction operations.

B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

1.19 NOISE CONTROL

A. Provide methods, means, and facilities to minimize noise produced by construction operations.

1.20 PEST CONTROL

A. Provide methods, means, and facilities to prevent pests and insects from entering facility.

1.21 POLLUTION CONTROL

A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

B. Comply with pollution and environmental control requirements of authorities having jurisdiction.

1.22 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion inspection.

B. Clean and repair damage caused by installation or use of temporary work.

C. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Product delivery requirements.

C. Product storage and handling requirements.

D. Product options.

E. Product substitution procedures.

F. Equipment electrical characteristics and components.

1.2 PRODUCTS

A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

1.3 PRODUCT DELIVERY REQUIREMENTS

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products in accordance with manufacturers' instructions.

B. Store with seals and labels intact and legible.

C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

D. For exterior storage of fabricated products, place on sloped supports above ground.

E. Provide off-site storage and protection when site does not permit on-site storage or protection.

F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.

H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.5 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

1.6 PRODUCT SUBSTITUTION PROCEDURES

A. Architect/Engineer will consider requests for Substitutions only within 15days after date established in Notice to Proceed.

B. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that Contractor:
   1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
   2. Will provide same warranty for Substitution as for specified product.

3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension which may subsequently become apparent.
5. Will reimburse Owner and Architect/Engineer for review or redesign services associated with re-approval by authorities having jurisdiction.

E. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to Contract Documents.

F. Substitution Submittal Procedure:

1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
3. Architect/Engineer will notify Contractor in writing of decision to accept or reject request.

PART 2 PRODUCTS

2.1 EQUIPMENT ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Include lugs for terminal box.

B. Cord and Plug: Furnish minimum 6 foot (2 m) cord and plug including grounding connector for connection to electric wiring system. Cord of longer length is specified in individual specification sections.

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures.

B. Final cleaning.

C. Starting of systems.

D. Demonstration and instructions.

E. Testing, adjusting and balancing.

F. Protecting installed construction.

G. Project record documents.

H. Operation and maintenance data.

I. Manual for materials and finishes.

J. Manual for equipment and systems.

K. Spare parts and maintenance products.

L. Product warranties and product bonds.

M. Maintenance service.

1.2 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect/Engineer's review.

B. Provide submittals to Owner required by authorities having jurisdiction.

1.3 FINAL CLEANING

A. Execute final cleaning prior to final project assessment.

B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.

D. Clean or Replace filters of operating equipment.

E. Clean debris from roofs, gutters, downspouts, and drainage systems.

F. Clean site; sweep paved areas, rake clean landscaped surfaces.

G. Remove waste and surplus materials, rubbish, and construction facilities from site.

1.4 STARTING OF SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Architect/Engineer seven days prior to start-up of each item.

C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable Contractors' personnel in accordance with manufacturers' instructions.

G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

1.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Owner's personnel two week prior to date of final inspection.

B. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

C. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

D. Required instruction time for each item of equipment and system is specified in individual sections.

1.6 TESTING, ADJUSTING AND BALANCING

A. Owner will appoint, employ, and pay for services of independent firm to perform testing, adjusting, and balancing.

B. Independent firm will perform services specified in Division 23.

C. Reports will be submitted by independent firm to Architect/Engineer indicating observations and results of tests and indicating compliance or non-compliance with requirements of Contract Documents.

1.7 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual specification sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

1.8 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, Product Data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract drawings.

G. Submit documents to Architect/Engineer.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit data bound in 8-1/2 x 11 inch binders with durable plastic covers.

B. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project.

C. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

D. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

E. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
   1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.
   2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
      a. Significant design criteria.
      b. List of equipment.
      c. Parts list for each component.
      d. Operating instructions.
      e. Maintenance instructions for equipment and systems.

f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

3. Part 3: Project documents and certificates, including the following:
   a. Shop drawings and product data.
   b. Air and water balance reports.
   c. Certificates.
   d. Copies of warranties.

1.10 MANUAL FOR MATERIALS AND FINISHES

A. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

B. Submit one copy of completed volumes. Draft copy be reviewed and returned after final inspection, with Architect/Engineer comments. Revise content of document sets as required prior to final submission.

C. Submit two sets of revised final volumes in final form after final inspection.

D. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations.

E. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

F. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.

G. Additional Requirements: As specified in individual product specification sections.

H. Include listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

1.11 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect/Engineer will review draft and return one copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents.

C. Submit one copy of completed volumes. Draft copy be reviewed and returned after final inspection, with Architect/Engineer comments. Revise content of document sets as required prior to final submission.

D. Submit two sets of revised final volumes in final form after final inspection.

E. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

F. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications.

G. Include color coded wiring diagrams as installed.

H. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions.

I. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

J. Include servicing and lubrication schedule, and list of lubricants required.

K. Include manufacturer's printed operation and maintenance instructions, and sequence of operation by controls manufacturer.

L. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

M. Include control diagrams by controls manufacturer as installed.

N. Include Contractor's coordination drawings, with color coded piping diagrams as installed.

O. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

P. Include test and balancing reports as specified in Section 01 40 00 - Quality Requirements.

Q. Additional Requirements: As specified in individual product specification sections.

R. Include listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

1.12 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.

B. Deliver to Project site and place in location as directed by Construction Manager.

1.13 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers.

B. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.

C. Verify documents are in proper form, contain full information.

D. Include Table of Contents and assemble in three D side ring binder with durable plastic cover.

1.14 MAINTENANCE SERVICE

A. Furnish service and maintenance of components indicated in specification sections.

B. Examine system components at frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by manufacturer of original component.

D. Do not assign or transfer maintenance service to agent or Subcontractor without prior written consent of Owner.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

DOCUMENT 00 01 10

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END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes structural steel.

1.2 REFERENCES

A. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

B. ASTM A 6 (ASTM A 6M) "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."

C. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel."

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. In addition to Product Data and mill test reports on structural steel and bolts, submit Shop Drawings detailing fabrication of structural steel components, including connections, splices, holes, welds, and bolts.

C. Include Shop Drawings signed and sealed by a professional engineer responsible for their preparation who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing structural steel engineering services.

1.4 QUALIFICATIONS

A. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 STRUCTURAL PERFORMANCE:

A. Engineer structural steel connections required by the Contract Documents to be selected or completed by the fabricator to withstand design loadings indicated.

1.6 ENGINEERING RESPONSIBILITY:

A. Engage a fabricator who utilizes a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for structural steel connections.

1.7 DELIVERY, STORAGE, AND HANDLING:

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

B. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

A. Structural Steel Shapes, Plates, and Bars: ASTM A 572 (ASTM A 572M), Grade 50, high-strength, low-alloy columbium-vanadium steel.

B. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B.

2.2 OTHER MATERIALS

A. Nonhigh-Strength Bolts, Nuts, and Washers (FOR ANCHOR BOLTS): ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel, hex-head bolts; carbon-steel nuts; and flat, unhardened steel washers, uncoated.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers, uncoated.

C. Primer: SSPC-Paint 25; red iron oxide, zinc oxide, raw linseed oil and alkyd primer.

D. Nonmetallic, Shrinkage-Resistant Grout: Premixed, ASTM C 1107, of consistency suitable for application.

2.3 FABRICATION

A. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.

B. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.

C. Shop install and tighten nonhigh-strength bolts, except where high-strength bolts are indicated.

D. Shop install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.

F. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

2.4 PREPARATION

A. Shop Priming: Shop prime steel, except surfaces embedded in concrete or mortar, surfaces to be field welded, surfaces to be high-strength bolted with slip-critical connections, and surfaces to receive sprayed-on fireproofing.

B. Surface Preparation: SSPC-SP 6 "Commercial Blast Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

D. Priming: Apply a 1-coat, nonasphaltic primer complying with SSPC's "Painting System Guide No. 7.00" to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

PART 3 EXECUTION

3.1 INSTALLATION

A. Erect structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.

B. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing

plates. Clean bottom surface of base and bearing plates and set on wedges, shims, or setting nuts as required.

C. Tighten anchor bolts, cut off wedges or shims flush with edge of base or bearing plate, and pack grout solidly between bearing surfaces and plates.

D. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

E. Install and tighten nonhigh-strength bolts, except where high-strength bolts are indicated.

F. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

G. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.

H. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

I. Shop and Field Quality Control: Owner will engage an independent testing and inspecting agency to perform shop and field inspections and tests and to prepare test reports.

J. All butt welds shall be 100% tested in accordance with AWS D1.1 Part C, Ultrasonic Testing of Groove Welds, Chapter 6, Part C.

K. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.

L. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

M. High-strength bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

N. In addition to visual inspection, welded connections will be inspected and tested according to AWS D1.1 procedures.

END OF SECTION

SECTION 05 52 00

METAL RAILINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes field-fabricated galvanized steel railings, fittings and handrails.

1.2 REFERENCES

A. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
4. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
5. ASTM A513 - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
6. ASTM B177 - Standard Guide for Chromium Electroplating on Steel for Engineering Use.
7. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.

B. National Ornamental & Miscellaneous Metals Association:
1. NOMMA Guideline 1 - Joint Finishes.

C. SSPC: The Society for Protective Coatings:
1. SSPC - Steel Structures Painting Manual.
2. SSPC Paint 15 - Steel Joist Shop Paint.
3. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).

1.3 DESIGN REQUIREMENTS

A. Design handrail, guardrail, and attachments to resist forces as required by applicable codes. Apply loads non-simultaneously to produce maximum stresses.
1. Guard Top Rail and Handrail Concentrated Load: 200 pounds (0.89 kN) applied at any point in any direction.
2. Guard Top Rail Uniform Load: 50 plf (0.73 kN/m) applied in any direction.
3. Intermediate Rails, Panels, and Baluster Concentrated Load: 50 pounds (0.22 kN) applied to 1 sf (300 sq mm) area.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

1.5 QUALITY ASSURANCE

A. Finish joints in accordance with NOMMA Guideline 1.

B. Perform Work in accordance with applicable standards.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

(Materials and requirements noted below will apply, unless otherwise specified on plans. See Architectural and Structural drawings notes to verify which of the listed materials below shall be used.)

2.1 HANDRAILS AND RAILINGS

A. Manufacturers:
1. Substitutions: Section 01 60 00 - Product Requirements.

2.2 STEEL RAILING SYSTEM COMPONENTS

A. Tubing: ASTM A513, Type 5, minimum 50 ksi yield strength.

B. Hollow Structural Sections: ASTM A500, Grade B. ASTM A501.

C. Pipe: ASTM A53/A53M, Grade B, Schedule 40.

D. Rails and Posts: Dimensions as indicated in drawings.

E. Fittings: Elbows, T-shapes, wall brackets, escutcheons.

F. Mounting: Brackets and flanges.

G. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.

H. Splice Connectors: Steel.

I. Galvanizing: ASTM A123/A123M.
   1. Shop and Touch-Up Primer: SSPC Paint 15, Type 1, red oxide.

2.3 FABRICATION

A. Furnish spigots and sleeves to accommodate site assembly and installation.

B. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

C. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

D. Exterior Components: Continuously seal joined pieces by intermittent and continuous welds. Drill condensate drainage holes at bottom of members at locations not encouraging water intrusion.

E. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

F. Accurately form components to suit stairs and landings, to each other and to building structure.

G. Accommodate for expansion and contraction of members and building movement without damage to connections or members.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field conditions are acceptable and are ready to receive work.

B. Verify concealed blocking and reinforcement is installed and correctly located to receive mounted handrails.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

3.3 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.

B. Anchor railings to structure with anchors, plates and angles, as needed.

C. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

D. Assemble with spigots and sleeves to accommodate tight joints and secure installation.

3.4 ERECTION TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

C. Maximum Offset From Alignment: 1/4 inch.

D. Maximum Out-of-Position: 1/4 inch.

3.5 SCHEDULES

A. Refer to drawings.

END OF SECTION

SECTION 06 05 73

WOOD TREATMENT

PART 1 GENERAL

1.1 SUMMARY

A. Preservative Wood Treatment.

1.2 REFERENCES

A. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. NFPA 255 - Standard Method of Test for Surface Burning Characteristics of Building Materials.

C. UL 723 - Standard Method of Test for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Section 01 33 00: Submittal procedures.

B. Product Data:
   1. Manufacturer's printed literature indicating product compliance to specified requirements.
   2. Manufacturer's recommendations for storage and protection of product on site.
   3. Copy of numbered National Evaluation Services Report specified in Quality Assurance Article of this Section.

1.4 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. Pure natural wood preservative. Hazardous decomposition product: Under severe thermal degradation, carbon monoxide and low molecular weight organic compound may be formed. This product will oxidize and can cause spontaneous heating. Avoid spontaneous combustion of contaminated rags or other ignitable absorbent material by immersing in water immediately.

1.5 QUALITY ASSURANCE

A. Certifications: Test results of fire performance, strength, and corrosive properties of fire retardant treated wood products issued in numbered National Evaluation Services Report.

B. Products have compliances with codes.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Store fire retardant treatment and linseed oil products on site in accordance with manufacturer's recommendations.

PART 2 PRODUCTS

2.1 PRESERVATIVE WOOD TREATMENT

A. Manufactures:
1. Lanco Mfg Corp. Model: Linseed Oil Pure Natural Wood Preservative
Urb. Aponte #5
San Lorenzo, PR 00754
(787) 736-4221
Fax (787) 736-5313
Web: http://www.lancopaints.com/english/home.html
Technical Data: Request technical data sheet directly throw the company.

B. Raw Linseed Oil is a natural wood preservative and finish that forms a moisture repellent film, which retards splitting on unfinished wood. Is best suited for exposed surfaces such as exterior wood siding, gutters and fence railing.

PART 3 EXECUTION

3.1 APPLICATION

A. Apply products in accordance to manufactures specification and instructions.

END OF SECTION

SECTION 06 10 00

ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes floor, wall, and roof sheathing; miscellaneous framing and sheathing; electrical panel back boards; and concealed wood blocking for support of wall cabinets and sheet water proof membrane.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A135.4 - Basic Hardboard.
2. ANSI A208.1 - Mat-Formed Wood Particleboard.

B. ASTM International:
1. ASTM D5456 - Standard Specification for Evaluation of Structural Composite Lumber Products.
2. ASTM F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

C. U. S Department of Commerce National Institute of Standards and Technology:
1. DOC PS 1 - Construction and Industrial Plywood.
2. DOC PS 2 - Performance Standard for Wood-Based Structural-Use Panels.
3. DOC PS 20 - American Softwood Lumber Standard.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings For Site Fabricated Truss Frame: Indicate dimensions, wood species and grades, component profiles, drilled holes, fasteners, connectors, erection details and sequence.

C. Product Data: Submit technical data on insulated sheathing, wood preservative materials, and application instructions.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with authorities having jurisdiction and codes.

B. Lumber and wood structural panels, submit manufacturer's certificate certifying Products meet or exceed specified requirements.

C. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Design structural shop fabricated trusses under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect trusses from warping or other distortion by stacking in vertical position, braced to resist movement.

PART 2 PRODUCTS

2.1 PRESSURE TREATED LUMBER

A. Manufacturers:

B. Distributor:

1. Tesoro del Ebanista. Model: Pressure Treated Lumber
   Calle Guayama 251
   San Juan, P.R. 00917 - 4202
   Phone: (787) – 758 - 6520
   Fax: (787) - 751 - 3884
   Web Site: http://www.tesoropr.com/
   Technical Data: Request to the company to get Technical Data.

2. Substitutions: Section 01 60 00 - Product Requirements. Not Permitted.

C. Pressured Treated Pine Wood Lumber: 2" x 4" x 8'and 2" x 4" x 10' dimensions.

2.2 SHEATHING MATERIALS

A. Pressure Treated Elioty Pine Wood Sheathing: Plywood; ½" of thickness; for Floor, Walls, Roof, and Electrical Panel Boards.

2.3 ACCESSORIES

A. Fasteners and Anchors:
Fasteners: Hot dipped galvanized steel for high humidity and treated wood locations, unfinished steel elsewhere.
1. Drywall Screws: Bugle head, hardened steel, power driven type, length to achieve full penetration of sheathing substrate.
2. Anchors: Bolt or ballistic fastener for anchorages to steel.

B. Structural Framing Connectors: Joist Hangers: Hot dipped galvanized steel, sized to suit framing conditions.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install the products in accordance to manufacturer's installation instructions and specifications.

3.2 SCHEDULES

A. See Construction Drawings for Schedules.

END OF SECTION

SECTION 06 15 00

WOOD DECKING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes plywood structural wood decking and preservative treatment of wood.

1.2 REFERENCES

A. ASTM C 208 - Standard Specification for Cellulosic Fiber Insulating Board.

B. ITS (Dir) - Directory of Listed Products; Intertek Testing Services.

C. ULC (FRD) - Fire Resistance Directory; Underwriters' Laboratories of Canada.

D. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.

E. UL 263 - Standard for Fire Tests of Building Construction and Materials.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal procedures.

B. Shop Drawings

C. Product Data: Submit technical data on wood preservative materials and storage and handling requirements and recommendations.

1.4 QUALITY ASSURANCE

A. Manufacturer: Single Source Responsibility: Obtain each type of fiberboard and related joint treatment materials from a single manufacturer.

B. Installer Qualifications: Perform work by company specializing in Work of this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Store products inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other damaging causes.

1.6 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results.

PART 2 PRODUCTS

2.1 PRESURE TREATED LUMBER

A. Manufacturers:
1. Tesoro del Ebanista Model: Pressure Treated Lumber
Calle Guayama 251
San Juan, P.R. 00917 - 4202
Phone: (787) – 758 - 6520
Fax: (787) - 751 - 3884
Web Site: http://www.tesoropr.com/
Technical Data: Request to the company to get Technical Data.

2. Substitutions: Permitted.

B. Pressured Treated Pine Wood Lumber: 2" x 4" x 12' dimensions.

2.2 ACCESSORIES

A. Fasteners and Anchors:
1. Fasteners: Hot dipped galvanized steel for high humidity and treated wood locations, unfinished steel elsewhere.
2. Nails and Staples: ASTM F1667.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Coordinate placement of nails for siding sheathing

3.3 INSTALLATION - WOOD DECKING

A. Install in accordance to manufacturers installation manuals and construction drawings.

END OF SECTION

SECTION 06 16 43

GYPSUM SHEATHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Fiberglass-mat faced, moisture resistant gypsum sheathing.

1.2 REFERENCES

A. ASTM International (ASTM):
1. ASTM C473 Standard Test Methods for Physical Testing of Gypsum Panel Products.
2. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
3. ASTM C1002 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
4. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
5. ASTM C1280 Standard Specification for Application of Gypsum Sheathing.
6. ASTM E72 Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
7. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.

1.3 SUBMITTALS

A. Product Data: Manufacturer's specifications and installation instructions for each product specified.

1.4 WARRANTY

A. Provide products that offer twelve months of coverage against in-place exposure damage (delamination, deterioration and decay).

B. Manufacturer's Warranty:
1. Five years against manufacturing defects.
2. Ten years against manufacturing defects when used as a substrate in architecturally specified EIFS.

PART 2 PRODUCTS

2.1 GYPSUM SHEATHING
A. Manufacturers:
1. Georgia-Pacific Building Products. Model: Fiberglass-Mat Faced Gypsum Sheathing: DensGlass Gold Exterior Sheathing

133 Peachtree Street NE
Atlanta, GA 30303
Phone: (404) 652-4000
Web Site: http://www.gp.com/
Technical Data: http://www.gp.com/build/product.aspx?pid=4674

2.2 MATERIALS

A. Fiberglass-Mat Faced Gypsum Sheathing: ASTM C1177:
   1. Thickness: 1/2 inch.
   2. Width: 4 feet.
   3. Length: 8 feet.
   4. Weight: 1900 pounds per M square feet.
   5. Edges: Square.
   6. Surfacing: Coated fiberglass mat on face, back, and long edges.
   7. Racking Strength (Ultimate, not design value) (ASTM E72): Not less than 540 pounds per square foot, dry.
   8. Flexural Strength, Parallel (ASTM C473): 80 lbf, parallel.
   9. Humidified Deflection (ASTM C1177): Not more than 1/4 inch.
   10. Permeance (ASTM E96): 23 perms.
   11. R-Value (ASTM C518): 0.56.
   12. Acceptable Products:
      a. 1/2 inch DensGlass Gold, Georgia-Pacific Gypsum.

2.3 ACCESSORIES

A. Screws: ASTM C1002, corrosion resistant treated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Inspection: Verify that project conditions and substrates are acceptable, to the installer, to begin installation of work of this section.

3.2 INSTALLATION

A. General: In accordance with ASTM C1280 and the manufacturer's recommendations.
   1. Manufacturer's Recommendations:
      a. Current "Product Catalog", Georgia-Pacific Gypsum.

3.3 PROTECTION

A. Protect gypsum board installations from damage and deterioration until date of Substantial Completion.

END OF SECTION

SECTION 06 20 00

FINISH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes finish carpentry items; wood casings and moldings; and hardware and attachment accessories.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A135.4 - Basic Hardboard.
2. ANSI A156.9 - Cabinet Hardware.
3. ANSI A208.1 - Mat-Formed Wood Particleboard.

B. APA-The Engineered Wood Association:
1. APA/EWA PS 1 - Voluntary Product Standard for Construction and Industrial Plywood.

C. ASTM International:
1. ASTM C1036 - Standard Specification for Flat Glass.
2. ASTM C1048 - Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. Architectural Woodwork Institute:
1. AWI - Quality Standards Illustrated.

E. American Wood-Preservers' Association:
1. AWPA C1 - All Timber Products - Preservative Treatment by Pressure Process.

F. Federal Specification Unit:
1. FS A-A-1936 - Adhesive, Contact, Neoprene Rubber.

G. Hardwood Plywood and Veneer Association:
1. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood.

H. National Electrical Manufacturers Association:
1. NEMA LD 3 - High Pressure Decorative Laminates.

I. National Fire Protection Association:
   1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
   2. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

J. Underwriters Laboratories Inc.:
   1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

K. U. S Department of Commerce National Institute of Standards and Technology:
   1. DOC PS 1 - Construction and Industrial Plywood.
   2. DOC PS 2 - Performance Standard for Wood-Based Structural-Use Panels.
   3. DOC PS 20 - American Softwood Lumber Standard.

L. Window and Door Manufacturers Association:
   1. WDMA I.S.4 - Water-Repellent Treatment for Millwork.

M. Woodwork Institute:
   1. WI - Manual of Millwork.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.

C. Product Data:
   1. Submit technical data of each product with certifications, award and codes.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with International Building Code, authorities having jurisdiction, and other codes.

B. Maintain one copy of each document on site.

1.5 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect work from moisture damage.

1.7 COORDINATION

A. Coordinate work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.

PART 2 PRODUCTS

2.1 MATERIALS

A. Wood specified in this section shall be of good quality, free of knots, warps cracks or any other defect. Wood shall be from reclaimed redwood or teakwood unless specified by architect, except teak plywood.

2.2 TEAK PLYWOOD

1. Manufacturers: Tesoro del Ebanista. Model: Teak Plywood
Calle Guayama 251
San Juan, P.R. 00917 - 4202
Phone: (787) – 758 - 6520
Fax: (787) - 751 - 3884
Web Site: http://www.tesoropr.com/
Technical Data: Request to the company to get Technical Data.

2.3 REDWOOD
1. Reclaimed Wood.

2.4 TEAK WOOD
1. Reclaimed Wood.

2.5 COMPONENTS

A. Hardwood Lumber. Custom.
1. Species of Wood: Redwood and Teak.

2.6 ACCESSORIES

A. ADHESIVE

B. Manufactured:
1. Franklin International; Model: Furniture Construction. Titebond III. Ultimate Wood Glue
2020 Bruk Steet Columbus,
Ohio USA 43207,
Phone: (800) 877-4583
Fax (614) 445-1813
Web Site: http://www.titebond.com/
Technical Data:
http://www.titebond.com/download/pdf/ww/UltimateIIITB.pdf

C. Screw, Nails and Anchors:
1. Teak for Rough Iron Self Drilling Screw 10 x 2FSD- 10 x 2" Square Drive (Robertson) Flat Head Sheet Metal.
2. Nails: Porter Cable; Finish Nails; GA 18 or 16.

D. Wood Treatment: See section06 05 73 Wood Treatment

2.7 FABRICATION

A. Fabricate to Custom, Standards.

B. Shops assemble work for delivery to site.

C. The wood was cleaned of all nails, old paints and glue materials; it was planed 1/8" to bring out the best quality of this material. It was cut and processed to make the different pieces to do the outer and inner skin.

2.8 SHOP FINISHING

A. Stain, seal, and varnish exposed to view surfaces.

B. Apply Linseed Oil to exposed the view surfaces according to section 06 05 73 Wood Treatment.

2.9 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements Testing, inspection and analysis requirements.

2.10 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

2.11 INSTALLATION

A. Install work in accordance with Custom quality standard.

2.12 ERECTION TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

2.13 SCHEDULES

A. Exterior:
   1. Redwood at walls.
   2. Teak at walls.

B. Interior:
   1. Teak at walls.

END OF SECTION

SECTION 06 40 13

EXTERIOR ARCHITECTURAL WOODWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section includes wood for exterior decking and planters and preservative treatment of wood.

1.2 REFERENCES

A. ASTM C 208 - Standard Specification for Cellulosic Fiber Insulating Board.

B. ITS (Dir) - Directory of Listed Products; Intertek Testing Services.

C. ULC (FRD) - Fire Resistance Directory; Underwriters' Laboratories of Canada.

D. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.

E. UL 263 - Standard for Fire Tests of Building Construction and Materials.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal procedures.

B. Shop Drawings

C. Product Data: Submit technical data on wood preservative materials and storage and handling requirements and recommendations.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Store products inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other damaging causes.

1.5 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MATERIALS

A. Wood specified in this section shall be of good quality, free of knots, warps cracks or any other defect. Wood shall be from reclaimed redwood or teakwood unless specified by architect.

2.2 ACCESSORIES

A. Fasteners and Anchors:
1. Fasteners: Hot dipped galvanized steel for high humidity and treated wood locations, unfinished steel elsewhere.
2. Nails and Staples: ASTM F1667.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. All measurements of wood at perimeter planters shall comply with construction drawings.

END OF SECTION

SECTION 06 41 00

ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section includes custom-fabricated cabinet units; counter tops; cabinet hardware; preparation for installing utilities in cabinets; and site finishing.

1.2 RELATED SECTIONS

A. Section 123530 - Appliances.

1.3 REFERENCES

A. American National Standards Institute:
1. ANSI A156.9 - Cabinet Hardware.
2. ANSI A208.1 - Mat-Formed Wood Particleboard.

B. Architectural Woodwork Institute:
1. AWI - Quality Standards Illustrated.

C. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. Hardwood Plywood and Veneer Association:
1. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood.

1.4 SUBMITTALS

A. Section 01 33 00: Submittal procedures.

B. Shop Drawings: Indicate materials, component profiles and elevations, assembly methods, joint details, fastening methods, accessory listings, hardware location and schedule of finishes.

C. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with construction drawings.

B. Maintain one of copies of the construction drawings of each cabinet specified on construction site.

1.6 QUALIFICATIONS

A. Fabricator: Company specializing in performing Work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements Product storage and handling requirements.

B. Protect units from moisture damage.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements

B. During and after installation of Work of this section, maintain same temperature and humidity conditions in building spaces as will occur after occupancy.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 CUSTOM CABINETS

A. Manufacturers:
1. Fabrication will be made by architecture students in association with industrial design students under the direct supervision of an expert.

2.2 COMPONENTS

A. Hardwood Lumber: AWI Grade I Premium Grade; maximum moisture content of 6 percent.

B. Reclaimed redwood or teakwood.

2.3 ACCESSORIES

A. Adhesive for High Pressure Decorative Laminates: Type recommended by laminate manufacturer to suit application.

B. Veneer Edge Band: Standard wood veneer edge band matching face veneer.

C. Fasteners and Anchors:
   1. Fasteners: Hot dipped, Electro galvanized steel for high humidity and treated wood locations, unfinished steel elsewhere.
   2. Nails and Staples: ASTM F1667.

D. Hinges: Butt Pivot Pin or Knuckle disappearing type (refer to drawings for specifications on hinges), steel with chrome finish.

2.4 FABRICATION

A. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.

B. Fit shelves, doors, and exposed edges with matching veneer edging. Use one piece for full length only.

C. When necessary to cut and fit on site, fabricate materials with ample allowance for cutting. Furnish trim for scribing and site cutting.

D. Apply high pressure decorative laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners.

E. Mechanically fasten back splash to counter tops with steel brackets at 16 on center.

F. Fabricate cabinets and counter tops with cutouts for plumbing fixtures, inserts, appliances, outlet boxes, fixtures and fittings. Verify locations of cutouts from on-site dimensions.

2.5 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.

B. Apply wood filler in exposed nail and screw indentations.

C. On items to receive transparent finishes, use wood filler matching surrounding surfaces and of types recommended for applied finishes.

D. Finish work in accordance with AWI - Section 1500 Factory Finishing; Premium Quality; Clear Transparent Type:
   1. Nitrocellulose Lacquer.
   2. Precatalyzed Lacquer.
   3. Postcatalyzed Lacquer.
   4. CAB & Water Acrylic Lacquer.
   5. Conversion Varnish.
   6. Synthetic Penetrating and Simulated Oil.

2.6 SOURCE QUALITY CONTROL AND TESTS

A. When fabricator is approved by authority having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with work of this section.

3.2 INSTALLATION

A. Set and secure casework in place; rigid, plumb, and level.

B. Use fixture attachments in concealed locations for wall mounted components.

C. Use concealed joint fasteners to align and secure adjoining cabinet units and counter tops

D. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.3 ADJUSTING

A. Adjust moving or operating parts to function smoothly and correctly.

3.4 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

3.5 SCHEDULES

A. Refer to construction drawings for cabinet schedules

END OF SECTION

SECTION 07 21 29

SPRAYED INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes closed-cell polyurethane spray foam insulation for walls, ceiling and floor

1.2 REFERENCES

A. ASTM International:
1. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
2. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
3. ASTM C739 - Standard Specification for Cellulosic Fiber (Wood-Base) Loose-Fill Thermal Insulation.
4. ASTM C1014 - Standard Specification for Spray-Applied Mineral Fiber Thermal or Acoustical Insulation.
5. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.
6. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
7. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C.

B. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

C. National Fire Protection Association:
1. NFPA 255 - Test of Surface Burning Characteristics of Building Materials.

D. Underwriters Laboratories, Inc.:
1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
2. UL - Fire Resistance Directory.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal procedures.

1.4 QUALITY ASSURANCE

A. Insulation Installed in Concealed Locations Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with [ASTM E84] [NFPA 255] [UL 723].

B. Insulation Installed in Exposed Locations Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with [ASTM E84] [NFPA 255] [UL 723].
   1. Attic Floor Insulation: Minimum 0.12 watt per sq cm critical radiant flux when tested in accordance with ASTM E970.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Installer: Company specializing in performing Work of this section.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Maintain acceptable ambient and substrate surface temperatures prior to, during, and after installation.

1.7 SCHEDULING

A. Apply insulation after hangers and supporting clips are installed but before subsequent construction is erected.

PART 2 PRODUCTS

2.1 SPRAYED INSULATION

A. Manufacturers:
   1. Honeywell Chemicals
      101 Columbia Road Morristown,
      NJ 07962
      Phone: 1-800-631-8138 or 1-800-455-2000
      Web Site: http://www.ccfoam.com/
      Technical Data:
      http://www51.honeywell.com/sm/chemicals/enovate/products-and-applications-sub/technical-data.html
      Safety Data:
      http://www51.honeywell.com/sm/chemicals/enovate/common/documents/enovate.pdf

B. Sprayed insulation foam, interior and exterior uses. Lightweight and very adaptable to uniquely shaped structures. No harmful ozone.

C. Substitutions: Not Permitted.

2.2 ACCESSORIES

A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify other Work on and within spaces to be insulated is complete prior to application.

3.2 PREPARATION

A. Mask and protect adjacent surfaces from overspray or damage.

B. Apply primer.

3.3 INSTALLATION

A. Apply insulation to a uniform monolithic density without voids.

B. Apply to minimum cured thickness specified on drawings

C. Tamp wet insulation surface to improve adhesion and to achieve smooth surface.

3.4 FIELD QUALITY CONTROL

A. Inspection includes verification of insulation thickness and density.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION

SECTION 07 26 00

VAPOR RETARDERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes sheet and sealant materials for controlling vapor diffusion.

1.2 REFERENCES

A. ASTM International:
1. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
2. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. Sealant, Waterproofing and Restoration Institute:
1. SWRI - Sealant Specification.

1.3 PERFORMANCE REQUIREMENTS

A. Vapor Retarder Permeance: Maximum 1 perm when tested in accordance with ASTM E96, Procedure A.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures Submittal procedures.

B. Product Data: Submit data indicating material characteristics, performance criteria, limitations.

C. Manufacturer's Installation Instructions: Submit preparation and installation requirements, techniques.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with SWRI - Sealant and Caulking Guide Specification requirements for materials and installation.

1.6 SEQUENCING

A. Section 01 10 00 - Summary Work sequence.

B. Sequence Work to permit installation of materials in conjunction with other retardant materials and seals and Do not install vapor retarder until items penetrating vapor retarder are in place.

PART 2 PRODUCTS

2.1 VAPOR RETARDERS

A. Manufacturers:
1. Danosa, Waterproofing the World. Model: Self-Dan
Lot 29 Luchetti Industrial Complex
Bayamon, P.R. 00961
Phone: (787) 785- 4545
Fax: (787) 787- 3902
Web Site: http://www.danosapr.com/

PART 3 EXECUTION

3.1 PREPARATION

A. Remove loose or foreign matter capable of impairing adhesion.

B. Clean and prime substrate surfaces to receive adhesive and sealants.

3.2 INSTALLATION

A. Application:
1. Installing according to manufacture instruction.

END OF SECTION

SECTION 07 52 00

MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes sheathing over deck surface, vapor retarder; and modified bitumen membrane roofing with protective covering, insulation, base flashings, roofing membrane expansion joints, cant strips and Counter flashings.

1.2 REFERENCES

A. ASTM International:
1. ASTM D5147 - Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Materials.
2. ASTM D146- Standard Test Methods for Sampling and Testing Bituminous-Saturated Felts and Woven Fabrics for Roofing and Waterproofing.

1.3 SYSTEM DESCRIPTION

A. Modified Bitumen Conventional Roofing System: One ply membrane system with sheathing, vapor retarder, insulation and aggregate surface, coated finish.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate setting plan for tapered insulation, layout of seams, direction of laps, base flashing details.

C. Product Data: Submit membrane materials, base flashing materials, insulation, sheathing, vapor retarders and protective coating.

D. Manufacturer's Installation Instructions: Submit special precautions required for seaming membrane.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures and wind velocity during application.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with NRCA Roofing and Waterproofing Manual.

B. Apply label from agency approved by authority having jurisdiction to identify each roof assembly component.

C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing Work of this section.

B. Review installation procedures and coordination required with related Work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Deliver products in manufacturer's original containers, dry, undamaged, seals and labels intact.

C. Store products in weather protected environment, clear of ground and moisture.

D. Stand roll materials on end.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not apply roofing membrane during inclement weather.

C. Do not apply roofing membrane to damp or frozen deck surface.

D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.

1.10 COORDINATION

A. Coordinate Work with installing associated metal flashings as work of this section proceeds.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer material and labor warranty to cover failure to prevent penetration of water.

PART 2 PRODUCTS

2.1 MODIFIED BITUMINOUS ROOFING

A. Manufacturers:
1. Danosa, Waterproofing the World. Model [GLASDAN R-36-SA]
Lot 29 Luchetti Industrial Complex
Bayamon, P.R. 00961
Phone: (787) 785- 4545
Fax: (787) 787- 3902
Web Site: http://www.danosapr.com/

2.2 APPLICATION

A. Insulation Application:
1. Installing according to manufacture instruction.

2.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Correct identified defects or irregularities.

C. Require site attendance of roofing and insulation materials manufacturers during installation of the Work.

2.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.

C. Repair or replace defaced or disfigured finishes caused by work of this section.

2.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Protect building surfaces against damage from roofing work.

C. Where traffic must continue over finished roof membrane, protect surfaces.

END OF SECTION

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes flashings and counter flashings.

1.2 REFERENCES

A. American Architectural Manufacturers Association:
1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
3. AAMA 2604 - Voluntary specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A625/A625M - Standard Specification for Tin Mill Products, Black Plate, Single Reduced.
3. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM B32 - Standard Specification for Solder Metal.
5. ASTM B101 - Standard Specification for Lead-Coated Copper Sheet and Strip for Building Construction.
6. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
7. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
8. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
9. ASTM D4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.

1.3 DESIGN REQUIREMENTS

A. Gutter and Downspout Components: Conform to applicable code for size and method of rain water discharge.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

C. Product Data: Submit data on manufactured components metal types, finishes, and characteristics.

D. Samples:
1. Submit two samples illustrating typical material and finish.

1.5 QUALIFICATIONS

A. Fabricator and Installer: Company specializing in sheet metal work with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

C. Prevent contact with materials causing discoloration or staining.

PART 2 PRODUCTS

2.1 SHEET METAL FLASHING AND TRIM

A. Manufacturers:

1. Nu Vue
   Ave. B. Lotes 26/27
   Urb. Industrial Los Frailes,
   Guaynabo P.R. 00969
   Phone: (787) 720-0442
   Web Site: http://nuvuepr.com/
   Technical Data: Not Available

B. Pre-Painted or mill finish Aluminum, G16, topcoat; color to match siding color or as specified by architect.

2.2 ACCESSORIES

A. Fasteners: Same material and finish as flashing metal.

2.3 FABRICATION

A. Form sections shape indicated on Drawings, accurate in size, square, and free from distortion or defects.

B. Fabricate cleats of same material as sheet metal, interlocking with sheet.

C. Form pieces in longest possible lengths.

D. Seal metal joints.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.2 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.

B. Install surface mounted reglets to lines and levels indicated on Drawings. Seal top of reglets with sealant.

C. Paint concealed metal surfaces with protective backing paint to minimum dry film thickness of 15 mil (0.4 mm).

3.3 INSTALLATION

A. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

B. Apply plastic cement compound between metal flashings and felt flashings.

C. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

D. Seal metal joints watertight.

3.4 FIELD QUALITY CONTROL

A. Inspection will involve surveillance of Work during installation to ascertain compliance with specified requirements.

END OF SECTION

SECTION 07 90 00

JOINT PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes sealants and joint backing.

1.2 REFERENCES

A. ASTM International:
1. ASTM C834 - Standard Specification for Latex Sealants.
2. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Products Data: Submit data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

C. Manufacturer's Installation Instructions: Submit special procedures, surface preparation, and perimeter conditions requiring special attention.

D. Warranty: Include coverage for installed sealants and accessories failing to achieve exhibit loss of adhesion or cohesion, and sealants which do not cure.

1.4 QUALITY ASSURANCE

A. Maintain one copy of each referenced document covering installation requirements on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Applicator: Company specializing in performing Work of this section.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Maintain temperature and humidity recommended by sealant manufacturer during and after installation.

1.7 COORDINATION

A. Coordinate Work with sections referencing this section.

PART 2 PRODUCTS

2.1 JOINT SEALERS

A. Manufacturers:
1. Lanco, Mfg. Corp. Model: SiliconFlex CC-766.
Urb. Aponte #5
San Lorenzo, PR 00754
Phone: 1- (787) - 736-4221
Fax: (787) 736-5313
Web Site: http://www.lancopaints.com/english/2.0.about.html
Technical Data:
http://www.lancopaints.com/spanish/products/Technical%20Data%20Sheet/5-Sealants/2-Elastomeric%20Latex/SiliconFlex.pdf

2. Lanco, Mfg. Corp. Model: SiliconSeal CC-781.
Technical Data:
http://www.lancopaints.com/spanish/products/Technical%20Data%20Sheet/5-Sealants/2-Elastomeric%20Latex/SiliconSeal.pdf

3. Substitutions: Section 01 60 00 - Product Requirements. Permitted.

B. Products Description:
1. High Performance Siliconized Acrylic Sealants: Elastomeric; ASTM C834-91, single component, paintable.
a. Type: SiliconeFlex CC-766. Manufactured by Lanco Mfg. Corp.
b. Color: Clear.
c. Applications: Use for:
1) Joints for siding corner, around windows, doors, skylights, vents, air ducts and chimneys.
2) Seals in concrete, drywall, wood, and metal.
3) Joints between metal frames and other materials.
4) Adhering tightly even to ceramic and glass substrates.

C. High Performance Adhesive and Sealant : Elastomeric; ASTM C920-86 Type S, Grade NS, Class 25, Uses NT; paintable, non-yellowing, mildew and moisture resistant.

a. Type: SiliconeSeal CC-781. Manufactured by Lanco Mfg. Corp.
b. Color: White.
c. Joint Mobility: Plus 50 percent.
d. Service Temperature Range: -10 to 170-degrees F (-23 to 77 degrees C).
e. Applications: Use for:
1) Joints for siding corner, around windows, doors, skylights, vents, air ducts and chimneys.

2.2 ACCESSORIES

A. Gun: Compatible with sealant manufacturer specifications.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: use polyethylene foam or oakumas backup filler.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify substrate surfaces and joint openings are ready to receive work.

B. Verify joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

A. Remove loose materials and foreign matter impairing adhesion of sealant.

B. Clean and prime joints.

C. Protect elements surrounding Work of this section from damage or disfiguration.

3.3 INSTALLATION

A. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean adjacent soiled surfaces.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Protect sealants until cured.

3.6 SCHEDULE

A. See Construction Drawings to schedules data.

END OF SECTION

SECTION 07 95 00

EXPANSION CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section includes expansion joint assemblies for exterior walls, interior floor and ceiling.

1.2 REFERENCES

A. ASTM International:
1. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
2. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
3. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
4. ASTM B455 - Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate joint and splice locations, miters, layout of work, affected adjacent construction and anchorage locations.

C. Product Data: Submit joint assembly profiles, profile dimensions, anchorage devices, available colors and finish.

D. Manufacturer's Installation Instructions: Submit rough-in sizes; provide templates for cast-in or placed frames or anchors; required tolerances for item placement.

1.4 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.5 FIELD MEASUREMENTS

A. Verify field measurements are as instructed by manufacturer.

1.6 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish resilient joint filler and one set of special tools required for accessing and servicing components.

PART 2 PRODUCTS

(Materials and requirements noted below will apply, unless otherwise specified on plans. See Architectural and Structural drawings notes to verify which of the listed materials below shall be used.)

2.1 EXPANSION JOINT ASSEMBLIES

A. Manufacturers:
1. Substitutions: Section 01 60 00 - Product Requirements.

2.2 COMPONENTS

A. Extruded Aluminum: ASTM B221.

B. Resilient Filler.

C. Threaded Fasteners.

D. Backing Paint: Asphaltic type.

2.3 FABRICATION

A. Joint Covers: Aluminum cover plate, aluminum frame construction, retainers with resilient filler strip, design to permit plus or minus 50 percent joint movement with full recovery, flush mounted. Back paint components in contact with cementitious materials.

B. Galvanize embedded ferrous metal anchors and fastening devices.

C. Shop assemble components and package with anchors and fittings.

D. Furnish joint components in single length wherever practical. Minimize site splicing.

2.4 FACTORY FINISHING

A. Floors: Mill finish.

B. Walls and Ceilings: Clear anodized.

C. Resilient Filler Exposed to View: Color to be selected by Architect.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify joint preparation and affected dimensions are acceptable.

3.2 PREPARATION

A. Provide anchoring devices for installation.

B. Provide templates and rough-in measurements.

3.3 INSTALLATION

A. Align work plumb and level.

B. Rigidly anchor to substrate to prevent misalignment.

3.4 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit traffic over unprotected floor joint surfaces.

C. Install removable strippable coating to protect finish surface.

3.5 SCHEDULES

A. Refer to plans.

END OF SECTION

SECTION 08 11 15

PRE-ASSEMBLED METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pre-assembled steel entry doors in metal wood frames.

1.2 REFERENCES

A. American Architectural Manufacturers Association:
1. AAMA 101 - Voluntary Performance Specification for Windows, Skylights and Glass Doors.
2. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

B. ASTM International:
1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
3. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
4. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference.
5. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference.
6. ASTM E547 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential.
7. ASTM C1036 - Standard Specification for Flat Glass.

C. Consumer Product Safety Commission:
1. CPSC 16 CFR 1201; Safety Standard for Architectural Glazing.

D. Glass Association of North America:
1. GANA - Glazing Manual.

E. National Fire Protection Association:
1. NFPA 80 - Standard for Fire Doors, Fire Windows.
2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

3. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

F. National Fenestration Rating Council Incorporated:
1. NFRC 100 - Procedures for Determining Fenestration Product U-Factors.

G. Underwriters Laboratories Inc.:
1. UL 10B - Fire Tests of Door Assemblies.
2. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
3. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
4. UL 1784 - Air Leakage Tests of Door Assemblies.

H. Uniform Building Code:
1. UBC Standard 7-2 - Fire Tests of Door Assemblies.

1.3 PERFORMANCE REQUIREMENTS

A. System Design: Design and size components to withstand dead loads and live loads caused by positive and negative wind loads acting normal to plane of wall as calculated in accordance with applicable code

B. Assembly: To accommodate, without damage to components or deterioration of seals, movement between door assembly and perimeter framing, deflection of lintel.

C. Water Leakage: None, when measured in accordance with ASTM E331. ASTM E547.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Indicate elevations, anchor types and spacing, location of cut-outs for hardware, cut-outs and reinforcement for door hardware, and glazing.

C. Product Data: Submit frame and door configurations, core materials, and finishes.

D. Manufacturer's Installation Instructions: Submit special installation instructions.

1.5 QUALITY ASSURANCE

A. Fire Rated Door and Frame Construction: Conform to NFPA 252.

B. Perform glazing Work in accordance with the following:
1. Insulated Glass: Fabricate insulated glass units in accordance with GANA (formerly FGMA) Glazing Manual.

2. Safety Glass: Conform to CPSC 16 CFR 1201 and applicable codes.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum eight years documented experience or approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept units on site in manufacturer's standard packaging. Inspect for damage.

C. Protect units from damage by storing in dry, protected area.

D. Break seal on site to permit ventilation.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 COORDINATION

A. Coordinate work with door opening construction and door hardware installation.

B. Coordinate installation to accommodate door hardware electric connections.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish four year manufacturer's warranty on workmanship and materials.

C. Furnish five year manufacturer's warranty for insulated glass units from seal failure, interpane dusting or misting, including replacement.

PART 2 PRODUCTS

2.1 PRE-ASSEMBLED STEEL DOORS AND FRAMES

A. Manufacturers:

1. Valcor Samcor, Security Window & Door System/ Architectural Aluminum & Glass Products
   Phone:(787) 653-0152
   Web Site: http://www.valcorsamcor.com/
   Technical Data: You have to register in the web site to access it.

2. Substitutions: Not Permitted.

2.2 ENTRY DOORS AND SIDELIGHT PANELS

A. Sidelight Panels: Match doors; glazing and design as indicated on Drawings.

2.3 DOOR FRAMES

A. Metal Frames: in accordance with manufacturers specifications.

2.4 COMPONENTS

A. Glazing Materials: Manufacturer's standard conforming with requirements specified in Section 08 80 00.

2.5 HARDWARE

A. Hinges: To be specified by manufacturer of doors.

B. Weather-stripping: Magnetic type on lock and head jambs, compression type elsewhere.

C. Thresholds: ADA compliant, extruded aluminum, thermally broken.

2.6 ACCESSORIES

A. Door Casings

B. Primer: Manufacturer's standard rust inhibitive type.

2.7 FABRICATION

A. Fabricate doors and frames as pre-hung folding doors full glass as manufactured by Valcor-Samcor

B. Configure exterior frames to accept weatherstripping.

C. Factory glaze doors.

2.8 FACTORY FINISHING

A. Doors, and Frames:
1. Primer: Electrostatically painted, baked on.
2. Factory applied baked enamel; color as selected by architect.

B. Hardware Finish:
1. Steel Components: Satin plated.
2. Brass Components: Polished.
3. Aluminum Components: Clear anodized.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify framed openings are correct size and thickness and project conditions are acceptable.

B. Correct unacceptable conditions before proceeding with installation.

3.2 INSTALLATION

A. Install units in accordance with manufacturer's installation instructions.

B. Install doors and frames plumb, level and square.

C. Anchor door frames securely.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Adjust door and frame units to ensure smooth and balanced movement.

3.4 SCHEDULES

A. Refer to Construction Drawings for doors schedules.

END OF SECTION

SECTION 08 12 14

STANDARD STEEL FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes steel frames.
   1. Provide frames for interior/exterior glazed lights.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

B. ASTM International:
   1. ASTM A591/A591M - Standard Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Mass Applications.
   2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

C. National Fire Protection Association:
   1. NFPA 80 - Standard for Fire Doors, Fire Windows.
   2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

D. Underwriters Laboratories Inc.:
   1. UL 10B - Fire Tests of Door Assemblies.
   2. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
   3. UL 1784 - Air Leakage Tests of Door Assemblies.

E. Uniform Building Code:
   1. UBC Standard 7-2 - Fire Tests of Door Assemblies.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate frame elevations, reinforcement, anchor types and spacing, location of cut-outs for hardware, and finish.

C. Product Data: Submit frame configuration and finishes.

D. Samples: Submit two samples of frame.

E. Manufacturer's Installation Instructions: Submit special installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Conform to requirements of ANSI A250.8.

B. Fire Rated Frame Construction: Conform to UBC Standard 7-2.

C. Perform Work in accordance with Washington DC Public Work's standard.

D. Maintain one copy of door and frames schedules document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept frames on site in manufacturer's packaging. Inspect for damage.

C. Break seal on-site to permit ventilation.

1.7 COORDINATION

A. Coordinate Work with frame opening construction, door, and hardware installation.

B. Sequence installation to accommodate required door hardware electric wire connections.

PART 2 PRODUCTS

2.1 STANDARD STEEL FRAMES

A. Manufacturers:
1. Valcor Samcor, Security Window & Door System/ Architectural Aluminum & Glass Products
Carr 189 km. 9.2 Gurabo
PO Box 1319 Gurabo, PR 00778
Phone: (787) 653-0152.
Web Site: http://www.valcorsamcor.com/
Technical Data: You have to register in the web site to access it.
2. Substitutions: Not Permitted.

B. Product Description: Standard shop fabricated steel frames, fire rated and non-rated types.
1. Frames: To suit ANSI A250.8

2.2 ACCESSORIES

A. Removable Stops: Rolled aluminum.

B. Primer: ANSI A250.10 rust inhibitive type.

C. Weatherstripping: Resilient aluminum retainer.

2.3 FABRICATION

A. Fabricate frames for gypsum board slip on type, except for exterior.

B. Mullions for Double Doors: Removable type, of same profiles as jambs.

C. Transom Bars for Glazed Lights: Fixed type, of same profiles as jamb and head.

D. Fabricate frames with hardware reinforcement plates welded in place.

E. Terminate door stops 6 inches (150 mm) above finished floor. Cut stop at 90 degree angle and close.

F. Prepare frames for silencers. Provide three single silencers for single doors [and mullions of double doors] on strike side. Provide two single silencers on frame head at double doors without mullions.

G. Configure exterior frames with special profile to receive recessed weatherstripping.

H. Attach fire rated label to each fire rated frame.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify opening sizes and tolerances are acceptable.

3.2 INSTALLATION

A. Install frames in accordance with ANSI A250.8.

B. Coordinate with gypsum board wall construction for anchor placement.

C. Coordinate installation of glass and glazing specified in Section 08 80 00.

D. Coordinate installation of frames with installation of hardware specified in Section 08 11 15.

E. Install roll formed steel reinforcement channels between two abutting frames. Anchor to structure and floor.

3.3 SCHEDULE

A. Refer to Door and Frame Schedule in construction drawings.

END OF SECTION

SECTION 08 14 16

POCKET WOOD DOOR

PART 1 GENERAL

1.1 SUMMARY

A. Section includes pocket wood doors, wood frame and aluminum rail.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI A135.4 - Basic Hardboard.

B. ASTM International:
   1. ASTM E413 - Standard Classification for Rating Sound Insulation.

C. Architectural Woodwork Institute:
   1. AWI - Quality Standards Illustrated.

D. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

E. National Electrical Manufacturers Association:
   1. NEMA LD 3 - High Pressure Decorative Laminates.

F. National Fire Protection Association:
   1. NFPA 80 - Standard for Fire Doors, Fire Windows.
   2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

G. Underwriters Laboratories Inc.:
   1. UL - Building Materials Directory.
   2. UL 10B - Fire Tests of Door Assemblies.
   3. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
   4. UL 1784 - Air Leakage Tests of Door Assemblies.

H. Uniform Building Code:
   1. UBC Standard 7-2 - Fire Tests of Door Assemblies.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures:

B. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, factory finishing criteria.

C. Product Data: Submit information on door core materials and construction, and on veneer species, type and characteristics.

D. Manufacturer's Installation Instructions: Submit special installation instructions.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with AWI Quality Standard Section 1300, Custom.

B. Finish doors in accordance with AWI Quality Standard Section 1500.

C. Attach label from agency approved by authority having jurisdiction to identify each fire rated door.

1. Indicate temperature rise rating for stair doors.
2. Attach smoke label to smoke and draft control doors.

D. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept doors on site in manufacturer's packaging. Inspect for damage.

1.7 COORDINATION

A. Coordinate Work with door opening construction, door frame and door hardware installation.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

C. Furnish manufacturer's "Life of Installation" warranty for interior and exterior doors.

PART 2 PRODUCTS

2.1 POCKET WOOD DOORS

A. Manufacturers:
1. Students in collaboration with professional contractors.
2. Substitutions: Section 01 60 00 - Product Requirements Not Permitted.

B. Product Description: Hollow pocket wood doors.

2.2 COMPONENTS

A. Teak Plywood Sheathing.

B. Teak Frame.

C. Aluminum Rail.

2.3 FABRICATION

A. Fabricate doors in accordance with AWI Quality Standards requirements.

B. Bond edge banding to cores.

C. Provide edge clearances in accordance with AWI 1300.

2.4 SHOP FINISHING

A. Factory finish doors in accordance with Architect/Engineer approved.

B. Seal door top edge with color or clear sealer to match door facing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify opening sizes and tolerances are acceptable.

B. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.2 INSTALLATION

A. Install doors in accordance with manufacture instruction.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust door for smooth and balanced door movement.

C. Adjust closer for full closure.

3.4 SCHEDULE

A. Refer to Door and Frame Schedule appended to this section.

END OF SECTION

SECTION 08 35 13

FOLDING DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes accordion folding doors, manually operated, with track and operating hardware.

1.2 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
3. ASTM E336 - Standard Test Method for Measurement of Airborne Sound Insulation in Buildings.
4. ASTM E413 - Standard Classification for Rating Sound Insulation.
5. ASTM F793 - Standard Classification of Wallcovering by Durability Characteristics.

B. National Fire Protection Association:
1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
2. NFPA 265 - Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Coverings on Full Height Panels and Walls.

C. Underwriters Laboratories Inc.:
1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate opening sizes, details of track and required supports, track loads, adjacent construction and finish trim, and stacking sizes.

C. Product Data: Submit data on door operation, hardware and accessories, colors and finishes available.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Describe cleaning materials detrimental to fabric surfaces and hardware finish. Include recommended cleaning methods, cleaning materials, and stain removal methods.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with manufacturer's instructions.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Installer: Company specializing in performing work of this section.

PART 2 PRODUCTS

2.1 ACCORDION FOLDING DOORS

A. Manufacturers:
1. Valcor Samcor. Model [Custom Folding Doors]
PO Box 1319
Gurabo, PR 00778
Phone :(787) 653-0152
Web Site: http://www.valcorsamcor.com/
Technical Data: You have to register in the web site to access it.

2. Substitutions: Section 01 60 00 - Product Requirements. Not Permitted.

B. Product Description: Accordion folding doors, manually operated, with track and operating hardware.

2.2 COMPONENTS

A. Non-Acoustical Accordion Folding Door Construction:
1. Frame: Extruded aluminum 6063-T5.
2. Surfacing: Nominal wall 0.100 inch (2.54 mm) thick steel sheet. Top and bottoms rails nominal wall 0.080 inch (2.03mm) thick steel sheet.
3. Finish: Etched and painted using first quality thermosetting TJIC powder paint.
4. Trim: Aluminum jamb.
5. Connector Molding: Shaped moldings of same surface and color as panel finish.

B. Track: Formed steel or extruded aluminum; thickness and profile designed to support loads; furnish track connectors where track size exceeds manufacturer's standard size.

C. Hardware: Shall have above hardware in the active leaf, stainless steel hinges in the inactive leaf and two flush bolt mounted on the edge of the door.

D. Glazing: See Section 08 80 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements are as instructed by manufacturer and shop drawings.

3.2 INSTALLATION

A. Fit and align door assembly level and plumb.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust door assembly to provide smooth operation from stacked to full open position.

3.4 SCHEDULES

A. See Construction Drawings schedules.

END OF SECTION

SECTION 08 51 13

ALUMINUM WINDOWS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes extruded jealousies aluminum windows, operator with "T" handle jamb, factory glazed, and operating hardware.

1.2 REFERENCES

A. Aluminum Association:
1. AA DAF-45 - Designation System for Aluminum Finishes.

B. American Architectural Manufacturers Association:
1. AAMA 101 - Voluntary Performance Specification for Windows, Skylights and Glass Doors.
2. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

C. American Society of Civil Engineers:
1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

D. ASTM International:
1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
3. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
4. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
5. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
6. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference.
7. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference.
8. ASTM E547 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential.

9. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Difference.
10. ASTM F588 - Standard Test Methods for Resistance of Window Assemblies to Forced Entry Excluding Glazing.

E. National Fenestration Rating Council Incorporated:
1. NFRC 100 - Procedures for Determining Fenestration Product U-Factors.

1.3 SYSTEM DESCRIPTION

A. Windows: Single thickness aluminum sections, factory fabricated, factory finished, factory glazed vision glass, related flashings, anchorage and attachment devices.

B. Glazing: See Section 08 80 00.

C. Forced Entry Resistance: Link plates on each end of torque bar to prevent louver blade from coming out of the frame loose aluminum rod inside the hollow center shaft to prevent torque bar from being saw-cut.

1.4 PERFORMANCE REQUIREMENTS

A. Primary Performance Requirements: Aluminum windows to meet performance criteria for AAMA 101 Designation or better.

B. System Design: Design and size components to withstand dead loads and live loads caused by pressure and negative wind loads acting normal to plane of window as calculated in accordance with applicable code.

C. Assembly: To accommodate, without damage to components or deterioration of seals, movement between window and perimeter framing, deflection of lintel.

D. Water Leakage: None, when measured in accordance with ASTM E331, ASTM E1105, and ASTM E547.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate opening dimensions, framed opening tolerances, affected related Work; and installation requirements.

C. Product Data: Submit component dimensions, anchorage and fasteners, glass, internal drainage, and typical details.

D. Manufacturer's Certificates: Certify Product performance ratings by independent third party such as AAMA, CAWM, or NFRC as meeting or exceeding specified requirements.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with the codes and Authorities Having Jurisdiction. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing aluminum windows with minimum three years experience, and with local service facilities.

B. Installer: Company specializing in installation of aluminum windows with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND PROTECTION

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Protect factory finished aluminum surfaces with wrapping or strippable coating. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 ALUMINUM WINDOWS

A. Manufacturers:
1. Valcor Samcor. Model [Aluminum Windows]
PO Box 1319
Gurabo, PR 00778

Phone :(787) 653-0152
Web Site: http://www.valcorsamcor.com/
Technical Data: You have to register in the web site to access it.

2. Substitutions: Section 01 60 00 - Product Requirements. Not Permitted.

B. Product Description: Jealousies windows with glass louvers, aluminum frames and sub frames. Window head, sill, and torque bar. Aluminum mullion tube screws for reinforcement of aluminum structural section.

2.2 COMPONENTS

A. Extruded Aluminum: ASTM B221; ASTM B221M; 6063 alloy, T5 temper.

B. Steel Sections: Profiled to suit mullion sections.

C. Glass: See Section 08 80 00.

D. Hardware:
1. Operator: Geared rotary handle fitted to projecting sash arms with limit stops.

E. Sills: Extruded aluminum; sloped for positive wash; one piece full width of opening jamb angles to terminate sill end.

F. Weather Stripping: Wool pile seals at head, sill, jambs and at every torque bar into special recesses in extruded members.

G. Insect Screen Frame: Rolled aluminum frame of rectangular sections; fit with adjustable hardware; nominal size similar to operable glazed unit.

2.3 ACCESSORIES

A. Window Washing Anchors: Stainless steel conforming with applicable codes.

B. Limit Stops: Resilient rubber.

2.4 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Arrange fasteners and attachments to ensure concealment from view.

E. Prepare components with internal reinforcement for operating hardware.

F. Furnish internal reinforcement in mullions with galvanized steel members to maintain rigidity.

G. Assemble insect screen frame, miter and reinforce frame corners. Fit mesh taut into frame and secure. Fit frame with four spring loaded steel pin retainers.

H. Single weather strip operable units.

I. Factory glaze window units. Install glass in accordance with Section 08 80 00.

2.5 SHOP FINISHING

A. Exterior Surfaces: Manufacturer's standard thermosetting finish, color as selected.

B. Interior Surfaces: Manufacturer's standard thermosetting finish, color as selected.

C. Locks, Operators, and Exposed Hardware: Enameled to match window finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify wall openings and adjoining air and vapor seal materials are ready to receive Work of this section.

3.2 INSTALLATION

A. Install in accordance with manufacturers specifications and instructions.

3.3 ERECTION TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust hardware for smooth operation and secure weathertight closure.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Remove protective material from factory finished aluminum surfaces.

C. Wash surfaces by method recommended and acceptable to sealant and window manufacturer; rinse and wipe surfaces clean.

D. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant and window manufacturer.

3.6 SCHEDULES

A. See Construction Drawings for schedules.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes hardware for aluminum and wood doors.
   1. Provide door gaskets, including weatherstripping and seals, and thresholds.

1.2 REFERENCES

A. Underwriters Laboratories Inc.:
   1. UL 10B - Fire Tests of Door Assemblies.
   2. UL 305 - Panic Hardware.
   3. UL - Building Materials Directory.

B. International Organization for Standardization
   1. ISO 9001 : 2000

1.3 PERFORMANCE REQUIREMENTS

A. Fire Rated Openings: Provide door hardware listed by UL, or other testing laboratory approved by applicable authorities.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings:
   1. Indicate locations and mounting heights of each type of hardware, schedules, and catalog cuts.
   2. Submit manufacturer's parts lists.

C. Samples:
   1. Submit one sample of typical hinge, latchset, lockset, and closer, illustrating style, color, and finish.
   2. Approved samples may be incorporated into Work. Samples will be returned to supplier.

D. Manufacturer's Installation Instructions: Submit special procedures, and perimeter conditions requiring special attention.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of installed cylinders and their master key code.

C. Operation and Maintenance Data: Submit data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

D. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with Authorities Having Jurisdiction.

B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Hardware Supplier: Company specializing in supplying door hardware.

C. Hardware Supplier Personnel: Employ qualified person to assist in work of this section.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

B. Include persons involved with installation of doors, frames, and hardware.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Package hardware items individually with necessary fasteners, instructions, and installation templates, when necessary; label and identify each package with door opening code to match hardware schedule.

1.10 COORDINATION

A. Coordinate Work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware and recessed items.
   1. Provide templates or actual hardware as required to ensure proper preparation of doors and frames.

B. Sequence installation to accommodate required utility connections.

C. Coordinate Owner's keying requirements during course of Work.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

1.12 MAINTENANCE MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance materials.

B. Furnish special wrenches and tools applicable for each different and for each special hardware component.

C. Furnish maintenance tools and accessories supplied by hardware component manufacturer.

1.13 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish ten extra key lock cylinders for each master keyed group.

PART 2 PRODUCTS

2.1 DOOR HARDWARE

A. Manufacturers:
   1. Exilgates Corp. Model: Door Levers; Lever 2112.
      Sanjuanera #110 Via Medieval
      Sector Sanjuanera, Hacienda San Jose
      Caguas, Puerto Rico 00725
      Phone: (787) 466 - 8510
      Fax: (787) 258 - 4783
      Web Site: http://www.atz.pt/

Technical Data: http://www.atz.pt/produto.php?id=660&lang=2
E-mail: pathfinder@coqui.net

2. Exilgates Corp. Model: Lock/Latches; Sliding Door Lock 3910
Technical Data: http://www.atz.pt/produto.php?id=933&lang=2

3. Exilgates Corp. Model: Lock/Latches; Lock 1134
Technical Data: http://www.atz.pt/produto.php?id=608&lang=2

4. Exilgates Corp. Model: Escutcheons and Roses; Long Escutcheon 62
Technical Data: http://www.atz.pt/produto.php?id=952&lang=2

5. Substitutions: Section 01 60 00 - Product Requirements. Not Permitted.

B. The stainless steel composition used the fabrication of ATZ products is the alloy of nickel chrome steel AISI 304 which is non-magnetic. The main reason for the use of this alloy is due to its over-all good resistance and durability to a normal everyday usability.

2.2 COMPONENTS

A. General Hardware Requirements: Where not specifically indicated, comply with applicable UL. Furnish each type of hardware with accessories as required for applications indicated and for complete, finished, operational doors.

B. Hinges: Complying with following general requirements unless otherwise scheduled.

C. Sliding and Bi-Folding Door Hardware: furnish complete hardware sets for operational installation.

2.3 ACCESSORIES

A. Lock Trim: Furnish levers with as selected from manufacturer's full range of levers and roses.

2.4 FINISHING

A. Finishes: furnish following finishes except where otherwise indicated in Schedule at end of section.
1. Typical Hinges, Interior and Exterior Door Hardware: nickel chrome stainless steel AISI 304.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify doors and frames are ready to receive door hardware and dimensions are as indicated on shop drawings.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Architectural Hardware Consultant inspects installation and certifies hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust hardware for smooth operation.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit adjacent work to damage hardware or hardware finish.

3.6 SCHEDULES

A. See Construction Drawings and Specifications and furnish proper hardware for door openings.

END OF SECTION

SECTION 08 80 00

GLAZING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes glass glazing for doors and windows.

1. Glass glazing materials and installation requirements are included in this section for other sections referencing this section.

B. GLASS BREAKAGE:

A. The glazing subcontractor shall be responsible for all glass broken, scratched, damaged or defective and shall replace same at his expense.

1.2 SUBMITTALS

A. Section 01 33 00: Submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Glass: Provide structural, physical and environmental characteristics, size limitations, and special handling or installation requirements.
5. Glazing Sealants, Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors were exposed.

C. Shop Drawings:
1. Indicate sizes, layout, thicknesses, and loading conditions for glass.
2. Detailing installation of film, anchoring accessories, and sealant.

D. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, represent actual product, color, and patterns.

E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

F. Manufacturers' warranties.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Do not install glazing when ambient temperature is less than 50 degrees F (10 degrees C).

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.

C. Store materials in a dry, warm, ventilated weather tight location.

PART 2 PRODUCTS

2.1 GLAZING

A. Flat Glass Manufacturers:
1. Valcor Samcor; Model FDFG3
Carr 189 km. 9.2 Gurabo
PO Box 1319 Gurabo, PR 00778
Phone: (787) 653-0152.
Web Site: http://www.valcorsamcor.com/
Technical Data: You have to registered in the web site to access it.

B. Substitutions: Not Permitted.

2.2 OTHER MATERIALS

A. Provide other materials not specifically described but required for a complete and proper installation.

2.3 SOLAR CONTROL FILM

A. Plastic Film Manufacturers:
1. Huper Optic USA; Model Select Series Nano Ceramic Window Films
17356-B Northwest Freeway
Houston, Texas 77040
Toll Free: 888-296-FILM (3456)
Phone: 832-467-1170
Fax: 832-467-1190

Web Site: http://www.huperoptikusa.com/
Technical Data: http://www.huperoptikusa.com/products_klasse.cfm

B. Substitutions: Not Permitted.

C. High heat rejection performance. These films reject damaging infra-red and ultra-violet light rays that cause heat and fading, all without significantly reducing visible light transmittance. Up to 70% total solar energy rejection. More than 99% ultra-violet rejection. Up to 98% infrared radiation rejection. Three levels of visible light transmission: 35%, 59%, or 77%. Low visible light reflectance of less than 8.28%.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing conditions are adequate for proper application and performance of film.

B. Verify glass is not cracked, chipped, broken, or damaged.

C. Do not begin installation until substrates have been properly prepared.

D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

E. Verify surfaces of glazing channels or recesses are clean, free of obstructions impeding moisture movement; weeps are clear, and ready to receive glazing.

3.2 PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions. Installation must be accomplished by a recognized professional installer of film for energy control purposes.

B. Install without bubbles, ripples, drips, dirt, cuts, tears or gaps between film and frame.

C. Clean newly installed film and window frames after installation.

D. Clean up cleaning solutions, run-off cleaning water and adhesive mounting solution.

3.4 PROTECTION OF INSTALLED CONSTRUCTION

A. Protect installed products until completion of project.

B. Where installed film could be damaged by subsequent construction provide tape warning strips or barricades to prevent contact.

END OF SECTION

SECTION 08 91 00

LOUVERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fixed louvers, frames and accessories.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:
1. AMCA 500- L - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:
1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

1.3 PERFORMANCE REQUIREMENTS

A. Louver: To permit passage of air.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blankout areas required, and frames.

C. Product Data: Submit data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit Operation and Maintenance Data.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with applicable code for closing louvers.

B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section.

1.8 COORDINATION

A. Coordinate Work with installation of mechanical ductwork and electrical services to motorized devices.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

A. ACCESS DOOR LOUVERS - BAFFLE STYLE

B. Manufacturers:
   1. Fabrication will be made by architecture students in association with industrial design students under the direct supervision of an expert.

C. Substitutions: Section 01 60 00 - Product Requirements. Permitted.

D. Louver Construction: Pine Wood.

E. Louver Panel Thickness: 1/4 inches (6.35 mm) deep, face measurements as indicated on Drawings.

F. Louver Blade Design: Sloped at 45 degrees; baffle style, pine wood.

G. Louver: To permit passage of air without blade vibration or noise.

H. Louver: To permit 50 percent free area.

I. Water Penetration: Less that is possible.

2.2 COMPONENTS

A. Custom Pine Wood frame.

2.3 ACCESSORIES

A. Fasteners and Anchors: Galvanized steel type.

B. Sealants: See section 07 90 00.

2.4 FABRICATION

A. Louver Blade Design: Slope and style as specified for each louver type; material thickness of (.25 inch) (6.35 mm) minimum.

B. Louver Frame: See Construction Drawings for dimensions. Form perimeter of frames with recessed channel to retain backer rod for sealant application.

C. Intermediate Mullions: Concealed of formed steel, profiled to suit louver frame.

2.5 FACTORY FINISHING

A. Exterior Wood Surfaces: See section 06 05 73 Wood Treatment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify prepared openings are ready to receive Work and opening dimensions are as indicated on shop drawings.

B. Install Work in accordance with drawings and codes.

3.2 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust operable louvers for freedom of movement of control mechanism. Lubricate operating joints.

3.3 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements - Final cleaning.

B. Strip protective finish coverings.

C. Clean surfaces and components.

3.4 SCHEDULES

A. Penthouse - West Wall: Intake louver, hinged bird screen, prefinished to match adjacent window frames.

END OF SECTION

SECTION 09 21 16

GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes metal stud wall framing; metal channel ceiling framing; shaft wall system; gypsum board and joint treatment; gypsum sheathing.

1.2 REFERENCES

A. ASTM International:
1. ASTM C473 Standard Test Methods for Physical Testing of Gypsum Panel Products.
2. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
3. ASTM C1002 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
4. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
5. ASTM C1280 Standard Specification for Application of Gypsum Sheathing.
6. ASTM E72 Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
7. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
8. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
9. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
10. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
11. ASTM C1178 - Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel.
12. ASTM C1396/C1396M - Standard Specification for Gypsum Board.
13. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
14. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
15. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

B. Underwriters Laboratories Inc.:
   1. UL - Fire Resistance Directory.
   2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.3 PERFORMANCE REQUIREMENTS

A. Acoustic Attenuation for Identified Interior Partitions.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate special details.

1.5 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years [documented] experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

PART 2 PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

A. Manufacturers:
   1. Georgia- Pacific Building Products; Model: DensGlass Gold Exterior Sheathing.
      133 Peachtree Street NE
      Atlanta, GA 30303
      Phone: (404) 652- 4000
      Web Site: http://www.gp.com/
      Technical Data: http://www.gp.com/build/product.aspx?pid=4674

B. See Section 06 16 43 Gypsum Sheathing for Product Description and Details Information.

2.2 COMPONENTS

A. Framing Materials:
1. Aluminum C Shape Channel 2inch.
2. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

2.3 ACCESSORIES

A. Gypsum Board Screws: ASTM C954, ASTM C1002; length to suit application.

1. Screws for Steel Framing: Type S.
2. Screws for Wood Framing: Type W.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions are ready to receive work and opening dimensions are as indicated on shop drawings. Instructed by manufacturer.

B. Repair and remodel existing gypsum board assemblies which remain or are to be altered.

3.2 INSTALLATION

A. Metal Stud Installation:

1. Install studs in accordance with ASTM C754, ASTM C1007, GA-216 and GA-600.

3.3 SCHEDULES

A. Finishes in accordance with construction drawings.

END OF SECTION

SECTION 09 23 00

GYPSUM PLASTERING

PART 1 PRODUCTS

1.1 SUMMARY

A. Section includes gypsum plaster with; gypsum plaster fireproofing for building structural members; plaster base for gypsum veneer plaster; and access panels.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures

B. Product Data: Submit data on plaster materials, characteristics, and limitations of products specified.

1.3 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.4 PRE-INSTALLATION MEETINGS

A. Surface in which product shall be apply must be dry, clean and free of contaminants such as dirt, grease, chalk, dust, wax, loose paint or plaster.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not apply plaster when substrate or ambient air temperature is less than 40 degrees F (5 degrees C) nor more than 80 degrees F (27 degrees C). Do not overspread. Keep from freezing.

PART 2 PRODUCTS

2.1 GYPSUM PLASTER

A. Manufacturers:

1. Lanco Mfg Corp.; Model Patching Plaster PP-223 White Patching Paste
   Urb. Aponte #5
   San Lorenzo, PR 00754
   Phone: (787) 736-4221
   Fax (787) 736-5313
   Web Site: http://www.lancopaints.com/english/home.html
   Technical Data:
   http://www.lancopaints.com/english/products/Technical%20Data%20Sheet/5-Sealants/6-Interior%20Spackling/Patching%20Plaster.pdf
   Safety Data: http://www.lancopaints.com/pdf/PP223.pdf

B. Non-flammable, anti-fungus, easy to sand, ready mixed, dries hard, white finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Grounds and Blocking: Verify items within walls for other sections of work have been installed.

B. Gypsum Lath and Accessories: Verify substrate is flat and surface is ready to receive work of this section. Verify joint and surface perimeter accessories are in place.

3.2 PREPARATION

A. Rough smooth surfaces with sandpaper before application

B. Clean and let dry surface after application of product.

3.3 INSTALLATION

A. Apply Plaster with putty knife. One fill is usually sufficient for small dents and holes.

B. For deep fills, apply two or more layers, allowing to dry between applications.

C. Can be sanded or painted two hours after application. Allow longer drying time for deep fills

END OF SECTION

SECTION 09 51 13

ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.1 SUMMARY

A. Wood panels that are slotted on the front side and perforated on the backside.

B. Sound absorbing blanket.

C. Hardware or ceiling suspension system as required for attachment to substrate.

D. Coordination with all trades having elements that attach to, penetrate through or are concealed behind/above the wood panels of this section.

1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

A. Sound Absorbing Blanket – Black, glass fiber (or mineral wool) 50 kg/m^3 (3 pcf) density.

B. Mounting hardware or ceiling suspension system.

1.3 ALTERNATES

A. Prior Approval: Proposed substitutions for products in this section may be submitted to the architect and acoustical consultant no later than ten working days prior to the bid due date. Substitutions shall only be considered if submitted with complete information including acoustic data and a sample not smaller than 45 cm x 45 cm (18" x 18") showing product design, composition, size, slot/hole pattern, veneer, finish, standard penetrations, standard joint and end conditions and mounting hardware with suspension grid if applicable. Acceptance of substituted products is contingent on the architect's and acoustical consultant's approval and the substitution's compliance with all specified criteria. The architect shall approve substitution request via addendum.

B. Unapproved Substitutions. Substitutions not approved via addendum shall not be submitted to the architect or acoustical consultant.

1.4 REFERENCES

A. Local Building Code – Current Edition

B. ISO 354 - Measurement of sound absorption in a reverberation room.

C. American Society for Testing & Materials (ASTM)
1. ASTM C 423 - Sound Absorption & Sound Absorption Coefficients by the Reverberation Room Method
2. ASTM C 635 - Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
3. ASTM C 636 - Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile & Lay-In Panel Ceilings
4. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials
5. ASTM E 795 - Standard Practice for Mounting Test Specimens during Sound Absorption Tests
6. ASTM E 1264 - Classification for Acoustical Ceiling Products

1.5 SYSTEM DESCRIPTION

A. Design Requirements: Sound absorption shall be provided via two mechanisms: Transparency and Tuned Resonant Absorption. High frequency sound absorption shall be provided by allowing sound energy to pass through the wooden surface by means of slots and perforations. The energy shall then be absorbed (converted to heat) by a non-woven matt adhered to the rear surface and also by additional porous absorption placed behind/above the panel. Mid and low frequency sound absorption shall be provided via Tuned Resonant Absorption with a typical bell curve configuration.

B. Performance Requirements

1. Random Incidence, Octave Band, Sound Absorption Coefficients (a) and Noise Reduction Coefficient (NRC): Tested by independent, accredited, facility according to ISO 354 with 30 mm thick mineral wool. (Comparable Tests: ASTM C 423 Mount and ASTM E 795 Mount).

Topakustik (50 mm System)				Octave Band (Hz) Absorption Coefficients						
Solid	Slot	Hole	Open	125	250	500	1000	2000	4000	NRC
6	2	M	8.4%	0.10	0.42	0.92	0.81	0.78	0.70	0.73
5	3	M	19.0%	0.10	0.54	1.12	0.99	0.97	0.83	0.91
9	2	M	6.0%	0.14	0.64	1.06	1.01	0.70	0.59	0.85
14	2	M	7.0%	0.12	0.60	1.05	1.03	0.79	0.61	0.87
13	3	M	12.0%	0.16	0.51	1.14	1.11	0.77	0.67	0.88
12	4	M	15.0%	0.12	0.57	1.13	0.94	0.79	0.61	0.86
28	4	M	7.5%	0.17	0.48	1.03	0.88	0.47	0.41	0.72

Topakustik (200 mm System)				Octave Band (Hz) Absorption Coefficients						
Solid	Slot	Hole	Open	125	250	500	1000	2000	4000	NRC
6	2	M	8.4%	0.26	0.65	0.87	0.86	0.78	0.79	0.79

5	3	M	19.0%	0.31	0.76	0.98	1.02	0.96	0.84	0.93
9	2	M	6.0%	0.33	0.77	0.90	0.88	0.74	0.59	0.82
14	2	M	7.0%	0.27	0.77	0.95	0.94	0.85	0.60	0.88
13	3	M	12.0%	0.34	0.83	0.90	0.99	0.72	0.59	0.86
12	4	M	15.0%	0.32	0.83	0.94	1.02	0.77	0.65	0.89
28	4	M	7.5%	0.65	0.94	0.94	0.73	0.51	0.43	0.78

1.6 SUBMITTALS

A. Product Data: Submit standard cut sheet including basic system description, options and component sizes. Identify all applicable features and options. Cross out any inapplicable features or options.

B. Shop Drawings: The contractor shall produce and submit shop drawings of products and suspension or mounting systems overlaid on base drawings (interior elevations or reflected ceiling plans) supplied electronically by the architect. Show overall layout with dimensions and references to details as necessary for penetrations, joints, ends and intersections with other materials or building components. Submit schedule of all quantities, sizes, hole/slot patterns, edge banding, borders, veneers and finishes. Field verify site conditions with dimensions shown on shop drawings.

C. Samples: Submit a 12.8 cm (5") x 10.2 cm (4") sample of core material with approximate finish or veneer and black, nonwoven, fiber backing material.

D. Design Data / Test Reports: Submit octave band sound absorption coefficient data and Noise Reduction Coefficient data according to ISO 354.

1.7 QUALITY ASSURANCE

A. Qualifications: Manufacturer and installation contractor shall have a minimum of three years experience with similar systems.

B. Single Source: All products under this section shall be supplied by a single manufacturer to ensure consistency in product size and finish.

C. Flame Spread / Smoke Developed Characteristics: Tested by independent, accredited facility.

1. Noncombustible (A2) Core: Cement or Gypsum
   Tests: DIN 4102

2. Class A (B1) Core: Medium density fiberboard (MDF) type B1
   Tests: ASTM E 84, NFPA 255 & DIN 4102

Composite Flame Spread Rating: 25 (maximum)
Smoke Developed: 450 (maximum)

3. Flammable (B2) — Core: Medium density fiberboard (MDF) type B2
Tests: DIN 4102

D. Pre-Installation Meeting: Installing contractor shall organize and conduct pre-installation meetings with all other trades to coordinate substrate conditions, conditioning of the space (temperature & humidity), and elements attaching to, penetrating through or concealed above/behind work in this section.

1.8 DELIVERY STORAGE AND HANDLING

A. Shipping, Handling and Unloading: Deliver wood panels to the project site in the manufacturer's original, unopened packaging. Do not unpack or handle finished products until the project environmental requirements have been met and the products are ready to be installed.

B. Storage and Protection: Store all wood panels and associated wood trim pieces in a clean, dry, fully-enclosed storage facility. Protect products from damage that may be caused by exposure to water, chemicals, direct sunlight or infestation.

C. Acceptance at Site: Ensure that all project environmental requirements have been met prior to unpacking or installing wood panels or associated wood trim products. Full or partial installation constitutes complete product acceptance.

D. Waste Management and Disposal: Dispose of all packaging materials and debris in a safe and environmentally responsible manner according to the instructions set forth by the General Contractor, local ordinances or codes and the Environmental Protection Agency.

1.9 PROJECT CONDITIONS

A. Project Environmental Requirements: Prior to unpacking or installing wood products, ensure that the installation area is fully enclosed and protected from moisture and direct sunlight. Ensure that the building's mechanical systems are fully operational and will not be turned off again even for testing and balancing of the mechanical systems. Coordinate with other trades to ensure that all work above or behind wood surfaces is complete and that all wet and dusty trades have completed work.

B. Product Acclamation: For a minimum period of seventy-two (72) hours and prior to unpacking or installing any wood products, allow both the installation area and the wood products to stabilize in temperature and humidity levels that are representative of the final temperature and humidity levels expected after

building completion and occupation. Do not install products if the humidity exceeds 70%.

C. Product Handling: Handle wood panels carefully so as to avoid chipping, scratching, scuffing or denting the wood finish or edges.

1.10 WARRANTY

A. Submit to Owner or Owner's Representative a written and dated warranty issued by the wood ceiling/wall manufacturer warranting the wood panels and associated trim pieces against defects in materials or manufacturing for a period of one (1) year from the date of delivery.

B. Components used in the system but not provided by the manufacturer are excluded from the manufacturer's warranty. Damage caused by exposure to moisture or rapid or extreme changes to temperature or humidity are excluded from the manufacturer's warranty. Damage caused by improper storage, handling, acclimatization, or installation is excluded from the warranty. Appearances and colorings of wood products, stains and finishes can vary over time and as site conditions change and are therefore excluded from the warranty.

1.11 OWNER'S INSTRUCTIONS

A. installing contractor shall provide to the building owner or to the owner's representative a copy of the manufacturer's maintenance manual supplied with the panels.

1.12 MAINTENANCE

A. Extra Materials: If provided per the project requirements, extra materials shall remain in the manufacturer's original, unopened packaging and shall be given to the building owner or owner's representative upon substantial completion of work.

PART 2 PRODUCTS

3.1 ACOUSTICAL PANEL CEILINGS

A. Manufacturers:

1. Patt SpA, Fantoni Group
   Via Udine, 40
   33040 Attimis (Udine), Italy
   Phone: +39 0432 976314
   Fax: 039 0432 976546

Web Site: http://www.pattspa.it/
Technical Data:
http://www.fantoni.it/Prodotti/PannelliFonoassorbenti/TOPAKUSTIK-eco/caratteristiche/leftColumnParagraphs/0/document/Patt_AP.pdf

3.2 MATERIALS

A. Core (standard): Medium density fiberboard (MDF) made of soft and hard wood fibers with added binding agents, 16 mm (0.67") thick.

B. Veneer:
1. Natural Wood: Beech, maple, oak, birch, cherry or other as selected by architect (1 mm thickness). Custom flitches or book/stitch/slip matching as selected by architect.
2. Melamine: Faux wood pattern (*e.g.*, maple or beech), color or other as selected by architect (negligible thickness).
3. None: Painted colors as selected by architect (negligible thickness).

C. Backing Fabric: Nonwoven, black, glass fiber matt, 60 g/m^2 (0.012 psf) surface weight.

D. Acoustic Insulation: Nonwoven, black, glass fiber batt (or mineral wool), 25.4 mm (1") thick, 50 kg/m^3 (3 pcf) density (optional).

3.3 MANUFACTURED UNITS

A. Panels: (consult manufacturer for available combinations)
1. Width: 128 mm
2. Length: 4086 mm
3. Thickness: 16 mm (paint or melamine) or 17 mm (natural wood veneer)
4. Slot width: 2 mm, 3 mm or 4 mm
5. Width between slots: 5 mm, 6 mm, 9 mm, 12 mm, 13 mm, 14 mm or 28 mm.
6. Perforations (round)
   a. M-Hole (single diameter): 10 mm or 12 mm
   b. Spacing: 8 x 8 mm, 10,66 x 10,66 mm, 16 x 16mm or 32 x 32 mm
7. Edge conditions
   a. Concealed
      1) Standard: Straight cut, no veneer, unfinished, partial perforations visible.
      2) Female rabbet: 4 mm deep female rabbet for spline joint, no veneer, unfinished, perforations set back from edge (not visible).
      3) Tongue & Groove: 4 mm deep tongue or groove, no veneer, unfinished, perforations set back from edge (not visible).

b. Visible

a) Standard: Straight cut, no veneer, finished, perforations set back from edge (not visible).
b) Veneer: Straight cut, veneer, finished (slots terminate at edge veneer).
c) Veneer & setback: Straight cut, veneer, finished, slots terminate at specified distance from edge (per drawings).
d) Edge molding: Standard (Type 1, 2 or 3) edge molding or custom trim per drawings.

3.4 ACCESSORIES

A. Edge Moldings: Pre-painted aluminum profiles and / or MDF profiles as per architectural drawings. Finish to match finish on panels.

B. Custom Trim: Custom wood trim pieces per drawings finished to match finish on panels.

Access Doors and Frames: Can be created at the time of assembly, where necessary, using the special kit comprising. Kit comprising include pivoting latch, striker plate, cables with ring bolts, and fixing plate with height adjustment of about 2.5 mm.

C. Ceiling suspension system:

1. Manufacturers:
Viale Caduti sul Lavoro; Model: Kit comprising (Kit di Sospensione Controsoffitti)
60030 Monsano (AN) – Italy
Phone: +39.0731.61.90.25 r.a.
Fax: +39.0731.61.92.80 r.a.
Web Site: http://akifix.com/
Technical Data: Request to the manufacturers. Not available in the web site.

3.5 FABRICATION

A. Shop Assembly: Panels used in downwardly accessible, suspended, concealed grid, ceiling systems shall have acoustic insulation adhered to the panel backs (optional) and hardware such as braces or spring torsion clips prefastened for direct attachment to ceiling grid system.

B. Fabrication Tolerances – 0.10 mm (slots & perforations); 0.50 mm (lengths & widths)

3.6 FINISHES

A. Shop Finishing: Panels shall be shop-finished with stain per selection by architect (optional) and clear, semi-gloss varnish (wood veneers) or painted (matte finish) per color selection by architect.

3.7 SOURCE QUALITY CONTROL

A. Manufacturing facility for panels shall be ISO 9001 certified and provide certification documentation upon request by Architect.

PART 3 EXECUTION

3.1 INSTALLERS

A. Installing contractor shall have a minimum of five (5) years successful experience installing wood ceiling and wall systems in similar applications using similar mounting techniques or suspension systems.

B. Web site installation manuals:
http://www.fantoni.it/Prodotti/PannelliFonoassorbenti/TOPAKUSTIK-eco/assembly/leftColumnParagraphs/0/document/1527_Low.pdf

3.2 EXAMINATION

A. Site Verification of Conditions: Examine installation area for compliance with all manufacturer's project environmental requirements and ensure uninstalled products have been stored, handled and acclimatized properly prior to commencing installation. Inspect all substrates for completion and quality of work to ensure that surfaces are level, plumb, clean, dry and completely cured from water or solvent evaporation. Do not commence installation if the structural capacity of the substrate is questionable or inadequate.

B. Coordination with Other Trades: Coordinate with all other trades to ensure that wet work including concrete, terrazzo, plastering, painting, etc. in the installation area is complete, cured and dry prior to installation. Coordinate with all other trades to verify that components associated with mechanical, electrical, lighting, data, telecommunication, audio, video, fire suppression and other building systems are installed behind or above designated installation areas prior to commencing installation. Coordinate the exact size, location and sequencing of building system components that penetrate the wood ceiling/wall panels.

3.3 PREPARATION

A. Protection: Protect all floor, wall and ceiling finishes against possible damage prior to commencing installation and during installation.

B. Surface Preparation: When necessary, field measure substrates to acquire accurate dimensions of wood panels and submit final dimensions to manufacturer.

3.4 INSTALLATION

A. Install wood panels as shown and detailed in the architectural drawings and according to manufacturer's guidelines and industry standards.

B. Install wood panels with expansion/contraction gaps equal to 1 mm (1/32") for every 1 meter (3.28') of length/width (3 mm minimum between panels).

C. Web site installation manual:

http://www.fantoni.it/Prodotti/PannelliFonoassorbenti/TOPAKUSTIK-eco/assembly/leftColumnParagraphs/0/document/1527_Low.pdf

3.5 CONSTRUCTION

A. Interface With Other Work: Support all light fixtures, HVAC air inlet/outlet devices, speakers, signage, sprinkler heads/piping, etc. independently from wood panels. Do not use wood panels to support the weight of any other building element or component.

3.6 ADJUSTING

A. Following initial installation, adjust mounting hardware or suspension system so that removable panels can be removed easily, yet stay safely secured upon replacement. Adjust panels so that surfaces are aligned, flush and level or plumb and gaps in between units are of a consistent width and straight.

B. Check that manufacturer's expansion/contraction requirements were maintained during installation. As required, adjust the mounting hardware or suspension system to allow for the appropriate amount of product expansion/contraction.

C. Remove and replace at no extra charge any damaged panels that cannot be repaired to the Owner's and Architect's satisfaction.

3.7 CLEANING

A. Remove dust from surfaces, grooves and penetrations by vacuuming using only a soft brush. Do not scratch wood surfaces with sharp metal or plastic vacuum cleaner extensions. Remove pencil marks with soft erasure. Remove general surface dirt with a clean, soft cloth dampened with a diluted, mild, cleaning agent and warm water. Wipe again with clean, soft cloth dampened only with warm water. Finally, dry surface completely with clean, dry cloth. Do not use abrasive cleaners with grit or cloths that could scratch the wood finish.

B. Remove and replace at no additional charge any materials that cannot be cleaned to the Owner's satisfaction.

3.8 DEMONSTRATION

A. Demonstrate to the building owner or to the owner's representative the safe and proper method for removing and replacing all types of accessible panels.

B. Supply the building owner or the owner's representative with any special tools provided by the manufacturer required to unlatch safety hardware on accessible panels.

3.9 PROTECTION

A. Upon completion of work, protect installed wood surfaces from damage or soiling until project substantial completion and owner occupancy.

END OF SECTION

SECTION 09 96 00

HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes high performance coatings and special preparation of surfaces.

1.2 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. Federal Specification Unit:
1. FS A-A-3054 - Paint, Heat Resisting (204 C).
2. FS A-A-3120 - Paint: For Swimming Pools.
3. FS QPL-TT-P-28-15 - Paint, Aluminum, Heat Resisting (1200 Deg. F).
4. FS TT-C-555 - Coating, Textured (For Interior and Exterior Masonry Surfaces).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Product Data: Submit data indicating coating materials and performance ratings.

C. Manufacture recommendation for storage and protection of the product on site.

D. Manufacturer's Installation Instructions: Submit special procedures, perimeter conditions requiring special attention.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit maintenance and cleaning requirements for coatings, repair and patching techniques.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Applicator: Company specializing in performing Work of this section.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Do not install materials when temperature is below 55 degrees F, 13 degrees C, or above 90 degrees F 32 degrees C.

C. Maintain this temperature range, 24 hours before, during, and 72hours after installation of coating.

D. Provide lighting level of 80 ft candles 860 lx measured mid-height at substrate surface.

E. Restrict traffic from area where coating is being applied or is curing.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Warranty: Include coverage for bond to substrate, degradation of chemical resistance.

PART 2 PRODUCTS

2.1 HIGH PERFORMANCE COATINGS

A. Manufacturers:
1. Harris Paints Company. Model: Titanium Acrylic Wall Primer.
PO BOX 364723 SAN JUAN, PR. 00936-4723
Phones: 787-798-1005
Fax: 787-798-3555
Web: http://www.harrispaints.com/
Technical Data: http://www.harrispaints.com/tech1.html.

2. Harris Paints Company. Model: Titanium Acrylic Flat White
   Technical Data: Request data to the manufacturers.

3. Substitutions: Section 01 60 00 - Product Requirements. Not Permitted.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify substrate surfaces are ready to receive work as instructed by coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.

3.2 PREPARATION

A. Clean surfaces of loose foreign matter.

B. Remove substances that would bleed through finished coatings. When removal is not possible, seal surface with shellac.

C. Remove finish hardware, fixture covers, and accessories and store.

3.3 INSTALLATION

A. Install Work in accordance with manufacturer's instructions.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Collect waste material which may constitute fire hazard, place in closed metal containers, and remove daily from site.

C. Clean surfaces immediately of overspray, splatter, and excess material.

D. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

END OF SECTION

SECTION 10 22 13

WIRE MESH PARTITIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes screen system for doors with interior aluminum frame and exterior teak wood frame, aluminum rail.

1.2 REFERENCES

A. Architectural Woodwork Institute:
1. AWI - Quality Standards Illustrated.

2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
4. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
5. ASTM B211M - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire (Metric).
6. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
7. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
8. ASTM C847 - Standard Specification for Metal Lath.

B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

C. SSPC: The Society for Protective Coatings:
1. SSPC - Steel Structures Painting Manual.

1.3 DESIGN REQUIREMENTS

A. Design partition system to provide for movement of components without damage, undue stress on fasteners or other detrimental effects, when subject to design loads.

B. Design system to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Indicate plan and vertical dimensions, elevations, component details, location of hardware. Include component details, framed openings, bearing, anchorage, loading, [welds,] type and location of fasteners, and accessories or items required of related work.

C. Product Data: Submit data for screen materials, finishes.

D. Manufacturer's Installation Instructions.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

1.6 FIELD MEASUREMENTS

A. Verify field measurements are as shown on Drawings, shop drawings, instructed by manufacturer.

PART 2 PRODUCTS

2.1 WIRE MESH PARTITIONS

A. Manufacturers:
1. Students in collaboration with professional contractors. Partitions are wood teak frame sliding screen doors.

2. Substitutions: Section 01 60 00 - Product Requirements. Not Permitted.

2.2 COMPONENTS

A. KOOLSHADE SOLAR SCREEN

B. Manufacturers:
1. Coopers. Model: Koolshade Solar Screen.
Edward House
Penner Road
Havant, Hampshire
PO9 1QZ
Phone: +44 (0)23 9245 4405
Fax: +44 (0)23 9249 2732
Web Site: http://www.koolshade.com/
Technical Data: http://www.koolshade.com/datasheets.htm

C. Interior Aluminum Frame: Fabrication directly from Koolshade Solar Screen manufacturers.

D. Exterior teak Frame: Reclaimed wood, see Section 06 20 00 Finish Carpentry.

E. Aluminum Rail: Have complied with codes.

2.3 FABRICATION

A. Fit and assemble in largest practical sections for delivery to site, ready for installation.

B. Furnish components required for anchorage to adjacent construction.

C. Frame openings made for penetrating mechanical and electrical components.

D. Fabricate door for sliding operation.

2.4 SHOP FINISHING

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. See section 06 05 73 Wood Treatment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify substrate surfaces and required openings are ready to receive work.

3.2 PREPARATION

A. Clean substrate surfaces.

3.3 INSTALLATION

A. Install doors in accordance with manufacture instruction.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust hinged doors to achieve free movement.

END OF SECTION

SECTION 10 28 00

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
1. Towel bars and holders.
2. Soap dishes, tumblers and containers.
3. Shelves and mirrors.
4. Toilet paper holders.
5. Grab bars and supports.

1.2 REFERENCES

A. ASTM International:
1. ASTM F 446 - Standard Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area.

1.3 DESIGN REQUIREMENTS

A. Design grab bars, shower seats, dressing room bench seats and attachments to resist concentrated load applied at any point in any direction.

1.4 SUBMITTALS

A. Section 01 33 00: Submittal Procedures.

B. Product Data: Manufacturer's standard catalog data for each product specified, including dimensions, finish information, details of function, and mounting details.

C. Verification Samples: Submit samples of each product specified, illustrating color and finish.
1. Approved samples will be returned to the Contractor and may be used in the project.

D. Shop Drawings:
1. Locate each specified unit in project.
2. Indicate mounting height of each unit.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's ordering instructions and lead time requirements.

B. Store products in manufacturer's unopened packaging until ready for installation.

1.6 COORDINATION

A. Coordinate installation of blocking, bracing and backing to receive products of this section.

B. Supply installation templates, required reinforcing, and recessed anchorage devices in timely fashion to installers of related work that will receive products of this section.

1.7 WARRANTY

A. Provide manufacturer's standard replacement warranty against defects in materials and workmanship.

PART 2 PRODUCTS

2.1 TOILET AND BATH ACCESSORIES

A. Manufacturer:
1. Kohler's Co.
444 Highland Drive
Kohler, WI 53044;
Phones: 1-800-456-4537 or 1-920-457-4441
Web: http://www.kohler.com/
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1013267_4.pdf

B. Kohler's Co. Model K-14450-CP, Towel Bar.

C. Kohler's Co. Model K-14456-CP, Towel Ring.

D. Kohler's Co. Model K-14458-CP, Robe Hook.

E. Kohler's Co. Model K-14461-CP, Soap Dish.

F. Kohler's Co. Model K-14463-CP, Tumbler/ toothbrush holder.

G. Kohler's Co. Model K-14459-CP, Toilet tissue holder.

H. Kohler's Co. Model K-14455-CP, Glass shelf.

I. Quality Glass. Model: Mirror, 18" x 24" x ¼".

J. Substitutions: According to Section 01 60 00: Product Requirements

2.2 UTILITY ROOM ACCESSORIES

A. Mop and Broom Holder: to be specified by architect during construction.

B. Drying Racks: to be specified by architect during construction.

C. Wall mount ironing: to be specified by architect during construction.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify that prepared openings are sized and located in accordance with approved shop drawings. Verify that blocking, reinforcement and anchoring devices are the correct type, have been located correctly, and have been installed properly.

3.2 PREPARATION

A. Deliver inserts and rough-in frames to site for timely installation.

B. Provide templates and rough-in measurements as required.

3.3 INSTALLATION

A. Install toilet and bath accessories in accordance with manufacturer's instructions.

B. Locate accessories as indicated on the drawings and at heights that are in accordance with Americans with Disabilities Act.

C. Web Site installations manuals:
1. Accessories:
http://www.us.kohler.com/onlinecatalog/pdf/1087646_2.pdf
2. Single door aluminum cabinet:
http://www.us.kohler.com/onlinecatalog/pdf/1070224_2.pdf

3.4 CLEANING

A. Clean surfaces as required, following procedures and employing cleaning materials as recommended by accessories manufacturer.

3.5 PROTECTION

A. Protect installed products from damage by subsequent construction activities, until completion of project. Field repair of damaged product finishes is prohibited. Replace products that have been damaged by subsequent construction activities.

END OF SECTION

SECTION 10 44 00

FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers installed as part of the project.

B. NIH-Furnished Material: Hand-carried fire extinguishers.

1.2 SUBMITTALS

A. Section 01 33 00: Submittal Procedures.

B. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets

C. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Do not install extinguishers when ambient temperature is capable of freezing extinguisher ingredients.

1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Failure of hydrostatic test according to NFPA 10.
   b. Faulty operation of valves or release levers.

PART 2 PRODUCTS

2.1 FIRE EXTINGUISHERS

A. Manufacturers: Subject to compliance with requirements, provide products which utilize the following spare parts maintained by the NIH Fire Department to allow their testing, recharge and maintenance.

B. Extinguisher Finish: Stainless steel, polished chrome.

2.2 ACCESSORIES

A. Extinguisher Brackets: Formed steel, chromed.

B. Graphic Identification: approved by NFPA, size may not be bigger than diameter of fire extinguisher.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

B. Remove and replace damaged, defective, or undercharged fire extinguishers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fire extinguisher and mounting bracket inside architectural woodwork cabinet (multi-purpose closet). Secure rigidly in place. Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

SECTION 11 31 13

RESIDENTIAL KITCHEN APPLIANCES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
1. Dishwashers.
2. Built-In Electric Cook tops.
3. Ventilation Hoods.
4. Refrigerators.

1.2 REFERENCES

A. EPA - Energy Star Appliances.

B. Public Law 101-336 - Americans with Disabilities Act.

1.3 SUBMITTALS

A. Section 01 33 00 Submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Model number and selected options for each appliance.
2. Preparation instructions and recommendations.
3. Rough in dimensions and utility connections.
4. Storage and handling requirements and recommendations.
5. Installation methods.
6. List of maintenance parts.

C. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable codes and regulations as applicable for the project.

B. Energy Rating: Provide appliances with the EPA Energy Star label where specified.

C. Coordinate rough-in requirements with adjacent construction. Coordinate components and fittings to ensure compatible parts are installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

1.6 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.7 WARRANTY

A. Provide manufacturer's standard written warranty for each type of appliance specified.

PART 2 PRODUCTS

2.1 DISHWASHERS:

A. Manufacturer:
1. Electrolux Major Appliances; Model EWDW6505G S 24" Built-in Dishwasher with Wave Touch
250 Bobby Jones Expressway
Augusta, GA 30907
Phone: 1-877-435-3287
Web Site: http://www.electroluxappliances.com/
Technical Data:
http://www.electroluxappliances.com/Files/Documents/Specifications/EWDW6505G_sp_EN.pdf

B. Built-in Dishwasher with Wave Touch: Energy Star Qualified. Wave Touch control panel, large capacity, stainless steel finishes, leak detection system, quiet system 45dBA sound level.

C. Substitutions: According to Section 01 60 00 – Product Requirements.

2.2 ELECTRIC COOKTOPS

A. Manufacturer:
Electrolux Major Appliances; Model Induction Hybrid Cooktops
EW30CC55G S
250 Bobby Jones Expressway
Augusta, GA 30907
Phone: 1-877-435-3287
Web Site: http://www.electroluxappliances.com/
Technical Data:
http://www.electroluxappliances.com/Files/Documents/Specifications/EW30CC55G_sp_EN.pdf

B. Two induction elements, black color, 8.1/7.1 Kw of power and 240V/208V; 40A, stainless steel frame.

2.3 VENTILATION HOODS:

A. Manufacturer:
1. General Electric; Model JV930SCBR, 30 Inch (762 mm) Slide Out Vent Hood
General Manager, Customer Relations
GE Appliances, Appliance Park
Louisville, KY 40225
Phone: 1 203 373 2211
Web Site: http://www.ge.com/
Technical Data:
http://products.geappliances.com/MarketingObjectRetrieval/Dispatcher?RequestType=PDF&Name=220954_jv930sc_r2.pdf

B. Slide Out Vent Hood: canopy range hood, 9 inch (229 mm) high. Brushed aluminum finishes. See-Through Glass Visor Slides In and Out. 300 CFM Performance. Variable speed fan control, auto heat sensor, and compact. Vertical exhaust Width 3-1/4" x 10" Rectangular Duct.

2.4 REFRIGERATORS:

A. Manufacturer:
1. Electrolux Major Appliances; Model EW23CS65G S Counter-Depth Side by Side Refrigerator
250 Bobby Jones Expressway
Augusta, GA 30907
Phone: 1-877-435-3287
Web Site: http://www.electroluxappliances.com/
Technical Data:
http://www.electroluxappliances.com/Files/Documents/Specifications/EW23CS65G_sp_EN.pdf

B. Counter Depth Side By Side Refrigerator: Energy Star Qualified. Capacity of 23 Cu. Ft. Refrigerator/Freezer with PureAdvantage Water Filtration. Ice and Water Dispenser. Stainless steel finished.

C. Accessories:
   1. Electrolux Major Appliances; Model EAFWF01 PureAdvantage Water and Air Filtration System.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared. Coordinate rough-in with appliance sizes and utility requirements.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Assemble appliances and trim and install in accordance with manufacturer's instructions and the following:
   1. Install appliances plumb and level and in proper relationship to adjacent construction.
   2. Connect appliances to building utility, supply and waste systems as applicable.
   3. Test for proper operation and drainage. Adjust until proper operation is achieved.

B. Web Site installation manuals:

   1. Dishwasher: http://www.electroluxappliances.com/Files/Documents/Install%20Guides/dishwasher_in.pdf

   2. Induction Cooktop: http://www.electroluxappliances.com/Files/Documents/Install%20Guides/EW30CC55G_in.pdf

3. Vent Hood: http://products.geappliances.com/MarketingObjectRetrieval/Dispatcher?RequestType=PDF&Name=49-80421.PDF

4. Refrigerator: http://www.electroluxappliances.com/Files/Documents/Install%20Guides/SideBySide_in_EN.pdf

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.5 APPLIANCE DATA SHEETS

A. Refer to the manufacturer's data sheets attached to this Section for required features and additional requirements.

END OF SECTION

SECTION 11 31 23

RESIDENTIAL LAUNDRY APPLIANCES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
1. Washer.
2. Dryer.

1.2 REFERENCES

A. EPA - Energy Star Appliances.

1.3 SUBMITTALS

A. Section 01 33 00: Submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Model number and selected options for each appliance.
2. Preparation instructions and recommendations.
3. Rough in dimensions and utility connections.
4. Storage and handling requirements and recommendations.
5. Installation methods.
6. List of maintenance parts.

C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

D. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, represent actual product, color, and patterns.

E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable codes and regulations as applicable for the project, including the Americans with Disabilities Act for appliances for the disabled.

B. Energy Rating: Provide appliances with the EPA Energy Star label where specified.

C. Coordinate rough-in requirements with adjacent construction. Coordinate components and fittings to ensure compatible parts are installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

1.6 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.7 WARRANTY

A. Provide manufacturer's standard written warranty for each type of appliance specified.

PART 2 PRODUCTS

2.1 WASHER

A. Manufacturer:
1. Electrolux Major Appliances; Model EWFLW65H SS, Electric Front Load Washers
250 Bobby Jones Expressway
Augusta, GA 30907
Phone: 1-877-435-3287
Web Site: http://www.electroluxappliances.com/
Technical Data:
http://www.electroluxappliances.com/Files/Documents/Specifications/EWFLW65H_sp_EN.pdf

B. EWFLW65H SS, Electric Front Load Washers: Energy Star Qualified, 4.7 Cu. Ft., stainless steel finishes, 1,000 Watts, 12A.

C. Substitutions: Section 01 60 00.

2.2 DRYER

A. Manufacturer:
1. Electrolux Major Appliances; Model EWMED65H SS, Electric Front Load Dryers
250 Bobby Jones Expressway
Augusta, GA 30907
Phone: 1-877-435-3287
Web Site: http://www.electroluxappliances.com/
Technical Data:
http://www.electroluxappliances.com/Files/Documents/Specifications/EWMED65H_sp_EN.pdf

B. EWMED65H SS, Electric Front Load Dryers: Energy Star Qualified, 8 Cu. Ft., stainless steel finishes, 5,500 Watts, 27A.

C. Substitutions: Section 01 60 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared. Coordinate rough-in with appliance sizes and utility requirements.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Assemble appliances and trim and install in accordance with manufacturer's instructions and the following:
1. Securely mount to substrate.
2. Install appliances plumb and level and in proper relationship to adjacent construction.
3. Connect appliances to building utility, supply and waste systems as applicable.
4. Test for proper operation and drainage. Adjust until proper operation is achieved.

B. Web Site installation manuals:

Washer:
1. http://www.electroluxappliances.com/Files/Documents/Install%20Guides/EWFLW65H_in_EN.pdf

Dryer:
2. http://www.electroluxappliances.com/Files/Documents/Install%20Guides/EWMED65H_in_EN.pdf

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.5 APPLIANCE DATA SHEETS

A. Refer to the manufacturer's data sheets attached to this Section for required features and additional requirements.

END OF SECTION

SECTION 12 35 30

RESIDENTIAL CASEWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section includes cabinets and counter tops; vanity cabinets and counter tops; and casework hardware.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A156.9 - Cabinet Hardware.
2. ANSI A161.1 - Performance and Construction Standard for Kitchen and Vanity Cabinets.

B. Kitchen Cabinet Manufacturers Association:
1. KCMA - Directory of Certified Cabinet Manufacturers.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Indicate casework locations, scale plans, elevations, rough-in and anchor placement dimensions and tolerances and clearances required.

C. Product Data: Submit component dimensions, configurations, construction details, and joint details.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with construction drawings and codes.

B. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

PART 2 PRODUCTS

2.1 RESIDENTIAL CASEWORK

A. Manufacturers
1. Talleres Inc.
Calle San Agustin #259
Puerta de Tierra, P.R.
Phone: 1-787-721-8104
Fax: 1-787-722-2857

2. Substitutions: Section 01 60 00 - Product Requirements. Not Permitted.

B. All wood casework including base unit, upper cabinet, counter top, movable table, multipurpose cabinet, and living/office will be custom made.

2.2 COMPONENTS

A. Cabinet Construction: Plywood framing and teak wood panel.

B. Counter Top: Treated Teak Wood with ultra gloss resin finish.

C. Side Splash: Treated Teak Wood with ultra gloss resin finish, square internal intersections to back splash and top surface contoured to suit counter top profile.

D. Door and Drawer Fronts: Formica Brand Laminated Finish over Teak Wood.

E. Bolts, Nuts, Washers and Screws: Of size and type to suit application.

F. Concealed Joint Fasteners: Threaded steel.

2.3 HARDWARE COMPONENTS

A. Drawer Slides: Epoxy Slides Bottom Mounted, ¾ Extension, Non Self Closing; 18": Item #423.38.145.

B. Hinges: Concealed Hinges A-200 Series- Salice; Model: C2P9A99; Hinge Type: 17; Nickel Plated: 329.03.503 9 (to be mounted in all cabinet doors). Middle Door Hinge- with Safety Feature; Item #: 372.64.790.

C. Drawer Swings: Swing-Up Fitting Gray RAL9006: Left-372.64.704, Right-372.64.703.

D. Door Bumpers: Resilient plastic with adhesive back; clear or brown color; 5/16" diameter x 3/64" and/or 3/8" diameter x 1/8".

E. Shelf Supports: Nylon with 5 mm diameter steel pin [no back,] [low back,] [high back] or [locking feature for 5/8" shelves]; [clear,] [white,] [brown] or [almond] color.

2.4 FABRICATION

A. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.

B. Fabricate corners and joints without gaps or inaccessible spaces or areas where dirt or moisture could accumulate.

C. Fabricate each unit rigid, not dependent on building structure for rigidity.

D. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.

E. Form edges smooth. Form material for counter tops, facing, shelves, and drain boards from continuous sheets.

F. Provide cutouts for plumbing fixtures, appliances, fixtures, and fittings. Prime paint contact surfaces of cut edges.

G. When necessary to cut and fit on site, furnish materials with ample allowance for cutting. Furnish trim for scribing and site cutting.

2.5 SHOP FINISHING

A. Exposed To View Surfaces: Plastic laminate: Formica Brand Laminated Finish color as selected.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify adequacy of support framing.

3.2 INSTALLATION

A. Install casework, components and accessories.

B. Use anchoring devices to suit conditions and substrate materials encountered.

C. Set casework items plumb and square, securely anchored to building structure.

D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch (1 mm). Use filler strips; not additional overlay trim for this purpose.

E. Close ends of units, back splashes, shelves and bases.

3.3 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust doors, drawers, hardware, fixtures, and other moving or operating parts to function smoothly.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean casework, counters, shelves, and hardware.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit finished casework to be exposed to continued construction activity.

3.6 SCHEDULES

A. See the kitchen plan in the construction drawings for further information on the schedules.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Adjust list below to suit Project.
2. Piping materials and installation instructions common to most piping systems.
3. Transition fittings.
4. Dielectric fittings.
5. Mechanical sleeve seals.
6. Sleeves.
7. Escutcheons.
8. Grout.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

PART 2 PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Section 22 11 00 pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

B. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Revise pressure ratings and temperatures in five paragraphs and associated subparagraphs below to suit Project or add other options for specific applications.

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

F. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

   1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

B. Sleeve in paragraph below is available with many end variations.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.7 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. Do not delete or combine types of escutcheons in seven paragraphs below until selections in Part 3 "Piping Systems - Common Requirements" Article are made.

C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

D. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.
      a. One-Piece, Floor-Plate Type: Cast-iron floor plate.

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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 in exposed interior spaces, unless otherwise indicated.

C. Install plumbing 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.

3.5 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

   a. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
   b. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 22 05 16

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Flexible pipe connectors.
2. Pipe alignment guides.
3. Pipe anchors.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.9 - Building Services Piping.
2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

1.3 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Include shop drawing information for piping expansion compensation in shop drawings for piping system.

C. Product Data:
1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Manufacturer's Installation Instructions: Submit special procedures.

E. Manufacturer's Certificate: Certify products meet or exceed requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

C. Operation and Maintenance Data: Submit adjustment instructions.

1.6 QUALITY ASSURANCE

A. Perform work in accordance manufacturer installation guide and specifications.

B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

1.11 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

A. Water connector of supply piping systems, FIP fitting. Patented braided polymer-coated fibers are engineered for corrosion protection even against harsh household chemicals. More flexible than stainless steel to bend freely without kinking or crimping.

2.2 PIPE ALIGNMENT GUIDES

A. Manufacturers:
1. VIEGA; Model: U Channel Fastener
301 N. Main, Floor 9
Wichita, KS 67202
Phone: 1-877-843-4262
Fax: 1-800-976-9817
Web Site: http://www.viega.com/
Technical Data: Not Available.

2. Substitutions: Section 01 60 00 - Product Requirements.

B. U Channel Fastener: Fasten rows of PEX Channel to foam board and snap tubing into it. Tubing insertion points every 2 inches for a variety of tubing spacing options.

2.3 PIPE ANCHORS

A. Pipe Anchors: anchors for suspended or supported piping systems.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install each product in accordance with manufacturer installation instructions and specifications.

3.2 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.

B. Submit the information to install the product.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Piping system insulation.
2. Equipment insulation.

1.2 REFERENCES

A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Samples: Submit two samples of representative size illustrating each insulation type.

D. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding [450] [50] in accordance with ASTM E84.

B. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements : Requirements for transporting, handling, storaging, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature during and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 PIPING SYSTEM INSULATION

A. Manufacturer:
1. Prodex Total Insulation Foil-Foam-Foil (FfmF) Model #ESR-2350.
P.O. Box 9020150
San Juan Station
San Juan, PR 00902-0150
Telephone:(787)-275-6095
Web Site: http://www.achatrading.com/
Technical Data: http://www.achatrading.com/insulation/prodex.htm

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Prodex Total Insulation: multi-layer reflective insulation product that reflects back radiant (infra-red) energy from the sun. It also reflects back radiant heat inside the house so it does not escape. The multi-layer reflective insulation product consists of aluminum foil, polyethylene backing, closed-cell polyethylene foam, polyethylene backing, and aluminum foil. Only reflective insulation that is ICC-ES recognized (4'x175' roll only) and Energy Star Qualified. More tear resistant and foam interior handles punctures and temperature extremes better than bubble wraps. Works in temperatures as extreme as low as (minus) -20 degrees Celsius and as high as 80 degrees Celsius. Provides 19 DB Soundproofing. The aluminum is creased to create more airflow in applications, which enhances performance. Easier to cut than bubble wraps and fiberglass batt. The two R Values of Heat Flow Down (roof/ceiling) are 21.10 R Value for two layers of Prodex installed to form two 2.64 inch airspaces and 15.67 R Value for one layer of Prodex installed to form two 2.64 inch airspaces. No asbestos. No toxic vapors in case of fire. Ozone Friendly (Member of UNITED STATES GREEN BUILDING COUNCIL).

2.2 EQUIPMENT INSULATION

A. Manufacturer:
1. Residential Honeywell Closed-Cell Spray Foam Insulation.
101 Columbia Road
Morristown, NJ 07962
Phone: (973) 455-2000
Web Site: http://www.ccfoam.com/
Technical Data: Not Available.

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Closed-Cell Spray Foam features structural strength, air infiltration control, moisture/condensation control and thermal insulation. It benefits in energy savings, improved indoor air quality, improved comfort (draft reduction), and a problem solving tool for ice dam, rim joist, pipe freeze, tub enclosures, unvented attics, unvented crawl space, leaky windows, foundations and R-23 using 2x4

framing. Provides LEED credits opportunities and LEED performance levels. Closed-Cell Spray Foam provides the highest R-value (6.8) of available insulation materials. It also provides the best defense against all six mechanisms of heat transfer. Unlike other insulation materials, closed-cell spray foam seamlessly fills regular and irregular spaces. It's semi-impermeable, allows for controlled breathing and drying. Uniformity and consistency enable it to resist passage of vapor equally well in all directions. It minimizes dew point problems and condensation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify piping and equipment has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Insulation products will be installed following the precise instructions provided by the manufacturer.
   1. Piping system insulation.
   2. Equipment insulation.

3.3 SCHEDULES

A. Plumbing Systems:
   1. See construction drawings for further information.

END OF SECTION

SECTION 22 11 00

FACILITY WATER DISTRIBUTION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Domestic water piping.
2. Fitting adapters.
3. Valves.
4. Relief valves.
5. Hose bibs.
6. Base-mounted pumps.
7. Pressure systems.
8. Manifold control unit.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI 112.26.2 - Relief Valves.

B. American Society of Mechanical Engineers:
1. ASME A112.18.1 – Plumbing Fixture Fittings
2. ASME B1.20.1 - Pipe Threads, General Purpose
3. ASME B1.20.7 - Hose Coupling Screw Threads

C. American Society of Sanitary Engineering:
1. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.

D. ASTM International:

1. ASTM F876 - Standard Specification for Cross-linked Polyethylene (PEX) Tubing.
2. ASTM F 877 - Standard Specification for Cross-linked Polyethylene (PEX) Tubing.
3. ASTM F 1807 - 08 Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing
4. ASTM F 2023 - 08 Standard Test Method for Evaluating the Oxidative Resistance of Cross-linked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water.

E. Manufacturers Standardization Society of the Valve and Fittings Industry.

F. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.

G. EPA Requirements Approved.

H. FDA Requirements Approved.

I. National Standard of Boiler & Pressure Vessel Inspectors.

J. NSF International Standard 14 and 61.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturer's catalog information.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
5. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements : Closeout procedures.

B. Project Record Documents: Record actual locations of valves and equipment.

C. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

1.5 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Installer: Performing the work of this section with installation manufacturer guide and specifications.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept valves and equipment on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

1.10 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING

A. Manufacturers:
1. VIEGA; Model Viega PEX Cross-linked Polyethylene Pipe
301 N. Main, Floor 9

Wichita, KS 67202
Phone: 1-877-843-4262
Fax: 1-800-976-9817
Web Site: http://www.viega.com/
Technical Data: http://www.viega.net/cps/rde/xbcr/en-us/TD-PFVP-1207_ViegaPEX.pdf

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Cross-linked Polyethylene Pipe: ASTM F876/F877. All Viega PEX tubing is manufactured from a cross-linkable high density polyethylene produced by grafting organo-silanes onto a polyethylene base. A catalyst (accelerator) added to the cross-linkable polyethylene during extrusion initiates the cross-linking process. Cross-linking is completed with hot water or steam (sauna). It is a hot and cold water distribution tubing. Available in red, and blue for easy identification of hot and cold lines. Bronze fittings and mechanical joints with stainless steel clamp. Diameter of ½ inches (12.7) mm.

2.2 FITTING ADAPTERS

A. Manufacturers:

1. VIEGA; Model Bronze PEX Press Male NPT Adapters ½" x ½"
   301 N. Main, Floor 9
   Wichita, KS 67202
   Phone: 1- 877-843-4262
   Fax: 1-800-976-9817
   Web Site: http://www.viega.com/
   Technical Data: http://www.viega.net/cps/rde/xbcr/en-us/TD-PFPX-1207_PEX_Press.pdf

2. VIEGA ; Model Bronze PEX Press Female NPT Adapters ½" x ½"
3. VIEGA; Model Stainless Steel Press Sleeves ½"

B. Bronze PEX Press Male NPT Adapters: ASTM standards; F877, F1807, PEX adapter fittings shall mate to NPT threads, copper tubing, copper fittings or Pro Press fittings.

C. Bronze PEX Press Female NPT Adapters: ASTM standards; F877, F1807, PEX adapter fittings shall mate to NPT threads, copper tubing, copper fittings or Pro Press fittings.

D. Stainless Steel Press Sleeves: ASTM F877; manufactured from 304 stainless steel that will not corrode, maintaining a clean appearance for the lifetime of the system.

2.3 GATE VALVES

A. Manufacturers:

1. Infiva Industrial Fittings and Valves Inc. Model: Gate Valves
P.O. Box 2329
Toa Baja, P.R. 00951
Francisco Jaen (Product Manager)
Phone: 787 - 379 - 2839
Email: franciscojaen1@yahoo.com
Web Site: Not Available.
Technical Data: Not Available.

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Bronze Gate Valves: ANSI/ASME B1.20.1/MSS SP-80; non-rising stem, solid wedge disc, back seat design, NPT ends, sizes 1/4" to 3", 200 WOG ;125 PSI Saturated Steam.

2.4 CHECK VALVES

A. Manufacturers:

1. Infiva Industrial Fittings and Valves Inc. Model: Check Valves
P.O. Box 2329
Toa Baja, P.R. 00951
Francisco Jaen (Product Manager)
Phone: 787 - 379 - 2839
Email: franciscojaen1@yahoo.com
Web Site: Not Available.
Technical Data: Not Available.

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Check Valves: ANSI/ASME B1.20.1, MSS SP-25; MSS SP-80; Resilient Disc, NPT ends, 1/2 inches (12.7 mm), 300 WOG, 150 PSI Saturated Steam.

2.5 ANGLE STOP VALVES

A. Manufacturers:

1. VIEGA. Model: PEX Press Angle Stop Valves, 1/4 Turn
301 N. Main, Floor 9
Wichita, KS 67202
Phone: 1- 877-843-4262
Fax: 1-800-976-9817
Web Site: http://www.viega.com/
Technical Data: Not Available.

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Angle Stop Valves: ASTM F877; manufactured out of a 304 grade or better stainless steel and have a view hole incorporated in it to ensure proper PEX tubing insertion.

2.6 RELIEF VALVES

A. Manufacturers:
1. Infiva Industrial Fittings and Valves Inc. Model: Water Pressure Reducing Valve
P.O. Box 2329
Toa Baja, P.R. 00951
Francisco Jaen (Product Manager)
Phone: 787 - 379 - 2839
Email: franciscojaen1@yahoo.com
Web Site: Not Available.
Technical Data: Not Available.

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Water Pressure Reducing Valve: ANSI 112.26.2; reducing valves are designed to reduce incoming water pressure to an appropriate, safe level. Reduced water pressure decreases water consumption and protects plumbing system components. The 1201 is suitable for water supply pressures up to 300 PSI (2,068 kPa) with an adjustable output of 25 to 75 PSI (172 to 517 kPa). The setting from the factory is 50 PSI (345 kPa). Components are serviceable while the valve is in-line, including the integral stainless steel strainer. When downstream pressure exceeds inlet pressure due to thermal expansion, the built-in by-pass permits water flow back through the valve to the main. Corrosion resistant adjustment hardware and female union inlet.

2.7 HOSE BIBS

A. Hose Bibs: ASME A112.18.1/ASME B1.20.7; Standard: for sediment faucets. Bronze body material. Seat: Bronze, replaceable. NPS 1/2 or NPS 3/4 threaded or solder-joint inlet supply connections. Pressure Rating: 100 psi.

B. Include operating key with each operating-key hose bib and include integral wall flange with each chrome, bronze or nickel-plated hose bib.

2.8 BASE MOUNTED PUMPS

A. Manufacturers:
1. Franklin Electric. Model Jet Pumps Cyclone Series JCY05P.
Corporate Headquarters

400 E Spring St.
Bluffton, IN 46714 USA
Phone: +1 260-824-2900
Fax: +1 260-824-2909
Web Site: http://www.franklin-electric.com
Technical Data:
http://www.franklin-electric.com/business/WaterSystems/Products/Pumps/pdfs/JC_Cyclone.pdf

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Available in non-corrosive thermoplastic. Replaceable in line nozzle/venturi design for maximum hydraulic efficiency and ease of service. Self cleaning, anti clogging injector screen. Thermoplastic impeller and diffuser ensure increased hydraulic performance. Floating stainless steel eye seal for maximum performance and efficiency. Square-flange mounting provides easy serviceability without disturbing the plumbing. Built-in drain plug for easy winterizing and servicing. Mechanical shaft seal allows positive protection against leaking. Order pressure gauge separately. Pressure switch is installed and set at 20/40 psi. Handles water temperatures up to 120 °F and working pressure up to 75 psi. Connections 1" FNPT discharge and 1.25" FNPT suction.

2.9 PRESSURE SYSTEMS

A. Manufacturers:

1. AMTROL Canada, Ltd. Model: Well X Troll Residential Stand WX-250.
275 Shoemaker Street
Kitchener, Ontario N2E 3B3
Telephone: 519-748-1138
Fax: 519-748-4231
Web Site: http://www.amtrol.com/
Technical Data:
http://www.amtrol.com/pdf/MC4380%2006_07WXTBrochure.pdf

2. Substitutions: Section 01 60 00 - Product Requirement.

B. FDA requirements for potable water supply: Stainless steel air valve is welded in position rather than mechanically threaded to prevent loss of air pressure and to minimize stress on the well's pump system. It also carries a tamper-evident warning label. Deep-drawn steel domes offer twice the strength of rolled steel while minimizing weight. Unique positive hoop ring seal secures diaphragm and liner for added strength and reliability. Heavy duty butyl diaphragm features seamless construction for uniform strength and flexibility. It conforms exactly to the shell configuration without stretching, creasing, or forming bubbles or corners that could trap water or sediment. Butyl is the best known elastomer to prevent air loss. Heavy duty butyl diaphragm is extremely resistant to bacterial growth.. Virgin polypropylene liner provides a 100% corrosion resistant, nonmetallic rigid water reservoir that is listed by NSF International Standard 61. Stainless-steel system

connection withstands aggressive water. Exclusive welding process eliminates interior rough spots and sharp edges which prevent damage to the diaphragm and liner. Each finished tank is pressure tested for safety. Each finished tank is pre-pressurized to the most common pump cut-in pressure. Exterior appliance-like finish looks attractive while protecting the tank from the elements.

2.10 MANIFOLD

A. Manufacturers:

1. VIEGA. Model: PureFlow® MANABLOC® Manifold Control
   301 N. Main, Floor 9
   Wichita, KS 67202
   Phone: 1- 877-843-4262
   Fax: 1-800-976-9817
   Web Site: http://www.viega.com/
   Technical Data:
   http://www.viega.net/cps/rde/xbcr/en-us/TD-PFMB-1007_Manabloc.pdf

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Manifold Control: ASTM F877; This specification designates requirements for the PureFlow MANABLOC Manifold Plumbing Control Unit. The MANABLOC parallel water distribution system supplies water to individual plumbing fixtures through dedicated ports and distribution lines. Each port (outlet) is equipped with a built-in shut off valve to provide control for each fixture from a central location. The MANABLOC has separate hot and cold water inlets and ports to manage the entire plumbing system. A variety of fitting options are available for the MANABLOC distribution ports.

PART 3 EXECUTION

3.1 EXAMINATION

A. Coordination and project conditions.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

3.3 INSTALLATION

A. Install each product of this section accordance manufacturer installation instructions, specifications, and International Residential Code.

B. Web site installation manuals:
   1. Domestic water piping:
      http://www.viega.net/cps/rde/xbcr/en-us/IM-PF-0307_Pureflow_Install.pdf

   2. Pressure systems:
      http://www.amtrol.com/pdf/9015A290revcWXT.pdf

   3. Manifold control unit:
      http://www.viega.net/cps/rde/xbcr/en-us/IM-PFMB-1007_Manabloc_Install.pdf

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test domestic water piping system.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Disinfect water distribution system.

C. Prior to starting work, verify system is complete, flushed and clean.

3.6 SCHEDULES

A. Pipe Hanger Spacing:

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet (m)	HANGER ROD DIAMETER Inches (mm)
Cross-linked Polyethylene Pipe	4 ft (1.219)	Varies

END OF SECTION

SECTION 22 12 00

FACILITY POTABLE-WATER STORAGE TANKS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes potable water storage tanks.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. Food and Drug Administration (FDA) standards.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions of tanks, materials of construction, tank lining methods, anchors, attachments, lifting points, taps, and drains.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Must follow manufacturer installation instructions.

1.5 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements : Product storage and handling requirements.

B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 DOMESTIC COLD WATER TANK

A. Manufacturers:
1. Vassallo Industries Inc. Custom Model: Vasstank.
1000 Carr. # 506
Coto Laurel, PR 00780-2935
Phone: (787) 848-1515
Web Site: http://www.vassalloindustries.com/
Technical Data: http://www.vassalloindustries.com/index.php?node=207

2. Substitutions: Section 01 60 00 - Product Requirements.

3. Tank: FDA approved material: polyethylene plastic material, lightweight, impact resistance, sunlight resistance, easy to transport, easy to install fused FPT plastic fittings, will not corrode, threaded top cap, water level indicators.

B. Accessories: Tank drain, water inlet and outlet.

C. Horizontal storage tank:
1. Overall Length: 19'- 6" ft. in. (594.360 cm).
2. Diameter: 2'-6" ft. in. (76.20 cm) diameter.
3. Height: 2' ft. (60.96 cm)
4. Nominal capacity: 702 gals. (2657.08 L).
5. Support: Steel frame stand with support 1.5in x 1.55in x 1.5in (38.10mm x 38.10mm x 38.10mm) with 1ft of spacing.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide support, independent of building structural framing members.

B. Clean and flush prior to delivery to site and after installation. Seal until pipe connections are made.

C. Install the piping accessories on domestic water piping connections. Refer to Section 22 11 00.

D. Install relief valve piping according plumbing drawings.

3.2 SCHEDULES

A. Domestic Cold Water Tank:

Location:	Deck
Capacity:	702 gal.
Length:	19'-6"
Diameter:	2'-6"
Height	2'

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

   1. Soil, Waste, and Vent Piping: 10-foot head of water.
   2. Sanitary Sewer, Force-Main Piping: 100 psig.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:
   1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
   2. Retain subparagraph below if sovent drainage system is retained.
   3. Sovent Drainage System: Include plans, elevations, sections, and details.

C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
   1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Grooved-Joint Systems:
1. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

C. Flanges: ASME 16.1, Class 125, cast iron.

2.5 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. Solvent Cement and Adhesive Primer.

2.6 SPECIAL PIPE FITTINGS

A. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

C. Aboveground, vent piping NPS 4 and smaller shall be the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
   1. Extra-Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

E. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
   1. Extra-Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.

F. Underground sanitary-sewage force mains NPS 4 and smaller shall be the following:
   1. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical joints.
      a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

3.2 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

F. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

G. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

H. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical

sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

J. 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.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install engineered soil and waste drainage and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
   2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
   3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

N. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

O. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

P. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

C. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
   2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
   3. Install backwater valves in accessible locations.
   4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialities."

3.5 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Install individual, straight, horizontal piping runs according to the following:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

I. Install supports for vertical PVC piping every 48 inches.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

C. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main or sanitary manhole.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water

closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Trench drains.
5. Roof flashing assemblies.
6. Through-penetration firestop assemblies.
7. Miscellaneous sanitary drainage piping specialties.
8. Oil interceptors.

B. Related Sections include the following:
1. Division 22 Section 22 14 23 Storm Drainage Piping Specialties for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
2. Division 22 Section "Plumbing Fixtures" for hair interceptors.
3. Division 22 Section "Healthcare Plumbing Fixtures" for plaster sink interceptors.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
1. Oil interceptors.

B. Manufacturer Seismic Qualification Certification: Submit certification that oil interceptors, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

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 NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:
1. Standard: ASME A112.14.1.
2. Size: Same as connected piping.
3. Body: Cast iron.
4. Cover: Cast iron with bolted or threaded access check valve.
5. End Connections: Hub and spigot or hubless.
6. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.

7. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

2.2 CLEANOUTS

A. Metal Floor Cleanouts:
1. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
2. Size: Same as connected branch.
3. Type: Heavy-duty, adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: Spigot.
7. Closure: Brass plug with tapered threads Cast-iron plug.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Polished bronze.
10. Frame and Cover Shape: Square.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Cast-Iron Wall Cleanouts:
1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Standard: ASME A112.6.3 with backwater valve.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Not required.
5. Anchor Flange: Not required.
6. Clamping Device: Not required.
7. Outlet: Bottom.
8. Backwater Valve: Drain-outlet type.
9. Coating on Interior and Exposed Exterior Surfaces: Not required.
10. Sediment Bucket: required.
11. Top or Strainer Material: Nickel bronze.

12. Top of Body and Strainer Finish: Polished bronze.
13. Top Shape: Square.
14. Top Loading Classification: Heavy Duty.
15. Funnel: Required.
16. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
17. Trap Material: Cast iron.
18. Trap Pattern: Standard P-trap.
19. Trap Features: Trap-seal primer valve drain connection.

2.4 TRENCH DRAINS

A. Trench Drains:
1. Standard: ASME A112.6.3 for trench drains.
2. Material: Ductile or gray iron.
3. Flange: Anchor.
4. Clamping Device: Not required.
5. Outlet: End.
6. Grate Material: Ductile iron or gray iron.
7. Grate Finish: Painted.
8. Top Loading Classification: Extra Heavy-Duty.
9. Trap Material: Not required.

2.5 ROOF FLASHING ASSEMBLIES

A. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

B. Air-Gap Fittings:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Vent Caps:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radius:
   a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
   b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
   c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

I. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

L. Install vent caps on each vent pipe passing through roof.

M. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

N. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Division 23 Section "Facility Fuel-Oil Piping."

O. Install wood-blocking reinforcement for wall-mounting-type specialties.

P. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

Q. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Oil interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 13 53

FACILITY SEPTIC TANKS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes facility septic tanks.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. Food and Drug Administration (FDA) standards

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions of tanks, materials of construction, tank lining methods, anchors, attachments, lifting points, taps, and drains.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Installer: Must follow manufacturer installation instructions.

1.5 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements : Product storage and handling requirements.

B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 FACILITY SEPTIC TANKS

A. Manufacturers:
1. Vassallo Industrias Inc. Custom Model: Vasstank
1000 Carr. # 506
Coto Laurel, PR 00780-2935
Phone: (787) 848-1515
Web Site: http://www.vassalloindustries.com/
Technical Data: http://www.vassalloindustries.com/index.php?node=359

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Tank: Polyethylene plastic materials. Lightweight tank that does not require heavy equipment for transportation and leveling Can be transported in a pick-up truck and floated across water to an island property. Easy to install. Unaffected by most chemicals. 100% pure virgin resin.

C. Accessories: Tank drain, water inlet and outlet.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide support, independent of building structural framing members.

B. Clean and flush prior to delivery to site and after installation. Seal until pipe connections are made.

C. Install the piping accessories on domestic water piping connections. Refer to Section 22 11 00.

3.2 SCHEDULES

A. See drawings to tanks dimensions.

END OF SECTION

SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following storm drainage piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

B. Related Sections include the following:
   1. Division 22 Section "Sump Pumps."

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

B. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:
   1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.

2. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.

C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
   1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
   1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

C. Solvent Cement and Adhesive Primer.

2.5 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Sleeve Materials:
      a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   1. Center-Sleeve Material: Stainless steel.
   2. Gasket Material: Natural or synthetic rubber.
   3. Metal Component Finish: Corrosion-resistant coating or material.

C. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

PART 3 EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Aboveground storm drainage piping NPS 6 and smaller shall be the following:
   1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and coupled joints.

2. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

B. Aboveground, storm drainage piping NPS 8 and larger shall be the following:
1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
4. Pressure pipe couplings if dissimilar pipe materials or piping with small difference in OD must be joined.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialities."

E. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

F. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Fire Plumbing."

G. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

H. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

I. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. 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.

J. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
   1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

L. Install engineered controlled-flow storm drainage piping in locations indicated.

M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

N. Install PVC storm drainage piping according to ASTM D 2665.

O. Install underground PVC storm drainage piping according to ASTM D 2321.

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results Plumbing."

B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.
   2. Install gate valve for piping NPS 2-1/2 and larger.

C. Backwater Valves: Install backwater valves in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
   2. Install backwater valves in accessible locations.
   3. Backwater valve are specified in Division 22 Section "Storm Drainage Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6: 60 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

I. Install supports for vertical PVC piping every 48 inches.

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following storm drainage piping specialties:
1. Backwater valves.
2. Cleanouts.
3. Trench drains.
4. Through-penetration firestop assemblies.
5. Miscellaneous storm drainage piping specialties.
6. Flashing materials.
7. Equipment drains and over flows.

B. Related Sections include the following:
1. Division 22 Section 22 13 19 Sanitary Waste Piping Specialties for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.3 DEFINITIONS

A. FOG: Fats, oils, and greases.

B. PE: Polyethylene plastic.

C. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:
1. Standard: ASME A112.14.1.
2. Size: Same as connected piping.
3. Body: Cast iron.
4. Cover: Cast iron with bolted or threaded access check valve.
5. End Connections: Hub and spigot or hubless.
6. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
7. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts:
1. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
2. Size: Same as connected drainage piping
3. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:
1. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule threaded, adjustable housing cleanout.
2. Size: Same as connected branch.
3. Type: Threaded, adjustable housing.
4. Body or Ferrule: Stainless steel.
5. Clamping Device: Not required.
6. Outlet Connection: Spigot.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Polished bronze.
10. Frame and Cover Shape: Square.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:
1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 TRENCH DRAINS

A. Trench Drains:
1. Standard: ASME A112.6.3 for trench drains.
2. Material: Ductile or gray iron.
3. Flange: Anchor.
4. Clamping Device: Required.
5. Outlet: Side.
6. Grate Material: Ductile iron or gray iron.
7. Grate Finish: Painted.
8. Top Loading Classification: Extra Heavy-Duty.
9. Trap Material: Not required.
10. Trap Pattern: Not required.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected pipe.
3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.5 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:
1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

2.6 FLASHING MATERIALS

A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.7 EQUIPMENT DRAINS AND OVERFLOWS

A. Equipment drains and over flows.
1. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joint ends.

2. Fittings: ASTM D2466, Schedule 40, PVC and ASTM D2665.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section 22 05 00 Common Work Results for Plumbing for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

F. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

G. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

H. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

I. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

J. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

B. Set flashing on floors and roofs in solid coating of bituminous cement.

C. Secure flashing into sleeve and specialty clamping ring or device.

D. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

   Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 33 30.26

RESIDENTIAL, COLLECTOR-TO-TANK, HEAT EXCHANGER COIL,

SOLAR-ELECTRIC DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Domestic Water Heat Exchangers.
2. Solar Evacuated Tubes.

1.2 REFERENCES

1. ISO 9001 Certified.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.

C. Product Data: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements.

D. Manufacturer's Installation Instructions: Submit mounting and support requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.5 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Installer: Must to follow manufacturer installation guide.

1.7 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Products storage and handling requirements.

B. Protect heat exchangers and tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 DOMESTIC WATER HEAT EXCHANGERS

A. Manufacturers:

1. STIEBEL ELTRON, Inc. Model: Single Heat Exchanger SB 150 S
   17 West Street, West Hatfield, MA 01088
   Phone: (413) 247-3380 • (800) 582-8423
   Fax: (413) 247-3369
   Web Site: http://www.stiebel-eltron-usa.com
   Technical Data: http://www.stiebel-eltron-usa.com/techdata_sbb.html

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Single Heat Exchanger SB 150 S: low standby heat loss, heavy gauge steel with porcelain enamel coating. Superb quality results in long service life, fitted with one or two large heat exchangers. Sacrificial anode rod with wear indicator and 3" urethane foam insulation.

2.2 SOLAR EVACUATED TUBES

A. Manufacturers:

1. Apricus Solar Hot Water, Inc. Model: Apricus 10 tube collector.
   19 Pu Si Road
   Pukou New & High Tech Development Zone
   Nanjing, China, 210061
   Phone: +86 25 58649133 (GMT+08:00)
   Web Site: http://www.apricus.com/
   Technical Data: http://www.apricus.com/html/evacuated_tubes.htm

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Use high efficiency twin-glass evacuated tubes to absorb solar energy and convert it into usable heat. Freeze protected heat pipes transfer heat from within the evacuated tube up to an insulated copper header pipe through which a heat transfer liquid is circulated. Suitable for domestic or commercial applications, maintain strong efficiency levels even at high delta-t temperatures. Collectors are ideal for cold regions and high temperature applications.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install each product of this section accordance manufacturer installation instructions and specifications.

B. Web site installation manuals:

1. Domestic Water Heat Exchangers:
   http://www.stiebel-eltron-usa.com/pdf/install_ifwh_sbb.pdf

2. Solar Evacuated Tubes:
   http://www.apricus.com/html/solar_collector_installation_basics.htm

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Water closets.
2. Lavatories.
3. Sinks.
4. Service sinks.
5. Showers.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI Z124.6 - Plastic Sinks.

B. American Society of Mechanical Engineers:
1. ASME A112.18.1 - Plumbing Fixture Fittings.
2. ASME A112.18.2 - Plumbing Fixture Waste Fittings.
3. ASME A112.19.2M - Vitreous China Plumbing Fixtures.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures

B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. Manufacturer's Installation Instructions: Submit installation methods and procedures.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Installer: Performing the work of this section with installation manufacturer guide and specifications.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

1.9 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 TANK TYPE WATER CLOSETS

A. Manufacturers:
1. Kohler Co. Model: Persuade ® two-piece elongated toilet K-3654
444 Highland Drive
Kohler, WI 53044 Phones: 1-800-456-4537 or 1-920-457-4441
Web Site: http://www.kohler.com/
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1087557_4.pdf

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Bowl: ASME A112.19.2; ASME A112.19.14. Elongated combination toilet shall be made of vitreous china, less supply. Toilet shall be 27-5/8"□(70.2 cm) in length, 14-3/16"□(36 cm) in width, and 31-1/2"□(80 cm) in height and 4-1/2"□(11.4 cm) x 5-3/4"□(14.6 cm) water area. Toilet shall be two-bolt installation and minimum 12"□(30.5 cm) rough-in. Toilet shall be 1.6 gpf (6 L) or .8 gpf (3 lpf) with Dual Flush. Toilet shall feature seat post holes with 5-1/2" (14 cm) centers and polished chrome push buttons.

C. Accessories
1. BreviaTM elongated toilet seat K-4664
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1006125_4.pdf

2. 1/2" NPT angle stop K-7660

2.2 LAVATORIES

A. Manufacturers:
1. Kohler Co. Model: Vessels Bateau Lavatory K-2273.
444 Highland Drive
Kohler, WI 53044
Phones: 1-800-456-4537 or 1-920-457-4441
Web Site: http://www.kohler.com/
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/116617_4.pdf

2. Kohler Co. Model: Stillness wall-mount lavatory faucet trim K-T944-4.
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1106495_4.pdf

3. Kohler Co. Model: Two handle ceramic valve K-410-K.
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1008172_4.pdf

4. Kohler Co. Model: Pop-up clicker drain K-7124.
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1052942_4.pdf

5. Substitutions: Section 01 60 00 - Product Requirements.

B. Vessels Bateau Lavatory: ASME A112.19.2M; vitreous china above the counter, 18-1/4" x 14-3/8" inches (46.4mm x 36.5mm) in width, and white sealant.

C. Wall-mount lavatory faucet: ASME A112.18.1/ANSI A117.1, NSF 61, EPA WaterSense. Brass construction. Product shall have a maximum flow rate of 1.5 gallons (5.7 liters) per minute. Product shall be dual control wall-mounted. Product

shall feature a 4-9/16" (3.3 cm) min to 6-1/16" (15.4 cm) maxspout from the wall to center of the outlet. ADA compliant lever handles and a stationary spout.

D. Two handle ceramic valve: ASME A112.18.1; brass construction. Valve shall have a maximum flow rate of 2.2 gallons (8.3 L) per minute. Valve shall be for dual control wall-mounted installation.

E. Pop-up clicker drain: ASME A112.18.1/ASME A112.18.2; lavatory drain shall be of brass construction. Drain shall feature a brass tailpiece with 1-1/4" OD connection. Drain shall be available without overflow. Drain shall have a pop-up stopper.

2.3 SINKS

A. Manufacturers:

1. Kohler Co. Model: Kathryn; Undercounter Entertainment Sink K-2330-N.
   444 Highland Drive
   Kohler, WI 53044
   Phones: 1-800-456-4537 or 1-920-457-4441
   Web Site: http://www.kohler.com/
   Technical Data:
   http://www.us.kohler.com/onlinecatalog/pdf/1071057_4.pdf

2. Kohler Co. Model: Lavatory grid drain without overflow K-7129-CP.
   Technical Data:
   http://www.us.kohler.com/onlinecatalog/pdf/1052943_4.pdf

3. Kohler Co. Model: Simplice® pull-down kitchen sink faucet K-647-CP.
   Technical Data:
   http://www.us.kohler.com/onlinecatalog/pdf/1048033_4.pdf

4. Substitutions: Section 01 60 00 - Product Requirements.

B. Undercounter Entertainment Sink: ASME A112.19.2; dimensions 17" (43.2 cm) in length and 13" (33 cm) in width. Made of vitreous china without overflow and less glazed underside.

C. Lavatory Grid Drain: ASME A112.18.2; ASME A112.18.1. Lavatory drain shall be of brass construction. Drain shall feature a brass tailpiece and 1-1/4"□OD connection. Drain with overflow is available with a non-removable metal stopper, rubber stopper or grid. Drain without overflow is available with a non-removable metal stopper or grid.

D. Kitchen Sink Faucet: ADA, ASME A112.18.1, ANSI A117.1. The pull-down kitchen sink faucet shall be of metal construction. Product shall have a maximum flow rate of 2.2 gallons (8.3 L) per minute with lower flow aerator options available (refer to the Kohler Price Book). Product shall feature a one-piece, self-contained ceramic disc valve, allowing volume and temperature control. Product shall feature temperature memory, allowing the faucet to be turned on and off at any

temperature setting. Product shall feature a high-temperature limit setting for added safety, remote valve, ADA compliant remote lever handle, and 360° spout rotation. Product shall feature a three-function sprayhead with spray, aerated flow, and pause function. Product shall include flexible connections for easy installation. Product shall be available with an 8"□(20.3 cm) or 9"□(22.9 cm) spout reach.

E. Accessories:
1. Product shall feature flexible connections for easy installation.

2.4 SHOWERS

A. Manufacturers:
1. Kohler Co. Model: Contemporary Rain Showerhead K-10121-CP.
444 Highland Drive
Kohler, WI 53044
Phones: 1-800-456-4537 or 1-920-457-4441
Web Site: http://www.kohler.com/
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1046512_4.pdf

2. Kohler Co. Model: Stillness® Rite-Temp® valve trim K-T950-4.
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1031652_4.pdf

3. Kohler Co. Model: Rite-Temp® pressure-balancing valve
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1110626_4.pdf

4. Kohler Co. Model: Shower Arm K-7396-CP.
Technical Data:
http://www.us.kohler.com/onlinecatalog/pdf/1050688_4.pdf

5. Substitutions: Section 01 60 00 - Product Requirements.

B. Rain Showerhead: ASME A112.18.1; flow rate of 2.5 gallons (9L) per minute. Showerhead shall have faceplate with 75 nozzles that prohibit mineral buildup. Shall have a ½"-14 NPT conection. Brass construction.

C. Stillness® Rite-Temp® valve trim: Rite-Temp® pressure-balancing single-control bath and shower faucet trim shall be of brass construction. Bath and shower trim shall include showerhead with arm and flange, 8-3/4"□(22.2 cm) non-diverter spout with NPT connection, and faceplate with handle and push-button diverter. Shower only trim shall include showerhead with arm and flange, and faceplate with handle. Valve only trim shall include faceplate with handle.

D. Rite-Temp® pressure-balancing valve: ASME A112.18.1. Rite-Temp pressure-balancing valve shall have a brass valve body. Product shall include a Rite-Temp

pressure-balancing diaphragm design valve with a one-piece diaphragm cartridge design for ease of maintenance. Product shall have mixing valve cycles from "cold" to "hot" and a high-temperature limit stop for added safety. Product shall be available without or with screwdriver stops.

E. Shower Arm: ASME A112.18.1; the ceiling-mount shower arm and flange shall be of brass construction. Shower arm shall have a 3" (7.6 cm) straight length. Shower arm shall have a ½" NPT connection at both ends.

2.5 SERVICE SINKS

A. Manufacturers:

1. The Swan Corporation. Model: DIT-S Single Drop-In Laundry Tub.
   515 Olive St.
   Suite 1800
   St. Louis, MO 63101
   Phone: 1-800-325-7008
   Web Site: http://www.swanstone.com/
   Technical Data: http://www.swanstone.com/images/link_spec/dits.pdf

2. Kohler Co. Model: Simplice Kitchen Sink Faucet K-596.
   444 Highland Drive
   Kohler, WI 53044
   Phones: 1-800-456-4537 or 1-920-457-4441
   Web Site: http://www.kohler.com/
   Technical Data:
   http://www.us.kohler.com/onlinecatalog/pdf/1086367_4.pdf

3. Substitutions: Section 01 60 00 - Product Requirements.

B. DIT-S Single Drop-In Laundry: ANSI Z124.6; made of sturdy Veritek with no surface coating to chip or crack. Will not mold or mildew. Available in solid and aggregate colors. Flat deck allows for a variety of faucet applications; 7 gallon capacity. An upgrade countertop laundry tub in a compact size. Color white.

C. Simplice Kitchen Sink Faucet: ASME A112.18.1; metal construction. The valve shall be a one-piece, self-contained ceramic disc valve, allowing both volume and temperature control. Product shall feature temperature memory, allowing the faucet to be turned on and off at any temperature setting. Product shall feature an ADA compliant side lever handle, flexible connections for easy installation, and integral pulldown sprayhead with retractable hose. Product shall feature a compact three-function spray, aerated flow, and pause functions. Product shall have a 2.2 gallon (8.3 L) per minute maximum flow rate. Product shall include a 10-1/2" (26.7 cm) escutcheon plate.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify walls and floor finishes are prepared and ready for installation of fixtures.

B. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install each product of this section accordance manufacturer installation instructions, specifications, and International Residential Code.

B. Web site installation manuals:

1. Water closets:
   http://www.us.kohler.com/onlinecatalog/pdf/1087557_2.pdf Toilet

2. Lavatories:
   http://www.us.kohler.com/onlinecatalog/pdf/1018899_2.pdf Lavatory
   http://www.us.kohler.com/onlinecatalog/pdf/1016742_2.pdf Faucet
   http://www.us.kohler.com/onlinecatalog/pdf/1015916_2.pdf Mixer
   http://www.us.kohler.com/onlinecatalog/pdf/1107909_2.pdf Pop-up

3. Sinks:
   http://www.us.kohler.com/onlinecatalog/pdf/1018893_2.pdf Sink
   http://www.us.kohler.com/onlinecatalog/pdf/1048033_2.pdf Faucet
   http://www.us.kohler.com/onlinecatalog/pdf/1107910_2.pdf Strainer

4. Service sinks:
   http://www.swanstone.com/images/link_installation/FORM662.pdf Sink
   http://www.us.kohler.com/onlinecatalog/pdf/1086367_2.pdf Faucet

5. Showers:
   http://www.us.kohler.com/onlinecatalog/pdf/1046289_2.pdf Head
   http://www.us.kohler.com/onlinecatalog/pdf/114811_2.pdf Mixer
   http://www.us.kohler.com/onlinecatalog/pdf/1088002_2.pdf Trim

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.

B. Clean plumbing fixtures and equipment.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Do not permit use of fixtures before final acceptance.

3.7 SCHEDULES

See drawings to see schedules.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Grout.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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 in exposed interior spaces, unless otherwise indicated.

C. Install HVAC 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.

3.5 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 23 07 00

HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Insulation Materials:
a. Cellular glass.
b. Flexible elastomeric.
2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied jackets.
10. Tapes.
11. Securements.
12. Corner angles.

B. Related Sections:
1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 22 Section "Plumbing Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.
4. Division 33 Section "Underground Hydronic Energy Distribution" for loose-fill pipe insulation in underground piping outside the building.
5. Division 33 Section "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

C. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cell-U-Foam Corporation; Ultra-CUF.
   b. Pittsburgh Corning Corporation; Foamglas Super K.
2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.

4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; All-Service Duct Wrap.

I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Armacell LLC; Tubolit.

b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
c. RBX Corporation; Therma-cell.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
1. Products: Subject to compliance with requirements, provide one of the following:
a. CertainTeed Corp.; FlameChek.
b. Johns Manville; Firetemp Wrap.
c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
d. Thermal Ceramics; FireMaster Duct Wrap.
e. 3M; Fire Barrier Wrap Products.
f. Unifrax Corporation; FyreWrap.
g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

2.3 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Insulco, Division of MFS, Inc.; SmoothKote.
b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.
d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
d. Marathon Industries, Inc.; 550.
e. Mon-Eco Industries, Inc.; 55-50.
f. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.6 SEALANTS

A. Joint Sealants:
1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.
   f. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Surefit.
      c. RPR Products, Inc.; Insul-Mate.
   2. Factory cut and rolled to size.
   3. Finish and thickness are indicated in field-applied jacket schedules.
   4. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   6. Factory-Fabricated Fitting Covers:
      a. Same material, finish, and thickness as jacket.
      b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      c. Tee covers.
      d. Flange and union covers.
      e. End caps.
      f. Beveled collars.
      g. Valve covers.
      h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      b. Compac Corp.; 120.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
      d. Venture Tape; 3520 CW.
   2. Width: 2 inches.
   3. Thickness: 3.7 mils.
   4. Adhesion: 100 ounces force/inch in width.
   5. Elongation: 5 percent.
   6. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.

B. Insulation Pins and Hangers:
   1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
         2) GEMCO; Perforated Base.
         3) Midwest Fasteners, Inc.; Spindle.
      b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      c. Spindle: Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
      d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

   2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) GEMCO; Nylon Hangers.
         2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
      b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
      c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
      d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

   3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.

2) GEMCO; Press and Peel.
3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide one of the following:
1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide one of the following:
1) GEMCO.
2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.

2.12 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

      a. For below ambient services, apply vapor-barrier mastic over staples.

   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

   1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate

insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic

with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
   2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed section of polystyrene insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:
   1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
   3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
   4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
   5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.9 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.10 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
   2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
   3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to

three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
8. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
9. Outdoor, concealed supply and return.
10. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.13 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber board, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

D. Concealed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber board, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated board; thickness as required to achieve 2-hour fire rating.

F. Exposed, Supply-Air Duct and Plenum Insulation: Mineral-fiber board, 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

G. Exposed, Return-Air Duct and Plenum Insulation: Mineral-fiber board, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

H. Exposed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber board, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

I. Exposed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber board, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

J. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated board; thickness as required to achieve 2-hour fire rating.

3.14 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric Polyolefin, 1 inch thick.

B. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric Polyolefin, 1 inch thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:
   1. Aluminum, Smooth: 0.020 inch thick.

D. Ducts and Plenums, Exposed:
   1. Aluminum, Smooth: 0.020 inch thick.

E. Equipment, Concealed:
   1. Aluminum, Smooth: 0.032 inch thick.

F. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. Aluminum, Smooth: 0.032 inch thick.

G. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
   1. Painted Aluminum, with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

H. Piping, Concealed:
   1. Aluminum, Smooth: 0.024 inch thick.

I. Piping, Exposed:
   1. None.
   2. Aluminum, Smooth: 0.032 inch thick.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig.
   2. Suction Lines for Heat-Pump Applications: 535 psig.
   3. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Shop Drawing Scale: 1/4 inch equals 1 foot.
   2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

2.2 VALVES AND SPECIALTIES

A. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

2.3 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Seal penetrations through fire and smoke barriers.

S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

U. Seal pipe penetrations through exterior walls according to Division 07 Section 07 90 00 Joint Protection for materials and methods.

V. Identify refrigerant piping and valves.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   3. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   4. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.

E. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

B. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

C. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

D. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

SECTION 23 31 13

METAL DUCTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.
5. Seismic-restraint devices.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.

8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

E. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches.
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
   10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.

5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.5 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Loos & Co.; Cableware Division.
6. Mason Industries.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
   1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Supply Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
   a. Pressure Class: Positive 1-inch wg.
   b. Minimum SMACNA Seal Class: B.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Constant-Volume Air-Handling Units:
   a. Pressure Class: Positive 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

3. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.

B. Return Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: B.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 3.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Pressure Class: Negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.

c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
   a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
   b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
   c. Welded seams and joints.
   d. Pressure Class: Positive or negative 3-inch wg.
   e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
   f. SMACNA Leakage Class: 3.

4. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel.
   2. Stainless-Steel Ducts:
      a. Exposed to Airstream: Match duct material.
      b. Not Exposed to Airstream: Match duct material.
   3. Aluminum Ducts: Aluminum.

E. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

      a. Velocity 1000 fpm or Lower:
         1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
         2) Mitered Type RE 4 without vanes.

      b. Velocity 1000 to 1500 fpm:
         1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
         2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
         3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:
   1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

F. Branch Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

      a. Rectangular Main to Rectangular Branch: 45-degree entry.
      b. Rectangular Main to Round Branch: Spin in.

END OF SECTION

SECTION 23 62 00

PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes air-cooled condensing units.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Wiring diagrams.

C. Operation and maintenance data.

D. LEED Submittal:
1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.

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. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
1. Warranty Period (Compressor Only): Five years from date of Substantial Completion.
2. Warranty Period (Condenser Coil Only): Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONDENSING UNITS, AIR COOLED, 1 TO 5 TONS

A. Manufacturers:
   1. Daikin Industries, LTD.

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

C. Compressor: Hermetic or semihermetic compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

   1. Capacity Control: Inverter.
   2. Refrigerant Charge: R-410A.
   3. Refrigerant: R-407C, or R-410A.

D. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

E. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:

   1. Permanently lubricated ball-bearing motors.
   2. Separate motor for each fan.
   3. Dynamically and statically balanced fan assemblies.

F. Operating and safety controls include the following:

   1. Manual-reset, high-pressure cutout switches.
   2. Automatic-reset, low-pressure cutout switches.
   3. Low oil pressure cutout switch.
   4. Compressor-winding thermostat cutout switch.
   5. Three-leg, compressor-overload protection.
   6. Control transformer.

7. Magnetic contactors for compressor and condenser fan motors.
8. Timer to prevent excessive compressor cycling.

G. Accessories:

1. Electronic programmable thermostat to control condensing unit and evaporator fan.
2. Low Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F.
3. Gage Panel: Package with refrigerant circuit suction and discharge gages.
4. Hot-gas bypass kit.
5. Part-winding-start timing relay, circuit breakers, and contactors.

H. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
3. Gasketed control panel door.
4. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection.
5. Condenser coil hail guard to protect coil from physical damage.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate condensing units according to ARI 210/240, ARI 340/360, or ARI 365.

1. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1-2004, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Install condensing units on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

C. Install roof-mounting units on equipment supports specified in Division 07.

D. Vibration Isolation: Mount condensing units on restrained spring isolators with a minimum deflection of 2 inch. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

G. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section "Refrigerant Piping."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform electrical test and visual and mechanical inspection.
   2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

C. Remove and replace malfunctioning condensing units and retest as specified above.

END OF SECTION

SECTION 26 01 26

MAINTENANCE TESTING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION:

A. After electrical installation is complete, make tests to demonstrate that entire system is in proper working order and in accordance with drawings and specifications. Make no tests less than those outlined hereafter, unless requested in writing and approved by Engineer. Tests are in addition to, and no substitution for, tests of individual items at manufacturer's plant. Make insulation and ground resistance tests before operating tests. Determine proper rotation of motors before permanent connections are made.

B. Pay all costs for tests including expenses incident to retests occasioned by defects and failures of equipment to meet specifications.

1. Replace wiring and equipment found defective, or failing to meet specified requirements, without charge, unless written acceptance for repair is given by Engineer.
2. Furnish three copies of all test results to Engineer.
3. Unless otherwise specified, Owner will supply electric current necessary for tests.

1.2 REFERENCE STANDARDS:

A. NEMA: National Electrical Manufacturers Association, 2101 L Street, Northwest, Washington D.C.

B. IEEE: Institute of Electrical and Electronic Engineers, 345 East 47th Street, New York, NY.

PART 2 PRODUCTS

2.1 TESTING EQUIPMENT:

A. Calibration:
1. Furnish suitable electrical instruments including voltmeters, ammeters, wattmeters, tachometers and all other equipment necessary to perform tests specified. Furnish certified copies of calibration curves of these instruments which have been calibrated for specific tests.
2. Make necessary openings in circuits for testing instruments and place and connect all instruments, equipment, and devices, necessary for the tests.

Upon completion of tests, remove instruments and instrument connections and restore all circuits to permanent condition.

3. Other Sections of specifications require services of one or more manufacturer's representatives, to ensure that equipment supplied has been installed properly and adjusted to proper working order. Advise representative of all applicable tests in this Section, so that work will be coordinated, and tests combined where feasible.

2.2 TESTING:

A. Coordination

1. Coordinate activities, and cooperate with others on project, to ensure that systems are energized when required, loads applied, and other requirements of Section are carried out on timely, coordinated basis.
2. Conduct tests in presence of Engineer. Notify Engineer seven calendar days or more in advance when any test to be performed, and do not start tests without Engineer's permission.

B. Preparation

1. Make up no high and/or medium-voltage connections at service entrance, transformers, substations, motors, medium voltage motor control centers, switchgear and generator permanently until correct phase rotation of all equipment is determined. Install and insulate these connections temporarily, if necessary, while determining proper rotation. Make permanent connections after proper rotation has been established and subsequent to completion of insulation resistance and dielectric tests.

PART 3 EXECUTION

3.1 INSULATION RESISTANCE TESTS OF CIRCUITS, 600 VOLTS AND BELOW:

A. Do not subject conductors rated 600 volts and below to high potential dielectric tests. Test each complete feeder and branch circuit of 600 volts or below with everything but power supply and power-consuming equipment, connected thereto, and have an insulation resistance between conductors and between each conductor and ground of not less than 1,000,000 ohms, unless otherwise accepted by Engineer.

B. Determine insulation resistance values with all switchboards, panelboards, fuseholders, switches, receptacles, and overcurrent devices in place.

C. Use megohmmeter having output of at least 500 volts to determine insulation resistance value for 600 volt rated conductors, and a 2400 volt megohmmeter for 5 kv and 15 kv rated conductors.

D. List each circuit and measured resistance as test data.

E. Maintain record of all insulation resistance values. Identify conductor, or equipment, date that value was taken and resistance value. Arrange information in suitable neat tabular form and turn to Engineer in triplicate.

3.2 INSULATION RESISTANCE TESTS FOR MOTORS:

A. After installation, test windings of all 3-phase motors with megohmmeter in accordance with, and meeting requirements of, IEEE Standard No. 43.

3.3 DIELECTRIC TESTS OF CONDUCTORS RATED 2400 VOLTS AND ABOVE:

A. After all high and/or medium-voltage conductors are installed, and before connecting and putting into service, subject to dielectric tests. Perform direct current, high-potential tests from phase to phase and from phase to ground. Make tests as specified in latest edition of the applicable IPCEA-NEMA Standard.

B. Complete and enclose splices in conductor system being tested within all pull, junction, or splice boxes before test is started, and complete all potheads and switchgear terminations. Disconnect potential transformers and all power consuming equipment or devices from circuit, if any are present.

3.4 GROUND RESISTANCE:

A. Test each ground rod in accordance with IEEE Std. 142, and submit tabulation of results to Engineer. Include identification of electrode, date of reading and ground resistance value in results.

B. Test each entire grounding system for continuity of connections and for resistance. Ensure that ground resistance of conduits, equipment cases, and supporting frames does not vary appreciably from that of system as whole and does not exceed 5 Ohms.

3.5 OPERATING TESTS:

A. Operate each motor and associated equipment, as nearly as possible, under normal operating conditions for as long as feasible and for length of time sufficient to demonstrate correct alignment, temperature rise, speed, and satisfactory operation. Load motors to full capacity, or as near as possible.

B. Operate switches, circuit breakers and control devices to show correct and satisfactory operation.

C. Associated equipment includes instruments, meters, relays, circuit breakers, switches, and other devices in substations, switchgear, motor control centers, panelboards, control and instrumentation panels, etc., related to motor being tested.

D. Where tests of any of above-referenced equipment included in other Sections of specifications, coordinate testing, as directed by Engineer, to avoid duplication and conflict between tests.

E. Perform above tests in addition to, and not in substitution for required manufacturer's factory tests of individual items.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 DESCRIPTION:

A. Furnish and install electric power, lighting, fire alarm, telephone and data systems, including the installation and wiring of miscellaneous instruments and devices.

1. Perform all work necessary as indicated on the drawings and as specified. Furnish and install all safety switches, starters, and other accessory equipment, all as indicated and as specified.
2. Furnish and install all conduit, wiring and connections for power and control to equipment furnished unless otherwise specified.

B. Furnish temporary circuits, overcurrent devices, conduit and wiring, and other equipment required during change-over from existing to proposed electric system.

1.2 RELATED WORK:

A. Disconnecting, removing, and relocating existing electrical equipment is a part of this Contract.

B. Include cutting, patching, demolition, removal, and alterations for this class of work.

C. Electrical work for engine-generator sets include installation and all materials related to the installation as illustrated and drawings.

1.3 QUALITY ASSURANCE:

A. Install electrical work in conformance with latest rules and requirements of National Fire Protection Association Standard No. 70 (National Electrical Code) and with requirements of P.R.E.P.A. and local agencies.

1.4 SUBMITTALS:

A. Shop Drawings and Data: Include manufacturer's drawings, bills of material, panel and equipment layouts, catalog data, wiring diagrams and other documentary or descriptive information as required for each assembly submitted in one package insofar as possible.

1. Bills of material: Include a numbered list of all components, with manufacturer's name, catalog number, rating, and other identification. Place item number or similar identification on all other drawings where item appears.
2. Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new work.
3. Shop drawings required are contained in, but not necessarily limited to, following list:

    a. Transformer
    b. Substation
    c. Lighting fixture
    d. Conductors
    e. Wiring devices
    f. Panelboard
    g. UPS
    h. Cable tray
    i. Poles
    j. Safety switch
    k. Alarm systems
    l. Sound systems

4. Mark shop drawings and data submitted showing only items applicable to specific contract.
5. Make early submission of certain drawings where dimensions of equipment, location of conduit entrances, etc., are important to facilitate construction.
6. Include one-line diagrams, schematic diagrams and wiring diagrams. Other drawings, such as control sequence diagrams, relay diagrams, metering, etc. may also be needed. Submit only completed drawings showing all local and remote devices associated with each item. Submit one complete package of shop drawings as far as possible. Partial submittals may be returned without action.
7. Submit time-current characteristic curves for all circuit breakers and fuses.
8. Submit list of type and make of conduit, fittings, wires, cables, switches, fixtures, receptacles, pushbuttons, sleeves and inserts, etc.
9. Submit for installation, operation, and maintenance of equipment, and parts list. Specifically mark standard publications forming a part of this contract. Cross out, blank out, or otherwise delete any non-applicable items.
10. Install nameplates on all devices or pieces of equipment for which use or identification not readily apparent, such as, starters, relays, contactors, pushbuttons, indicating lights, and switches. Ensure position of nameplates readable after equipment installation.
11. Submit sample of wire and cable.
12. Services of the manufacturer's representative following equipment:
13. As soon as possible after award of contract, submit all information and data on wires, cables, and other long delivery items proposed. Early

submission for review and early ordering are required to avoid delays in completion of work.

14. As soon as practicable after selecting manufacturer and before any shop drawings are submitted for substation, arrange for a meeting, time and place acceptable to both parties, between the manufacturer's representative and Engineer at office of Engineer. Purpose of the meeting is to answer any questions which manufacturer may have and to establish Engineer's requirements for content, form, and submittal procedures for shop drawings in order to permit expeditious review and acceptance. Give Engineer minimum of one week notice.

1.5 INTERFERENCE AND ERRONEOUS LOCATIONS:

A. Locations of electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations determined or accepted by Engineer during construction.

B. Verify, in field, all data and final locations of work, done under other sections of specifications, required for placing of electrical work.

C. In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials necessary to complete work.

1.6 APPROVAL AND MARKING EQUIPMENT:

A. Insure that devices and materials are listed and/or labeled by Underwriters' Laboratories, Inc., wherever standards have been established by that agency. Where Underwriters' Laboratories listing is not available for equipment, submit certified test reports of adequately equipped, recognized, independent testing laboratory, approved by the local inspecting authority, indicating that equipment is in conformance with local code requirements or any other applicable requirements. In lieu of independent test reports, written approval of equipment by local electrical inspecting authority will be acceptable. Tests and/or inspections necessary for approval of equipment will be performed at no additional cost to Engineer.

B. Clearly mark equipment, devices and material with name or trademark of manufacturer and rating in volts and amperes and other pertinent information on a nameplate.

1.7 ELECTRIC SERVICE:

A. Electrical power system operates on 208/120-volt, 3-phase, 3-wire, 60-Hertz.

1. Electrical lighting system operates on 120/208 volt, 3-phase.

B. Electrical work for lighting system: Include, panelboards, raceways, wiring, fittings, fixtures, receptacles, switches, and other appurtenances necessary for satisfactory completion of system.

C. Supply lighting contactor panel and time switch.

D. Earth and rock excavation, backfill, concrete masonry, concrete reinforcement, and construction joints required for electrical work: Include under this section and conform to requirements specified under applicable sections of Contract for General Construction.

1.8 EQUIPMENT SPECIFIED ELSEWHERE:

A. Certain items of control and other equipment are indicated on electrical drawings for `connection, but are specified in other sections pertaining to plumbing; heating, ventilating and air conditioning; instrumentation; etc. Such items are not furnished as part of electrical work.

1.9 INCOMING SERVICE:

A. The power company will install primary pole in the point of connection.

B. Contractor to furnish and install all electrical materials and labor.

C. Furnish and install all necessary conduit and wire to service pole, extend conduit up pole for distance of 10 feet, and leave sufficient length of conductors to reach power company's overhead conductors. Connections at pole made by the power company. Perform work at service pole in accordance with power company's requirements.

D. Charges and fees by power company for providing service are included under this section at no additional expense to the Owner.

E. Notify power company, in writing, as early as possible before construction begins on incoming service and at least within minimum time requirements of power company.

PART 2 PRODUCTS

2.1 METERING EQUIPMENT:

A. Metering equipment furnished by power company and installed by electrial contractor.

PART 3 EXECUTION

3.1 METERING EQUIPMENT:

A. Obtain from power company drilling templates, dimensions, and mounting arrangements for metering transformers. Transmit this information to substation manufacturer for necessary cutting and drilling.

B. Ensure that metering equipment installation is in accordance with requirements of power company by submitting drawings, sketches, catalog information and other appropriate material for power company approval.

3.2 REMOVAL AND RELOCATION OF MATERIAL AND EQUIPMENT:

A. Carefully dismantle and salvage electrical equipment, switches, fixtures, conduits, cables, wiring, etc. as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.

B. Deliver material and equipment not indicated for reuse to Owner for his disposal.

C. Remove from site and dispose of material and equipment not indicated for reuse.

3.3 PROTECTION OF ELECTRICAL EQUIPMENT:

A. Protect electrical equipment from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction. Do not store equipment outdoors. Where equipment is installed or stored in moist areas, such as unheated buildings, etc., provide acceptable means to prevent moisture damage, such as uniformly distributed source of heat to prevent condensation. Protective means, as acceptable by Engineer.

3.4 DEFECTIVE OR DAMAGED EQUIPMENT:

A. Thoroughly dry out equipment or material subjected to possible water damage, and put through special dielectric test as directed, without additional compensation.

3.5 DRAWINGS AND SPECIFICATIONS:

A. Drawings and specifications are typical of work done and of arrangement desired. Furnish and install accessories and appurtenances which Engineer deems functionally necessary for complete installation, whether or not explicitly indicated or described.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

B. See Division 16 Section "Undercarpet Cables" for flat cables for undercarpet installations.

1.2 SUBMITTALS

A. Field quality-control test reports.

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 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Manufacturers:
Alcan Aluminum Corporation; Alcan Cable Div.
2. American Insulated Wire Corp.; a Leviton Company.

3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.
6. Substitutions: Approved equal.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper complying with NEMA WC 5 solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

D. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5.

E. Multiconductor Cable: Armored cable, Type AC with ground wire.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.
6. Approved equal.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: XHHW, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.

Exposed Branch Circuits, including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

H. Underground Feeders and Branch Circuits: Type UF multiconductor cable.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."

F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

G. Identify and color-code conductors and cables according to Division 16 Section "Basic Electrical Materials and Methods and Electrical Identification."

H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) 12 inches (300 mm) of slack.

3.3 FIELD QUALITY CONTROL

Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Requirements specified in this Section may be supplemented by requirements of other Sections.

1.2 SUBMITTALS

A. Product Data: For ground rods and grond wire.
B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled under UL 467 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; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Apache Grounding/Erico Inc.
2. Boggs, Inc.
3. Chance/Hubbell.
4. Copperweld Corp.

Dossert Corp.

6. Erico Inc.; Electrical Products Group.
7. Framatome Connectors/Burndy Electrical.
8. Galvan Industries, Inc.
9. Harger Lightning Protection, Inc.
10. Hastings Fiber Glass Products, Inc.
11. Heary Brothers Lightning Protection Co.
12. Ideal Industries, Inc.
13. ILSCO.
14. Kearney/Cooper Power Systems.
15. Korns, C. C. Co.; Division of Robroy Industries.
16. Lightning Master Corp.
17. Lyncole XIT Grounding.
18. O-Z/Gedney Co.; a business of the EGS Electrical Group.
19. Raco, Inc.; Division of Hubbell.
20. Robbins Lightning, Inc.
21. Salisbury, W. H. & Co.
22. Superior Grounding Systems, Inc.
23. Thomas & Betts, Electrical.
24. Substitutions: Approved equal.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."

B. Equipment Grounding Conductors: Insulated with green-colored insulation.

C. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare, Solid-Copper Conductors: ASTM B 3.

G. Assembly of Bare, Stranded-Copper Conductors: ASTM B 8.

H. Bare, Tinned-Copper Conductors: ASTM B 33.

I. Copper Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

J. Copper Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

Tinned-Copper Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

L. Ground Conductor for Overhead Distribution: No. 4 AWG minimum, soft-drawn copper.

M. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulated spacer.

N. Connectors: Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items. exothermic-welded type, in kit form, selected per manufacturer's written instructions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

B. Ground Rods: Sectional type; copper-clad steel.

1. Size: ¾" x 10'-0"

C. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the indicated height above the floor.

Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade or bury 12 inches (300 mm) above duct bank when installed as part of the duct bank.

F. Equipment Grounding Conductors: Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

1. Install insulated equipment grounding conductors in feeders and branch circuits.

2. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
3. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.
4. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
5. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install an insulated equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

6. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
7. Air-Duct Equipment Circuits: Install an insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
8. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install an insulated equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
9. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

    a. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6.4-by-50-by-300-mm) grounding bus.
    b. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing an insulated equipment grounding conductor with supply branch-circuit conductors.

11. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

G. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except as otherwise indicated. Make connections without exposing steel or damaging copper coating.

I. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

J. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers or supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

K. Metal Water Service Pipe: Provide 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 by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

L. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

M. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

N. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

O. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

Connections: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

6. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
7. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
8. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
9. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A].
10. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
11. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

Q. Overhead Line Grounding: Comply with IEEE C2 except where stricter requirements are indicated. Use 2 or more parallel ground rods if a single ground rod electrode resistance to ground exceeds 25 ohms.

1. Drive ground rods to a depth of 12 inches (300 mm) below finished grade in undisturbed earth.
2. Ground Rod Connections: Use clamp-type connectors listed for the purpose for underground connections and connections to rods.
3. Lightning Arresters: Separate arrester grounds from other grounding conductors.
4. Secondary Neutral and Tank of Transformer: Interconnect and connect to grounding conductor.

Protect grounding conductors on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

R. Duct Banks: Install a grounding conductor with at least 50 percent ampacity of the largest phase conductor in the duct bank.

S. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

T. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

U. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches (450 mm) below grade and 6 inches (150 mm) from the foundation.

3.2 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is indicated and at service disconnect enclosure grounding terminal. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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. Perform tests, by the fall-of-potential method according to IEEE 81.
3. Provide drawings locating each ground rod, ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order,

and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Nominal maximum values are as follows:

Equipment Rated 500 kVA and Less: 10 ohms.

b. Equipment Rated 500 to 1000 kVA: 5 ohms.
c. Equipment Rated More Than 1000 kVA: 3 ohms.
d. Overhead Distribution Line Equipment: 25 ohms.
e. Substations and Pad-Mounted Switching Equipment: 5 ohms.
f. Manhole Grounds: 10 ohms.

END OF SECTION

SECTION 26 05 33

ELECTRICAL RACEWAY SYSTEMS

PART 4 GENERAL

4.1 DESCRIPTION:

A. Furnish and install complete raceway systems, with all accessories, fittings, boxes, etc., as indicated and specified.

B. All raceway runs are shown diagrammatically to outline general routing of raceway. Avoid interfering with pipes, ducts, structural members, or other equipment. Deviations in accordance with Engineer, after acceptance, are without additional compensation.

C. Furnish and install PVC conduits in interiors of buildings. Furnish and install PVC conduit for all above ground exterior buildings use, unless otherwise noted.

4.2 REFERENCE STANDARDS:

A. National Fire Protection Association (NFPA):

1. National Electrical Code (NEC)

B. Underwriter's Laboratories, Inc. (UL):

1. U.L.-1 Electrical Flexible Metal Conduit
2. U.L.-6 Rigid Metal Electrical Conduit
3. U.L.-360 Electrical Liquid-Tight Flexible Steel
4. U.L.-651 Schedule 40 and 80 PVC Conduit
5. U.L.-886 Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class 1, Groups A, B, C, and D and Class 11, Groups E, F, and G.
6. U.L.-1242 Intermediate Metal Conduit

C. National Electrical Manufacturers Association (NEMA):

1. TC-2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

4.3 SUBMITTALS:

A. Submit shop drawings and manufacturers' product data in accordance with requirements of General Specifications and Section 16050.

PART 2 - PRODUCTS

4.4 MANUFACTURER'S COMPLIANCE:

A. Manufacturer's acceptance contingent upon products compliance with specifications:

B. Polyvinylchloride (PVC) Conduit:

1. Triangle Conduit & Cable Company, Inc., New Brunswick, NJ.
2. Republic Steel Corp., Cleveland, OH.
3. Carlon Electrical Sciences, Inc., Cleveland, OH.

C. Flexible Conduit:

1. American Flexible Conduit Company, New Bedford, MA.
2. Anaconda Metal Hose, Waterbury, CT.
3. International Metal Hose Company, Bellevue, OH.

D. Boxes and Fittings:

1. O.Z./Gedney Company, Terryville, CT.
2. Crouse-Hinds Electrical Construction Materials, Syracuse, NY.
3. Appleton Electric Company, Chicago, IL.

E. Fiberglass-Reinforced Polyester Boxes:

1. Crouse-Hinds Electrical Construction Materials, Syracuse, NY.
2. Hoffman Engineering Company, Anoka, MN.

4.5 MATERIALS AND COMPONENTS:

A. Flexible-Metal Conduit:

1. Provide flexible-metal conduit for use in dry areas and match fittings, size, and material to rigid conduit to which it is connected. Flexible-metal conduit conforming to U.L.-1.
2. Provide liquid-tight flexible-metal conduit for use in damp and corrosive areas consisting of flexible-metal conduit, with liquid-tight, sunlight-resistant jacket extruded over the conduit. On 1-1/4-in. and larger conduits, furnish separate external ground wire. Liquid-Tight flexible-metal conduit conforming to U.L.-360.

B. Polyvinylchloride (PVC) Conduit:

1. Provide PVC conduit, Schedule 40 or 80 conforming to industry NEMA Standard TC-2 and UL-651.

C. Boxes:

1. Provide PVC, outlet and junction boxes constructed of code-gauge. Size each box as required by the NEC.
2. Provide boxes containing fixture studs for hanging fixtures. Use concrete-tight boxes for installation in concrete. Do not use shallow boxes unless building construction is such that it is impossible to use standard-depth boxes.
3. Provide polyvinylchloride boxes for use as junction boxes and provide high impact strength fiberglass-reinforced polyester boxes for use as device boxes, pull boxes, and terminal boxes for use with polyvinylchloride conduit. Size each box as required by the National Electrical Code.
4. Provide pull boxes used below motor control centers and large pull boxes (10 inches by 10 inches by 6 inches deep and larger) hung from ceilings constructed of angle or channel frames, and sheet metal with welded joints. All welds to be ground smooth. Provide neoprene gaskets for complete sealing. Sectionalize covers longer than 40-in. to facilitate handling and gasket sectionalized covers where covers meet, using angle iron or channel cross members at the joint. Sheet metal to be not less than No. 12 gage galvanized sheet steel. Make interior angles and supports of galvanized steel, or carbon steel with a corrosion-resistant phosphate coating and primer. Provide each box with a grounding lug for connection to the nearest ground bus. Current capacity of ground lug at least that required by the National Electrical Code for the largest feeder entering the equipment.
5. Construct telephone cabinets of code-gauge galvanized steel with a hinged flush door. Provide backboard of 3/4-in. exterior grade plywood in the cabinet. Cabinet sizes and locations shall be as indicated on the drawings and required by the telephone company. Furnish and install telephone cabinets as directed by the telephone company.

D. Fittings:

1. Provide suitable expansion fittings where conduits cross expansion joints. Equip these fittings with grounding straps, clamps, and copper bonding jumpers.

PART 3 - EXECUTION

4.6 GENERAL

A. Perform all work in accordance with the National Electric Code.

B. Use no conduit less than 3/4 inches in diameter, unless otherwise indicated.

4.7 INSTALLATION OF FITTINGS:

A. Install expansion fittings wherever conduits cross structural expansion joints. Keep the fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.

B. Do not install fittings to replace elbows and pull boxes, unless space or other problems make use of fittings necessary. Use oversize fittings whenever large cable is installed, in order to maintain proper bending radius.

C. Terminate ends of all floor conduits installed for future use with couplings and readily removable plugs set flush with finished floor surface. Cap spare wall conduits at wall where they enter building.

D. Equip ends of all conduits with suitable conduit fittings. Fit conduits terminating at motor control center or power distribution equipment, or in box above or below, with grounding type bushings, or solidly ground by locknuts or other acceptable fittings. Connect each grounding bushing to ground bus by a bare or green-covered copper wire. Do not use ground wire smaller than 12 awg. Install ground wire larger than 12 gauge when required by NEC. Where conduits terminate in unprotected areas or where bonding is required over expansion joint, flexible conduit or equivalent; use ground wires No. 6 Awg. copper or larger.

E. Terminate conduits entering gasketed sheet-metal boxes or gasketed sheet-metal equipment enclosures with gasketed hubs.

F. Terminate conduits entering nongasketed sheet-metal boxes or enclosures with double locknuts and insulated bushings, or with acceptable equivalent.

4.8 INSTALLATION OF RACEWAYS:

A. Install exposed raceways parallel or at right angles to walls and ceiling beams. Make all changes in directions with approved bends, elbows, and pull boxes. Space parallel runs uniformly throughout. Secure in place by approved hangers and approved fasteners. Effectively ground raceways by connection to properly grounded enclosures, bonding, or other approved means, to obtain permanent low resistance path to ground throughout installation. Ensure that raceway sections in single run and in parallel runs are of same type and finish.

B. Support raceways concealed above suspended ceilings from slab above ceiling in same manner as exposed raceways. Do not support raceways from ceiling supports.

C. Provide cast-in-place inserts in concrete to support all runs, unless otherwise permitted. Use stainless steel sleeve type concrete anchors for installing boxes, conduit supports, etc. Provide stainless steel nut, bolts, washers, etc. for use with concrete anchors.

D. Provide bolts or machine screws on steel work. Support conduits by hangers or pipe straps spaced according to NEC, but in no case more than 10 feet on centers.

E. Provide galvanized supports for conduits.

F. Install conduits in slabs as close to middle of concrete slabs as practicable without disturbing reinforcement. Do not use conduit with outside diameter exceeding one-third of slab thickness. Do not place conduits closer than three diameters on centers, except at cabinet locations where slab thickness is increased as permitted by Engineer.

G. Where conduits are concealed in bottom floor slab, place in concrete slab and not in fill below slab.

H. Provide sleeves passing through exterior walls and slabs which are wall entrance seals of watertight construction. For new construction furnish watertight seal between slab and sleeve, and between sleeve and conduit or cable similar to O.Z./Gedney Type "FSK". For existing construction furnish watertight seal for use in core bit drilled holes that provides seal between concrete and conduit or cable similar to O.Z./Gedney Type "CSM1". Use wall-entrance seals or malleable iron with watertight sealing gland which may be tightened any time after installation.

I. Do not use dissimilar metals in conjunction with each other. Use suitable insulation between adjoining surfaces so as to eliminate direct contract and any resultant electrolysis. Maintain electrical continuity of system. Use bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials as insulation.

J. Install fittings to match raceway being used.

K. Where conduits pass through firewalls, grout hole around the conduit to the full depth of the material penetrated.

L. Provide separate raceways for all low voltage instrumentation raceways (50 volts and below) from control and power raceways.

4.9 BENDS:

A. Make all bends carefully to prevent distortion of circular cross section. Field bend conduit to have an inside radius of not less than nine diameters.

B. Where bends of less than nine diameters are necessary, use standard factory elbows. Size conduit to permit cable-bending radius within the factory elbow of at least eight times cable diameter.

C. Use concentric bends in parallel runs. Allow no conduit to have more than two 90 degree bends or equivalent thereof between pulling points.

4.10 CUTTING, THREADING AND CONNECTING:

A. Make all field cuts in conduits squarely, file cut ends, ream to remove rough edges and thread in accordance with N.E.C.. No running thread permitted. Make all connections mechanically strong and tight, and with acceptable connectors. Where conduit surface coating is damaged or removed in the cutting, threading or reaming process restore the surface to the original condition.

4.11 CONDUIT CLEANING:

A. Clean all conduit carefully before and after installation, ream ends free of burrs, and free inside surfaces from all imperfections likely to injure cable.

B. After installation of each complete new conduit run, snake the run with band to which is attached a tube cleaner with cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of conduit. Remove and replace all conduit through which mandrel will not pass.

C. Use a sponge with steel brush to clean steel conduit and use a sponge with nylon brush to clean PVC conduits.

D. After cleaning, protect ends of all conduit with standard caps to prevent entrance of water, concrete, debris, or other foreign substance.

4.12 CONDUIT DRAINAGE:

A. Where practicable, pitch conduit to drain to outlet boxes, or install so as to avoid trapping moisture. Where dips are unavoidable in exposed conduits, install fitting with suitable drain hole at low point.

4.13 INSTALLATION OF BOXES:

A. Install sheet metal boxes only in dry, accessible location. Install cast metal boxes (unless otherwise indicated) in outside concrete or masonry walls, in floor slabs, in basements and all other below grade locations. Cast metal boxes must be used (unless otherwise indicated) where vapor-tight fixtures are required, for all surface mounting of wall switches and receptacles and for all outdoor use. Install pull boxes for motor control centers and large ceiling hung boxes where indicated.

B. Install boxes in conformity with all requirements of NEC. Install boxes designed for type of construction involved. Support boxes in same manner as required for conduit. Size boxes to provide bending radius for wire or cable of at least eight times diameter or in accordance with NEC, whichever is larger.

C. Center all outlets in panels, or spaces and adjust to structural finish. Where specific locations are not indicated, locate outlets with respect to equipment served.

D. Place all outlet boxes, junction boxes, pull boxes, etc., in accessible locations when they are installed above or behind plastered ceilings, furred spaces, or suspended ceilings. Install access panels of suitable size. Mark all access panels for all boxes so panels can be readily located in future. Mark, using metal tabs or plastic buttons which cannot mark ceilings or walls, appropriate for type of construction being used.

E. Assemble cast-metal boxes with threaded conduit hubs in such manner that conduit connections and gasketed covers are watertight. Close all unused threaded openings with pipe plugs and compound.

F. Provide cast boxes with covers and device plates suitable for the area classification. Install screws of stainless steel or high brass for iron boxes.

4.14 FLEXIBLE CONNECTIONS TO MOTORS AND EQUIPMENT:

A. At all motors and electrically operated equipment to which conduit connections are made, install with a complete connection between end of conduit and terminal box of motor or other equipment.

B. Install the conduits in locations permitting direct connection to motors.

C. Make connections between raceway and motor or equipment subject to vibration and adjustment using flexible conduit. Make each connection with at least one quarter bend so that no vibration can be transmitted beyond flexible connection.

D. Install flexible metal conduit, fittings, and accessories in dry areas in accordance with requirements of NEC.

E. Install liquid-tight flexible metal conduit in damp and corrosive areas. Locate conduit to reduce the possibility of damage to the exterior coating. Use fittings that screw into flexible conduit and provide gaskets where required.

4.15 TELEPHONE RACEWAY INSTALLATION:

A. Install empty conduit between all telephone outlets, terminal boxes, and cabinets. Provide pull cable and leave in conduit for telephone installer use.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 1.2 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS

A. A. Product Data: For each electrical identification product indicated.

B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate color, lettering style, and graphic features of identification products.

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size. Color: Black letters on orange field.

1. Legend: Indicates voltage and service.

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.

C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (0.08 mm thick by 25 to 51 mm wide).

E. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick (152 mm wide by 0.102 mm thick).
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend indicating type of underground line.

F. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

G. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4-mm-) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

H. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

I. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch (0.05 mm) thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.

J. Brass or Aluminum Tags: 2 by 2 by 0.05-inch (51 by 51 by 1.3-mm) metal tags with stamped legend, punched for fastener.

2.2 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

C. Engraved legend with black letters on white face.

1. Punched or drilled for mechanical fasteners.

D. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.

E. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.

F. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.3 kg) minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: According to color-coding.

B. Paint: Formulated for the type of surface and intended use.

1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work. Self-Adhesive Identification Products: Clean surfaces before applying.

D. Circuits with More Than 600 V: Identify raceway and cable with "DANGER--HIGH VOLTAGE" in black letters 2 inches (51 mm) high, stenciled with paint at 10-foot (3-m) intervals over a continuous, painted orange background. Identify the following:

1. Entire floor area directly above conduits running beneath and within 12 inches (305 mm) of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to conduits concealed within wall.
3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in the building, or concealed above suspended ceilings.
4. Entire surface of exposed conduits.

E. Install painted identification according to manufacturer's written instructions and as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime surfaces using type of primer specified for surface.
3. Apply one intermediate and one finish coat of enamel.

F. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:

1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
3. Apply the following colors to the systems listed below:

    a. Fire Alarm System: Red.
    b. Fire-Suppression Supervisory and Control System: Red and yellow.
    c. Combined Fire Alarm and Security System: Red and blue.
    d. Security System: Blue and yellow.
    e. Mechanical and Electrical Supervisory System: Green and blue.
    f. Telecommunication System: Green and yellow.

G. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

I. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
   Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

J. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. direct-buried cables Install line marker for underground wiring, both direct-buried cables and cables in raceway.

K. Color-Coding of Secondary Phase Conductors: Use the following colors for service feeder and branch-circuit phase conductors:

1. 208/120-V Conductors:

   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.

2. 480/277-V Conductors:

   a. Phase A: Yellow.
   b. Phase B: Brown.
   c. Phase C: Orange.

3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:

   a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- (25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
   b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

L. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Tag Fasteners: Nylon cable ties.
3. Band Fasteners: Integral ears.

Apply identification to conductors as follows:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

N. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

O. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high lettering on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

1. Panelboards, electrical cabinets, and enclosures.
2. Access doors and panels for concealed electrical items.
3. Electrical switchgear and switchboards.
4. Electrical substations.
5. Emergency system boxes and enclosures.
6. Motor-control centers.
7. Disconnect switches.
8. Enclosed circuit breakers.
9. Motor starters.
10. Push-button stations.
11. Power transfer equipment.

12. Contactors.
13. Remote-controlled switches.
14. Dimmers.
15. Control devices.
16. Transformers.
17. Inverters.
18. Rectifiers.
19. Frequency converters.
20. Battery racks.
21. Power-generating units.
22. Telephone switching equipment.
23. Clock/program master equipment.
24. Call system master station.
25. TV/audio-monitoring master station.
26. 26. Fire alarm master station or control panel.
27. 27. Security-monitoring master station or control panel.

END OF SECTION

SECTION 26 09 13

ELECTRICAL CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 SUMMARY

A. Furnish, install and connect the electrical control equipment and miscellaneous electrical equipment, including such instruments and devices as are indicated and specified. Enclosures for electrical equipment shall be as indicated.

B. Where type of enclosure is not indicated, furnish the equipment with a NEMA Type 12 enclosure.

C. Furnish and install all steel channels necessary for mounting of electrical equipment.

1.2 RELATED WORK:

A. Conduit, wiring, and connections for equipment and devices; Section 15806.

B. Control equipment, relays, control wiring, conduit, and connections for control of heating, ventilating and air-conditioning; Section 15806.

1.3 REFERENCE STANDARDS:

A. UL: Underwriters' Laboratories, Inc., 33 Pfingsten Road, Northbrook, Illinois

B. NEMA: National Electrical Manufacturers Association, 2101 L Street, Northwest, Washington, D.C.

C. FM: Factory Mutual Engineering Corporation, Factory Mutual System, 1151 Boston/Providence Turnpike, Norwood, Massachusetts.

PART 2 PRODUCTS

2.1 MANUFACTURERS OF MISCELLANEOUS EQUIPMENT:

A. General Electric Company

B. Westinghouse Company

C. Square D Company

D. Russell & Stoll, Livingston, NJ

E. Acceptable equivalent.

2.2 STEEL CHANNEL MANUFACTURERS

A. Unistrut Corp., Wayne, MI

B. Power-Strut Division, Van Huffel Tube Corp., Warren, OH

C. T.J. Cope, Division of Cyprus Mines Corp., Collegeville, PA

D. Acceptable equivalent.

2.3 SWITCHES

A. Furnish HAND-OFF-AUTO switches, safety switches, tumbler switches and other accessory devices as necessary for the control of motors and other electrical equipment or devices.

1. Furnish heavy duty type, safety switches, with external operating handles, 3 PST, rated 240 volt, 60 Hertz with ampere rating as indicated, and having provisions for padlocking.

2. Furnish fuses for safety switches as indicated.

2.4 CONDUIT AND WIRING

A. Furnish conduit and wiring necessary to make connections between intruments panels, consoles, cabinets and external equipment and devices.

2.5 PUSHBUTTON STATIONS:

A. Furnish pushbutton stations designed for heavy-duty service and with momentary or maintaining contacts as indicated or as necessary for starting and stopping motor.

B. At pushbutton stations furnish nameplates with white letters on black background.

C. Furnish safety lockout station with position indication located near motor to prevent application of current. Where pumps are located on lower levels than driving motors, furnish safety lockout station near each pump or other item of equipment.

D. Rate explosion-proof pushbutton stations for the Group, Division and Class as indicated.

E. Galvanized cast-iron enclosures for NEMA Type 4 watertight pushbutton stations.

F. Furnish fiberglass reinforced polyester enclosures for pushbutton stations and pushbutton external surfaces located in highly corrosive area. Also furnish pushbutton external surface with external neoprene boot over fiber glass reinforced polyester enclosure. Furnish gaskets with stainless steel screws, to prevent entry of chemicals.

2.6 MANUAL MOTOR STARTERS:

A. Furnish manual motor starters where indicated and for 120-volt, 60-Hertz fractional horsepower motors that do not have built-in thermal overload devices.

B. Furnish each manual motor starter with overload heater or heaters of suitable capacity for motor-running over-current protection for motor it controls. Furnish manual starters as single or 2 pole, as necessary, and with toggle mechanisms indicating OFF and ON positions. Where indicated, furnish manual starters with built-in HAND-OFF-AUTO switches. Furnish enclosures as indicated.

C. Manual starters within sight of motors, as defined by N.E.C.

2.7 COMBINATION STARTERS:

A. Unless otherwise indicated, furnish each combination starter with motor circuit protector and full-voltage magnetic starter. Furnish motor circuit protectors and starters as specified under Motor Control Centers.

B. Furnish control transformer with current limiting primary fuses.

C. Furnish indicating lights of the transformer type, heavy duty, oiltight unit rated at 120 volts.

D. Furnish heavy duty, oiltight type pushbuttons to provide momentary contacts or maintained contacts as necessary for starting and stopping the motor.

2.8 CIRCUIT BREAKERS:

A. Furnish manually operated circuit breakers, ambient-compensated, providing thermal magnetic inverse time-limit overload and instantaneous short circuit protection. Furnish overload protection on all poles; trip settings as indicated.

B. Furnish breakers that are rated 208 volt alternating current; 3 PST or 2 PST, have 100-amp. or larger frames, and have an interrupting capacity of not less than 10,0000 rms symmetrical amperes at 208 volts.

C. Furnish time-current characteristics curves for each size of circuit breaker furnished.

D. Furnish circuit breakers housed in NEMA type 1 enclosure indicated, having external operating handles with provisions for padlocking.

E. Furnish circuit breakers manufactured by General Electric Company, Square D Company, Westinghouse Electric Corp., or acceptable equivalent.

2.9 ELECTRIC CLOCKS:

A. Furnish electric clock operating on 120-volt, 60 Hertz at each clock outlet. Unless otherwise indicated, furnish each clock with white circular dial with sweep-second hand and black-enameled numerals and hands. Size of clocks as indicated.

B. Enclose each clock in a satin aluminum finish, metal case for surface mounting.

2.10 CONTROL PANELS:

A. Furnish control panels for A/C and other equipment, as indicated in mechanical drawings. Enclosure that dimensions, construction and mounting of equipment is as indicated.

B. Furnish panels constructed of at least 3/32 gage steel and provided with terminal blocks for connection of all external wiring.

C. Furnish pushbuttons, indicator lights and switches of heavy duty, oil tight types. Furnish relays of industrial types, with 120-volt, 60-Hertz operating coils, and contacts rated for intended service.

D. Furnish nameplates for each panel and each device on panel. Nameplates of laminated plastic material, at least 3/32 in. thick, and with white letters on a black background.

PART 3 EXECUTION

3.1 WIRING OF MISCELLANEOUS DEVICES:

A. Make all electrical connections required for recording and indicating instruments, and miscellaneous devices and provide electrical supplies to metering, instrumentation, control, and alarm systems.

B. Connect HAND-OFF-AUTO switches, safety switches, tumbler switches, and other accessory devices as indicated or necessary for control of motors and other electrical equipment or devices.

C. Install conduit and wiring and make all necessary electrical connections between all instrument panels, consoles, cabinets, and external equipment and devices. Panels, cabinets, etc., are indicated.

3.2 WIRING OF EQUIPMENT FURNISHED UNDER OTHER SECTIONS:

A. As specified under Electrical Work General, install conduit, wiring, and connections for equipment and devices furnished under other Sections of specifications, and as indicated.

B. Refer to heating, ventilating, and air-conditioning specifications and drawings for locations of air-handling units, duct heaters, air-conditioning units, damper motors, ventilating and exhaust fans, and other equipment requiring 480-volt and 208-volt supply; provide supply to equipment.

C. Where indicated on drawings, install manual and magnetic starting equipment for heating and ventilating equipment.

D. Unless otherwise indicated on drawings, all control equipment, relays, control wiring, conduit, and connections necessary for control of heating, ventilating, and air-conditioning systems provided under Section 15806. Refer to mechanical specifications and drawings for locations of pressure-operated control switches, float switches, butterfly valves, solenoid-operated valves, sump pumps, metering instruments, control panels, alarm actuating contacts, indicating lamps, limit switches, and other devices requiring wiring or interconnections with equipment supplied under electrical Sections of these specifications.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.1 DESCRIPTION

A. Furnish and install panelboards including circuit breakers and cabinets complete, in conformance with the latest NEMA Standards and Federal Specifications listed below.

1.2 REFERENCE STANDARDS:

A. National Electrical Manufacturers Association (NEMA):
1. PB1- Panelboards
2. AB1- Molded Case Circuit Breakers

B. Federal Specifications (FS):
1. W-P-115A - Panel, Power Distribution.
2. W-C-375B - Automatic Circuit Breakers.
3. QQ-S-365B - Silver Plating, Electro deposited, General Requirements for

C. National Fire Protection Association (NFPA):
1. National Electrical Code (NEC)

D. Underwriters Laboratories, Inc.:
1. UL 67 - Panelboards

PART 2 PRODUCTS

2.1 PANELBOARD MANUFACTURERS:

A. Manufacturers acceptable contingent upon products' compliance with the specifications:

1. General Electric Company, Schenectady, NY.
2. Westinghouse Electric Corp., Distribution Equipment Division, St. Louis, MO.
3. Square D Company, Park Ridge, IL.
4. Cutler-Hammer Products, Milwaukee, WI.
5. I-T-E Electrical Products (Siemens), Alpharetta, GA.

2.2 PANELBOARDS:

A. Factory assembled deadfront type panelboards.

B. Furnish panelboards complete with branch circuit breakers and a main circuit breaker or main lugs only as indicated.

C. Furnish panelboards with full capacity separate ground bus, separate insulated neutral bus and furnish panelboards connected to a 3-phase, 4-wire service or single phase, 3-wire service as indicated.

D. Provide panelboards with the voltage, frequency and current ratings as indicated conforming to NEMA Standard PB1, Federal Specification W-P-115A. U.L. 67, and the N.E.C.

E. Furnish the panelboard main and neutral buses, with minimum 98 percent conductivity rectangular copper bars provided with bolted type lugs as necessary.

F. Drill buses to fit either "A", "B" or "C" Phase connectors, and ensure that connectors are interchangeable and installed in a distributed phase sequence.

G. Silver plate buses, connectors and terminals to a minimum thickness of 0.005-in., conforming to the requirements of Federal Spec. QQ-S-365B.

H. Prevent terminal lugs from turning per NEMA standard PBI and ensure they are suitable for the conductor material and size.

I. Provide main bus-bracing for each panel board adequate for 10,000 amperes symmetrical short circuit at 240 volts and 14,000 amperes symmetrical short circuit at 480 volts unless otherwise indicated.

2.3 CIRCUIT BREAKERS:

A. Furnish bolt-on type branch and main circuit breakers. Furnish frame sizes, trip settings and number of poles as indicated. Clearly and visibly mark circuit breakers with ampere trip rating. Furnish breakers meeting the requirements of F.S. W-C-375B and NEMA AB1

B. Furnish all breakers with quick-make, quick-break, toggle mechanisms and thermal-magnetic, inverse time-limit overload and instantaneous short circuit protection on all poles, unless otherwise indicated. Automatic tripping indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position. Furnish breaker handle that is trip-free on overloads.

C. Do not use single pole breakers with handle ties or bails in lieu of multipole breakers.

D. Furnish handle lock device on breakers as indicated to prevent the manual opening of the selected breakers.

E. Furnish padlocking device on breakers as indicated to prevent the opening of indicated breakers.

F. Ensure that voltage and interrupting rating of all breakers in a panelboard is not less than voltage and short circuit rating of the panelboard main buses, as indicated. Furnish breakers suitable to operate satisfactorily at the frequency indicated.

G. Furnish ground fault interrupter circuit breakers for certain circuits as indicated on the drawings.

H. Furnish single pole breakers with full module size. Do not install two pole breakers in a single module.

I. Furnish time-current characteristic curves and catalog information and data for each size of breaker furnished.

2.4 CABINETS:

A. Provide NEMA I cabinets, unless otherwise indicated and without knockouts. Drill cabinets only for the exact conduit entrances and mounting bolts.

B. Finish cabinet fronts, trims and surface-mounted boxes in ANSI No. 61 or 49, light-gray enamel over a rust-inhibitive primer. Attach the fronts (exterior trims) to the boxes or interior trims, by quarter-turn, indicating trim clamps. Design cabinets for surface or flush mounting as indicated.

C. Unless otherwise specified, construct panelboard cabinets of code-gauge galvanized, sheet steel and equip with gutters of ample size for the risers and outgoing circuits. Ensure that the cabinets do not exceed 78-in. (1980 mm) in height.

PART 3 EXECUTION

3.1 INSTALLATION:

A. Mount all panelboards such that the height of the top operating handle does not exceed 6 ft. 6-in. (1980 mm) from the floor.

B. Hang each door of the cabinet on semi- or fully-concealed hinges with a combination catch and lock.

C. On cabinets 48 in. (1200 mm) high and over, install a 3 point catch assembly latching at top, bottom and approximate middle.

D. Provide directory card filled-out.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 PART 1 - GENERAL

1.1 SUMMARY

A. Furnish, install, field test, and place in operating condition, wiring devices as indicated and as specified.

1.2 REFERENCE STANDARDS:

A. National Electrical Manufacturers Association (NEMA):
   a. National Electrical Code (NEC).

B. Federal Specifications:
   a. W-S-896-F (1P-2P-3W) Switch, Toggle, Single Unit with wall plates.
   b. W-C-596-F Plug, Electrical Connector, Receptacle, Electrical.

C. Underwriters' Laboratories, Inc. (UL):
   a. UL-20, General Use Snap Switches.

D. National Fire Protection Association (NFPA):
   a. National Electrical Code (NEC).

1.3 SUBMITTALS:

A. Submit shop drawings and manufacturer's product data in accordance with requirements of General Specifications and Section 16050.

PART 2 PART 2 - PRODUCTS

2.1 MANUFACTURER'S COMPLIANCE:

A. Manufacturers acceptance contingent upon products compliance with specifications.

B. Provide all devices with U.L. label.

2.2 MANUFACTURERS:

A. Arrow-Hart, Inc., Florence, KY.

B. Allen-Bradley Co., Milwaukee, WI.

C. Appleton Electric Co., Chicago, IL.

D. Bryant Electric, Div. of Westinghouse, Bridgeport, CT.

E. Cutler Hammer, Inc., Milwaukee, WI.

F. Crouse-Hinds Co., Syracuse, NY.

G. Harvey Hubbell, Inc., Bridgeport, CT.

H. Pass & Seymore, Inc., Syracuse, NY.

2.3 MATERIALS AND COMPONENTS:

A. Wall Switches:

a. Provide alternating current, general-use, snap switches, in flush device boxes or on outlet box covers, totally enclosed in composition case, with insulated mounting yoke and sidewired, binding screw-type terminals. Single-pole, 2-pole, 3-way, or 4-way switches rated 20 amperes at 120/277 volts a.c. Switch to meet Fed. Spec. W-S-896-F and UL-20.

b. Switches for controlling lighting:

1) Arrow-Hart Cat. No. 1991, 1992, 1993 or 1994.
2) Harvey Hubbell Cat. No. 1221, 1222, 1223 or 1224.
3) Bryant Electric Cat. No. 4901, 4902, 4903 or 4904.
4) Pass & Seymore, Cat. No. 20AC1, 20AC2, 20AC3 or 20AC4.

c. Provide pilot lights for switches controlling lights in seldom frequented locations consisting of either separate units or a 2-unit combination with separate switch and yoke-mounted candelabra base socket rated 75 watts, 125 volts, and fitted with a ruby lens. Provide a clear 6- or 7-watt lamp with each pilot.

B. Watertight Switches:

a. Provide watertight switches consisting of flush mounting switches in NEMA Type 4 gasketed cast metal boxes. Switch operable through shaft in matching cast metal cover, twenty-ampere, 120/277-volt switch enclosures:

1) Crouse-Hinds Type MC or MCC.
2) Allen-Bradley Cat. No. 600-TCX-4.
3) Cutler-Hammer Cat. No. 9101 H98.

C. Flush Receptacles:

a. Provide 20-ampere, 125-volt flush receptacles constructed in flush device boxes, and of grounding type in composition case with

insulated mounting yoke, side-wired, binding screw-type terminals. Receptacles to meet Fed. Spec. WC596-F.

b. Duplex receptacles:

1) Arrow-Hart Cat. No. 5342.
2) Harvey Hubbell Cat. No. 5362.
3) Bryant Electric Cat. No. 5362.
4) Pass & Seymore Cat. No. 5342.

D. Single receptacles:

a. Arrow-Hart Cat. No. 5361.
b. Harvey Hubbell Cat. No. 5361.
c. Pass & Seymore Cat. No. 5351.

E. Clock Receptacles:

a. Provide 3-wire, 15-ampere, 125-volt hanger receptacle with flush stainless steel plate for each clock:

1) Arrow-Hart Cat. No. 5708.
2) Harvey Hubbell Cat. No. 5235.
3) Bryant Electric Cat. No. 2828GS.
4) Pass & Seymore Cat. No. 2123.

F. Special Receptacles:

a. Provide weatherproof devices rated 20 ampere, 125-volt, consisting of single receptacles with spring-loaded, soft-gasketed hinged covers with stainless steel spring. Covers as follows:

1) Arrow-Hart Cat. No. 4500FS.
2) Harvey Hubbell Cat. No. 5206.
3) Bryant Electric Cat. No. 4510.
4) Crouse-Hinds Cat. No. WLRS-1.

b. Provide in corrosive areas (NEMA 4X) a receptacle similar to the weatherproof device described above. Cover as follows:

1) Crouse-Hinds Cat. No. WLRS-1-S752.

c. Provide watertight, gasketed cast-metal enclosures with covers in areas subject to hose-down, meeting requirements, and either standard single or duplex type:

1) Appleton Electric Cat. No. AEE3382 and AEP3361, Style 2.
2) Crouse-Hinds Cat. No. ARRH33 and APJ3385, Style 2.

d. Provide receptacles with matching plug or cord cap designed to meet NEMA 4 requirements when plug, cord and receptacle are assembled.

e. Provide explosionproof 20-ampere receptacles, of the delayed action type, preventing contact from being broken until arc has been extinguished. Receptacles with angle covers and spring-closed flaps:

1) Crouse-Hinds Type CPS.
2) Appleton Electric Type CPS.

f. Furnish one explosionproof plug for each three receptacles, with minimum of one, plugs to match receptacles and from same manufacturer.

g. Provide welding receptacles whereby plug ground contact makes contact with receptacle ground contact before current carrying contacts engage, and when withdrawing plug, ground contact remains engaged until after current carrying ground contacts disengage. Provide ampere rating as indicated on the drawings.

G. Outlet Boxes and Enclosures:

a. Provide outlet boxes and enclosures conforming to Section 16110, Electrical Raceway Systems and enclosure schedule on the drawings unless otherwise indicated.

H. Device Plates:

a. Provide device plates suitable for type of outlet boxes and enclosures used. Plates for flush-mounting by device manufacturer. Plates for surface-mounting boxes by either device manufacturer or box manufacturer.
b. Provide flush device plates of high corrosion resistant, Type 302 stainless steel.
c. Provide flush device plates of material and finish indicated, in certain designated areas.

I. Nameplates.

J. Provide nameplates or equivalent markings on switch enclosures to indicate ON and OFF positions of each switch. Do not use ON and OFF for 3-way or 4-way switches. Receptacles for special purpose shall have nameplates indicating their use, unless use is obvious. Nameplates shall otherwise conform to requirements specified under Section 16050.

PART 3 PART 3 - EXECUTION

3.1 GENERAL:

A. Perform all work in accordance with the National Electrical Code (NEC).

3.2 CONNECTION:

A. Securely and rigidly attach wiring devices in accordance with regulating agency, and as indicated, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets and centered under or on the device, unless otherwise indicated.

3.3 GROUNDING:

A. Ground all devices in accordance with NEC.

B. Ground switches and their metal plates through switch mounting yoke, outlet box, and raceway system.

C. Ground flush receptacles and their metal plates through positive ground connection to outlet box and grounding system. Maintain ground to each receptacle by spring-loaded grounding contact to mounting screw, or by grounding jumper, both making positive connection to outlet box and grounding system at all times.

D. Ground explosionproof receptacles and plugs by making contact between the metal shells, and also by using grounding pin to make contact before power contacts are made.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes fuses rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: For each fuse type indicated.

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. Source Limitations: Obtain fuses from one source by a single manufacturer.

C. Comply with NFPA 70 for components and installation.

1.4 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish quantity equal to 20 percent of each fuse type and size installed, but not less than one set of each type and size.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide fuses by one of the following:
1. Cooper Industries, Inc.; Bussmann Div.

2. Eagle Electric Mfg. Co., Inc.
3. Ferraz Corp.
4. General Electric Co.; Wiring Devices Div.
5. Gould Shawmut.
6. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
7. Approval equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; voltage rating consistent with circuit voltage.

PART 3 EXECUTION

3.1 FUSE APPLICATIONS

A. Main Service: RK1, time delay.

B. Main Feeders: RK1, time delay.

C. Motor Branch Circuits: Class RK1, time delay.

D. Other Branch Circuits: Class RK1, non-time delay.

3.2 INSTALLATION

A. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

3.3 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

A. A. This Section includes individually mounted enclosed switches and circuit breakers, rated 600 V and less, used for disconnecting and protection functions.

B. See Division 16 Section "Fuses" for fuses for fusible disconnect switches.

1.2 SUBMITTALS

A. Section 01 33 00: Submittal Procedures.

B. Product Data: For each type of switch and circuit breaker indicated.

C. Shop Drawings: Include wiring diagrams for shunt-tripped circuit breakers.

D. Field quality-control test reports.

E. Operation and maintenance data.

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. Source Limitations: Obtain switches and circuit breakers through one source from a single manufacturer.

C. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Corp.; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D Co.
5. Approved equal.

2.2 ENCLOSED SWITCHES

A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle, interlocked with cover.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, and lockable handle, interlocked with cover.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. 3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
4. 4. GFCI Circuit Breakers: Single- and two-pole configurations with [5] [30]-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Suitable for number, size, trip ratings, and material of conductors.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

2.4 ENCLOSURES

A. Listed for environmental conditions of installed locations, including:

1. Outdoor Locations: NEMA 250, Type 3R.
2. Food Service Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 EXECUTION

3.1 INSTALLATION

A. Temporary Provisions: Remove temporary lifting provisions and blocking of moving parts.

B. Identify components; provide warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods and Electrical Identification."

3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and circuit breakers and after electrical circuits have been energized, demonstrate product capability and compliance with requirements.

B. Inspections and Tests for Switches and Circuit Breakers: Make internal and external inspections and perform tests, including the following:

1. Inspect for freedom from physical damage, proper unit rating, mechanical condition, enclosure integrity, cover operation, unit anchorage, clearances, and tightness of electrical connections. If a loose electrical connection is observed on any unit, check each electrical connection for each switch and circuit breaker with a torque wrench for compliance with manufacturer's torquing instructions.
2. Test insulation resistance of each pole, phase-to-phase, and phase-to-ground, following manufacturer's written instructions. Test insulation resistance of shunt trip circuits. Use 500-V minimum test voltage for units and circuits rated up to 250 V, 1000-V minimum test voltage for units rated

more than 250 V. Measured insulation resistance must be 25 megohms, minimum, for switches rated up to 250 V, and 100 megohms, minimum, for switches rated more than 250 V.

3. Test cover and other interlocks and interlock release devices for proper operation.

C. Additional Inspections and Tests for Switches: Include the following:

1. Inspect for proper rating and fuse provisions.
2. Check adequacy and integrity of fuseholders by removing and installing fuses.
3. Check integrity of phase barriers.

D. Inspect blade alignment visually while operating switch to observe adequacy of blade pressure.

E. Additional Inspections and Tests for Circuit Breakers: Include the following:

1. Inspect for proper frame, trip, and fault current interrupting rating.
2. Test shunt trip devices, circuits, and actuating components for proper operation.

F. Correct defective and malfunctioning units on-site, where possible, and reinspect and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION

SECTION 26 31 00

PHOTOVOLTAIC COLLECTOR

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Photovoltaic panels.
2. Accessories

1.2 REFERENCES

A. IEC 61215 , Safety tested IEC 61730

B. UL listed (UL 1703)

C. Class C Fire Rating

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures

B. Product Data: Submit dimensions, ratings, and performance data.

C. Certificates: Manufacturer's quality certificates and published test reports.

D. Manufacturer's Instructions: Manufacturer's complete shipping, handling, installation and maintenance instructions.

E. Manufacturer's Installation Instructions: Submit installation methods and procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Product Data: Submit dimensions, ratings, and performance data.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section.

B. Installer: Performing the work of this section with installation manufacturer guide and specifications.

1.5 SAFETY PRECAUTIONS

A. Cover all modules in the PV array with an opaque cloth or material before making or breaking electrical connections.

B. All installations must be performed in compliance with the National Electrical Code (NEC) and any applicable local codes.

C. There are no user serviceable parts within the module. Do not attempt to repair any part of the module.

D. Installation should be performed only by authorized personnel.

E. Remove all metallic jewelry prior to installing this product to reduce the chance of accidental exposure to live circuits.

F. Use insulated tools to reduce your risk of electric shock.

G. Do not stand on, drop, scratch, or allow objects to fall on modules.

H. If the front glass is broken, or the back sheet is torn, contact with any module surface or module frame can cause electric shock.

I. Do not install or handle the modules when they are wet or during periods of high wind.

J. Contact your module supplier if maintenance is necessary.

1.6 DELIVERY, STORAGE, AND HANDLING, SITE CONSIDERERATIONS

A. Accept product on site in factory packaging. Inspect for damage. Storage and Protection

B. Store panels in manufacturer's unopened package until ready for installation.

C. Protect installed panels from damage by securing areas and by leaving factory packaging in place to protect panels and prevent use.

All SunPower modules must be mounted in environments that ensure SunPower modules will operate within the following maximum and minimum operating temperatures:

Maximum Operating Temperature	+90 ˚ Celsius, +194 ˚ Fahrenheit
Minimum Operating Temperature	-40 ˚ Celsius, -40 ˚ Fahrenheit

D. SunPower modules are designed to meet a maximum positive (or upward, e.g. wind) and negative (or downward, e.g. static load) design pressure of 50 lb/ft² when mounted in one of the mounting configurations specified in Section 5.2. Design strength of 50 lb/ft² corresponds approximately to a wind speed of 125 mph. When mounting modules in snow-prone or high-wind environments, special care should be taken to mount the modules in a manner that provides sufficient design strength while meeting local code requirements.

1.7 WARRANTY

A. 25 year limited power warranty.

B. 10 year limited product warranty.

PART 2 PRODUCTS

2.1 305 SOLAR PANEL

A. Manufacturers:
Sun Power Corporation. Model: Sun Power 305 Solar Panel.
Corporate Headquarters
3939 N. 1st Street
San Jose, California 95134
Tel: (408) 240-5500
Fax: (408) 240-5400
Web Site: http://www.sunpowercorp.com
Technical Data: http://www.sunpowercorp.com/Products-and-Services/~/media/Downloads/for_products_services/spwr_305wh_com_en.ashx

1. Substitutions: Section 01 60 00 - Product Requirements.

B. The SunPower 305 Solar Panel provides today's highest efficiency and performance. Utilizing 96 next generation SunPower all-back contact solar cells, the SunPower 305 delivers an unprecedented total panel conversion efficiency of 18.7%. The 305 panel's reduced voltage temperature coefficient and exceptional low-light performance attributes provide outstanding energy delivery per peak power watt.

C. Accessories:

1. Electrical Connections:
Modules may be connected in series and/or parallel to achieve the desired electrical output as long as certain conditions are met. Please use only the same type of modules in a combined source circuit.

2. Equipment Grounding:

D. To avoid 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. SunPower recommends the following two methods of grounding the module frame. Attach an equipment ground conductor with stainless steel hardware at one of the four designated 0.17" grounding holes on the module frame. If an equipment ground conductor larger in diameter than #10 AWG is necessary, a grounding lay-in lug is required. A thread-forming 10-32 stainless steel screw is required when using a self-drilling type screw to make the frame ground connection. Please refer to NEC Article 690 on grounding PV arrays for specific requirements. SunPower modules can be grounded using third-party grounding washer or clip systems provided they have been tested and certified to meet UL 467 requirements for bonding/grounding systems and are installed according to the manufacturer's specified instructions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrate, areas and conditions where installation of solar panels will occur. Verify that substrate and conditions are satisfactory for installation.

3.2 MOUNTIGN CONFIGURATIONS

A. Modules may be mounted at any angle, from horizontal to vertical. Select the appropriate orientation to maximize sunlight exposure. Specific information on module dimensions and the location of mounting and grounding holes is provided below.

B. In order to prevent water from entering the junction box, which could present a safety hazard, modules should not be mounted such that the front/top glass faces downward (e.g., on a tracking structure that positions the modules with the junction box facing skyward during sleep mode).

C. Clearance between the module frames and structure or ground is required to prevent wiring damage and allows air to circulate behind the module.

3.3 INSTALLATION

A. Assemble solar panels and install in accordance with manufacturer's instructions and following:

1. Securely mount to substrate

2. Install solar panels plumb and level and in proper relation to adjacent construction

3. Test for proper operation. Adjust until proper operation is achieved.

B. Refer to manufacturer's published installation instruction and construction documents for detailed installation instructions.

C. Installation Manual may be download at: http://www.sunpowercorp.com/Products-and-Services/~/media/Downloads/ /for_products_services/SunPower_Safety_and_Installation_Instructions_UL_L.ashx

3.4 ADJUSTING

A. Aim and adjust panels as indicated on Drawings.

3.5 CLEANING

A. Protect surfaces from damage until date of substantial completion. Repair or replace damaged work.

B. Clean installed products in accordance with manufacturer's instruction prior to competition.

END OF SECTION

SECTION 26 51 00

INTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes interior luminaire, lamps, ballasts, and accessories.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C82.1 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions and components for each luminary not standard product of manufacturer.

C. Product Data: Submit dimensions, ratings, and performance data.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 FLUORESCENT LUMINAIRES

A. Manufacturers:
1. ARTEMIDE INC. Model: Basic strip 24-36-48, Type A, B, C Interior Luminaire
The USA National Headquarters
1980 New Highway
Farmingdale, New York 11735

Tel: 631-694-9292
Fax: 631-694-9275
Web Site: http://www.artemide.us/
Technical Data:
http://www.artemide.us/Products/Ron_Rezek/Basic_Strip_Wall/Basic_Strip_Wall.pdf

2. ARTEMIDE INC. Model: Luceri 15 recessed ceiling, Type D Interior Luminaire
Technical Data:
http://www.artemide.us/Products/Artemide_inc/luceri_recessed/Luceri_Recessed.pdf

3. ARTEMIDE INC. Model: Talo 21 mini wall, Type F Interior Luminaire
Technical Data:
http://www.artemide.us/Products/Architecture_Indoor/Wall/Talo_Mini_Wall/Talo_21_Mini_Wall.pdf

4. Substitutions: Section 01 60 00 - Product Requirements.

B. Type A, B, C Interior Luminaire Basic strip 24-36-48: Wall mounted luminaire for direct linear fluorescent lighting. Linear exposed fluorescent lamp. Size: 24-36-48 inches long by 1.5 inches deep by 2.75 inches high. Body in aluminum extrusion with natural anodized or matte white powder coated finish and end caps in chrome, silver, or white finish. Basic strip 24 wall fluorescent source 1x17W (G13/T8), Basic strip 36 wall fluorescent source 1x25W (G13/T8), Basic strip 48 wall fluorescent source 1x32W (G13/T8).

C. Type D Interior Luminaire Luceri 15 recessed ceiling: metallized reflector surface is made of high quality technopolymers that are specifically designed to maximize the lamps performance. Recessed housing in galvanized steel construction with interior reflector of metallized technopolymer plastic. Luminaries fluorescent source 1x13W (G24q-1/T4). Supplied recessed housing equipped with thermally protected, class P, high power factor 120V electronic fluorescent ballast (277V optional).

D. Type F Interior Luminaire Talo 21 mini wall: direct/indirect energy saving, high efficiency fluorescent lighting. Size: 8 1/4 inches long by 4 inches deep by 1 1/4 inches high. Body in die-cast aluminum in white or silver grey powder coated finish, polished chrome or satin chrome finish. Bathroom wall supporting plate in steel. Fluorescent source 1x18W (G24q-2/T4). Standardly equipped with thermally protected, class P, high power factor 120V electronic fluorescent ballasts (277V optional). Fluorescent model upper and lower diffusers in opaline molded polycarbonate and halogen model upper and lower diffusers with borosilicate shatter guard glass.

2.2 TUNGSTEN HALOGEN LAMP

A. Manufacturers:

1. Delta Light 2008. Model: Circle S1 202 11 10, Type E Interior Luminaire
Delta Light USA, LLC.
4850 W Prospect Rd
Fort Lauderdale, FL 33306
Phone: + 1-954- 667-9800
Web Site: http://deltalight.gusdev.com/#/home/
Technical Data:
http://deltalight.gusdev.com/downloads/pdf_holder/ds_202%2011%201019.pdf

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Circle S1 202 11 10, Type E Interior Luminaire: 3.50 inches Ø by 2.72 inches high. Luminaries designed for use with self-shielded tungsten halogen lamps only. (1 x QR-C51 20W) ORIENTABLE 0°- 35° / 350°. Suited for goods at very low voltage (below 50 V AC). Suitable for direct mounting on flammable surfaces.

2.3 FLUORESCENT LAMP

A. Manufacturers:

1. Lithonia Lighting. Model: UC8 15
Consumer Products Group
One Lithonia Way, Conyers, GA 30012
In Canada: 160 Avenue Labrosse,
Point-Claire, P.Q., H9R 1A1
Phone: 800-748-5070
Fax: 770-860-3903
Web Site: http://www.lithonia.com/
Technical Data:
http://www.acuitybrandslighting.com/Library/CPG/documents/SpecSheets/08GU.pdf
http://www.visual-3d.com/tools/photometricViewer/default.aspx?id=26303

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Lithonia Rugged post painted low profile housing with snap on/off hinged service tray. Shatter-resistant, acrylic white diffuser, soft widespread illumination with zip-lock design, cleaning and superior retention. Standard with electronic ballast (120 volt, 60Hz). Size: 18 inches long by 4 inches deep by 1 3/8 inches high. Fluorescent source (1) 15W linear T8.

C. Accessories: Utilizes linear T8 lamp for energy efficiency, superior color rendering and long life. Use with on dimmable switches only.

2.4 LED LUMINAIRES

A. Manufacturers:

1. Aldabra Oficine-di-luce Contemporanea. Model: Sirius with Spring, Type G Interior Luminaire
Via Europa, 12 20049
Concorrezzo-Milano-Italia
Phone: 39.039.6908061/62/69
Fax: +39.039.6908659/666
Web Site: http://www.aldabra.it/
Technical Data: http://www.aldabra.it/NT-PDF/sirius.pdf

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Sirius with Spring, Type G Interior Luminaire: Recessed spotlight 0.79 inches diameter made of polycarbonate with front part in polished or satin stainless steel or satin polycarbonate, designed so that 0.5 W and 1W LEDS can be built in. Through special springs made of stainless steel or special nut, it can be fixed to surfaces of any thickness, either directly into the hole or by means of a housing box. The product is complete with a protection glass or 60° lens in optical glass and cable 19.7 inches long. Protection degree IP67.

PART 3 EXECUTION

3.1 INSTALLATION

A. Locate recessed ceiling luminaires as indicated on Drawings as indicated on reflected ceiling plan.

B. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install recessed luminaires to permit removal from below.

D. Install recessed luminaires using accessories and fire stopping materials to meet regulatory requirements for fire rating.

E. Install clips to secure recessed grid-supported luminaires in place. Install wall-mounted luminaires at height as indicated on Drawings as scheduled.

F. Install accessories furnished with each luminaire.

G. Connect luminaires to branch circuit outlets provided using flexible conduit as indicated on Drawings.

H. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

I. Install specified lamps in each luminaire.

J. Web Site installation manuals:

1. Basic strip 24-36-48, Type A, B, C Interior Luminaire: http://www.artemide.us/Products/Ron_Rezek/Basic_Strip_Wall/install_Basic_Strip.pdf

2. Circle S1 202 11 10, Type E Interior Luminaire: http://deltalight.gusdev.com/downloads/manual/PART_B.pdf

3.2 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

B. Measure illumination levels to verify conformance with performance requirements.

3.3 ADJUSTING

A. Aim and adjust luminaires as indicated on Drawings.

3.4 CLEANING

A. Remove dirt and debris from enclosures.

B. Clean photometric control surfaces as recommended by manufacturer.

C. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK

A. Relamp luminaires having failed lamps at Substantial Completion.

3.6 SCHEDULES

A. Refer to Drawings and Part 2 Products.

END OF SECTION

SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes exterior luminaries, poles, and accessories.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions and components for each luminaire not standard Product of manufacturer.

C. Product Data: Submit dimensions, ratings, and performance data.

1.3 QUALIFICATIONS

A. Manufacturer: Delta Light established in 1987; the company is recognized throughout the world for its subtle blend of ambiance, functionality and design.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Store and protect products in accordance with manufacturers' instructions.

D. Store with seals and labels intact and legible.

PART 2 PRODUCTS

2.1 TUNGSTEN HALOGEN LAMP

A. Manufacturers:

1. Delta Light 2008. Model: Genie 90 ROP 213 15 21, Type J Exterior Luminaire
Delta Light USA, LLC.
4850 W Prospect Rd
Fort Lauderdale, FL 33306
Phone: + 1-954- 667-9800
Web Site: http://deltalight.gusdev.com/#/home/

Technical Data:
http://deltalight.gusdev.com/downloads/pdf_holder/ds_213%2015%20214.pdf

2. Substitutions: Section 01 60 00 - Product Requirements.

B. Genie 90 ROP 213 15 21, Type J Exterior Luminaire: Not suitable for direct mounting on normally flammable surfaces (suitable only for mounting on non-flammable surfaces). Size: 3.54 inches Ø by 4.94 inches wide. Aluminum housing. Suitable for exterior use, taking the indicated IP rating into consideration. (IP65). Luminaries designed for use with self-shielded tungsten halogen lamps only. (1 x QR+CBC51 20W) ORIENTABLE 0°-35°

2.2 LED LAMPS

A. Manufacturers:

1. Delta Light 2008. Model: Relation 334 X 339 12 134, Type I Exterior Luminaire
Delta Light USA, LLC.
4850 W Prospect Rd
Fort Lauderdale, FL 33306
Phone: + 1-954- 667-9800
Web Site: http://deltalight.gusdev.com/#/home/
Technical Data:
http://deltalight.gusdev.com/downloads/pdf_holder/ds_339%2012%2013413.pdf

2. Delta Light 2008. Model: Look Out 304 13 11, Type V Exterior Luminaire
Technical Data:
http://deltalight.gusdev.com/downloads/pdf_holder/ds_304%2013%201112.pdf

3. Substitutions: Section 01 60 00 - Product Requirements.

B. Relation 334 X 339 12 134, Type I Exterior Luminaire: suitable for direct mounting on flammable surfaces. Size: 13.31inches long by 1.46 inches wide by 1.42 inches deep. Aluminum housing. Suitable for exterior use, taking the indicated IP rating into consideration. (IP54). 1 x LEDSTRIP White.

C. Look Out 304 13 11, Type V Exterior Luminaire: suitable for direct mounting on flammable surfaces. Size: 3.35inches long by 3.35 inches wide by 2.1 inches deep. Aluminum housing. Suitable for indoor and outdoor use, taking the indicated IP rating into consideration. (IP54). 1 x LED POWERLED WHITE 1W/5500k.

2.3 LED LUMINAIRES

A. Manufacturers:

1. Aldabra Oficine-di-luce Contemporanea. Model: STRIP LED IP67, Type H Exterior Luminaire

Via Europa, 12 20049
Concorrezzo-Milano-Italia
Phone: 39.039.6908061/62/69
Fax: +39.039.6908659/666
Web Site: http://www.aldabra.it/
Technical Data: http://www.aldabra.it/NT-PDF/strip-led.pdf

2. Substitutions: Section 01 60 00 - Product Requirements.

B. STRIP LED IP67, Type H Exterior Luminaire: flexible light profile made of transparent PVC. Size: 3.35inches long by 3.35 inches wide by 2.1 inches deep. Aluminum housing material. It is recommended in outdoor or indoor applications, with protection degree IP67. Fixation wall recessed deck planter. Strip LED 3.6W per linear meter.

2.4 PRODUCT OPTIONS

1. Product Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

2.5 PRODUCT SUBSTITUTION PROCEDURES

1. Substitutions: Architect/Engineer and students will consider requests for Substitutions as needed.

2. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.

B. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

3.2 INSTALLATION

A. Install each luminaires as indicated on Drawings.

B. Install lamps in each luminaire in accordance with manufacturers' installation manuals.

C. Web Site installation manuals:

1. Genie 90 ROP 213 15 21, Type J Exterior Luminaire:
http://deltalight.gusdev.com/downloads/manual/213_11_21_HAND.pdf
http://deltalight.gusdev.com/downloads/manual/PART_B.pdf

2. Relation 334 X 339 12 134 Type I Exterior Luminaire:
http://deltalight.gusdev.com/downloads/manual/339_12_134_HAND.pdf
http://deltalight.gusdev.com/downloads/manual/PART_B.pdf

3. Look Out 304 13 11, Type V Exterior Luminaire:
http://deltalight.gusdev.com/downloads/manual/304_13_11_HAND.pdf
http://deltalight.gusdev.com/downloads/manual/PART_B.pdf

3.3 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

B. Measure illumination levels to verify conformance with performance requirements.

3.4 ADJUSTING

A. Aim and adjust luminaries to provide illumination levels and distribution as indicated on Drawings.

3.5 CLEANING

A. Clean photometric control surfaces as recommended by manufacturer.

B. Clean finishes and touch up damage.

3.6 PROTECTION OF FINISHED WORK

A. Relamp luminaries [having failed lamps] at Substantial Completion.

3.7 SCHEDULES

A. Refer to Drawings.

END OF SECTION

SECTION 28 31 00

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes automatic smoke and heat detectors, fire alarm signaling appliances, and auxiliary fire alarm equipment and power and signal wire and cable.

1.2 REFERENCES

A. National Fire Protection Association:
1. NFPA 72 - National Fire Alarm Code.

B. US Department of Housing and Urban Development
1. HUD.

1.3 SYSTEM DESCRIPTION

A. Fire Alarm System: NFPA 72, manual local fire alarm system with connections to central electrical system of the house.

B. Zoning: As indicated on Drawings.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection; indicate annunciator layout, and design calculations.

C. Product Data: Submit catalog data showing electrical characteristics and connection requirements.

D. Test Reports: Indicate procedures and results for specified field testing and inspection.

E. Manufacturer's Field Reports: Indicate activities on site, adverse findings, and recommendations.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of fire alarm equipment.

B. Operation and Maintenance Data: Submit manufacturer's standard operating and maintenance instructions.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with State or Municipality standards.

B. Maintain one copy each document on site.

1.7 QUALIFICATIONS

A. Design fire alarm under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.8 MAINTENANCE SERVICE

A. Furnish service and maintenance of fire alarm equipment for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 COMBINATION SMOKE AND CARBON MONOXIDE ALARM

A. Manufacturers:
1. SmokeSign.Com Model: Combination Smoke & CO # 900-0114E
Sarsam LLC, dba SmokeSign.Com
619 Peach Tree
GPW, MI 48236
fax: 313-884-2719
Phone: 1-888-922-9531
www.smokesign.com

2. Substitutions: Section 01 60 00 - Product Requirements. Not Permitted.

B. Product Description: NFPA 72, ionization type ceiling smoke detector and electrochemical carbon monoxide sensor with the following features:

1. 120V Hardwire Combination Smoke & CO Alarm w/battery back-up.
2. Flashing Red LED gives a visual indication that the alarm is sounding
3. AC Power Light & Alarm Memory (Green LED): Steady on indicates 120V AC power is being delivered to the alarm.

4. Alkaline Battery Backup: Continues protection in case of AC power failure.
5. Test/Reset Button: Tests alarm operation.
6. Smart Hush: Nuisance alarms are silenced by pressing the hush button. Advanced hush feature can only be activated when smoke is present and will automatically deactivate when smoke clears the unit.
7. Peak Level Memory: If the unit has detected CO of 100ppm or greater, it will announce "CO Previously Detected" when the test/reset button is pushed.
8. Smart Interconnect: Singly or multiple station capability-up to 24 units interconnects with both smoke and carbon monoxide alarms. When smoke alarm sounds, only interconnected smoke alarms sound. When CO alarm sounds, only interconnected CO alarms sound.
9. Adjustable Mounting Bracket: Fits all standard electrical boxes and allows for perfect alignment.
10. Smoke sensor: ionization
11. Carbon monoxide sensor: electrochemical

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.

B. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

C. Verify products and systems receiving devices are ready for installation.

3.2 INSTALLATION

A. Coordinate and install in accordance with NFPA 72 and local fire department requirements.

3.3 FIELD QUALITY CONTROL

A. Test in accordance with NFPA 72 and local fire department requirements.

END OF SECTION

SECTION 32 84 00

PLANTING IRRIGATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Hose, emitters, and accessories.

1.2 SYSTEM DESCRIPTION

A. Manual controlled irrigation system.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate plant and landscaping features, site structures, schedule of outlets and fittings to be used.

C. Product Data:
1. Product description

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of concealed components.

C. Operation and Maintenance Data:
1. Temperature Range F&C: -40f to + 190F (-40C + 88C). Do not uses for oil, grease or fuel transfer.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

A. Convene one or less than a day prior to commencing Work of this section

1.7 FIELD MEASUREMENTS

A. Field measurements are as indicated on shop drawings.

1.8 COORDINATION

A. Coordinate the Work with site backfilling, landscape grading and delivery of plant life.

PART 2 PRODUCTS

2.1 PIPE MATERIALS

A. Manufacturers:
1. Goodyear; Model: Sureline Washdown Hose
2. Goodyear; Model: Commercial Premium Rubber House.

3. Substitutions: Section 01 60 00 - Product Requirements Permitted

B. Sleeve Material: EPDM - RMA Class C Oil Resistance or rubber.

2.2 NOZZLE

A. Manufacturers:
1. L. R. Nelson Corporation; Model 50502.
2. Gilmour Lawn Care: Model 594.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of existing conditions before starting work.

3.2 PREPARATION

A. Layout and stake locations of system components.

B. Coordinate locations of sleeves to accommodate system.

3.3 INSTALLATION

A. Connect to utilities.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. System is acceptable when no leakage or loss of pressure occurs.

3.5 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust head types for full water coverage as directed by Architect/Engineer/Students.

END OF SECTION

SECTION 32 93 00

PLANTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Preparation of topsoil.
2. Topsoil bedding.
3. Plants and ground cover.
4. Mulch.
5. Fertilizer.
6. Pruning.
7. Maintenance.

B. Allowances: Include under provisions of Section 01 20 00 - Price and Payment Procedures. Allowance includes furnishing of trees, plants and ground cover. Installation is included in this section and is part of Contract Sum/Price. Furnishing and installing of trees, plants and ground cover.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Plants:
1. Basis of Measurement: By each.
2. Basis of Payment: Includes preparation of topsoil, placing topsoil, planting, watering and maintenance to specified time period.

1.3 REFERENCES

A. American National Standards Institute:
1. ANSI Z60.1 - Nursery Stock.

1.4 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit list of plant material sources, data for fertilizer and other accessories.

C. Submit garden area plans, sample of topsoil proposed. Forward sample to testing laboratory in sealed containers to prevent contamination.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Operation and Maintenance Data: Include pruning objectives, types and methods: types, application frequency, and recommended coverage of fertilizer.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with the district of Washington D.C. standard.

1.8 QUALIFICATIONS

A. Maintenance Services: Performed by installer.

1.9 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

C. Protect and maintain plant life until planted.

D. Deliver plant life materials immediately prior to placement. Keep plants moist.

E. Plant material damaged as a result of delivery, storage or handling will be rejected.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Do not install plant life when ambient temperatures may drop below 35 degrees F or rise above 90 degrees F.

C. Do not install plant life when wind velocity exceeds 30 mph.

1.12 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Maintain plant life immediately after placement.

C. Maintenance includes:
1. Applying herbicides for weed control. Remedy damage resulting from use of herbicides.
2. Remedy damage from use of insecticides.
3. Irrigating sufficient to saturate root system.
4. Pruning, including removal of dead or broken branches.
5. Disease control.
6. Repair or replace accessories when required.
7. Replacement of mulch.

PART 2 PRODUCTS

2.1 TREES, PLANTS, AND GROUND COVER

A. Planting Stock:
1. Species: In accordance with Standardized Plant Names, official code of American Joint Committee on Horticulture Nomenclature.
2. Identification: Label individual plants or each bundle of plants when tied in bundles.
3. Plants: No. 1 Grade conforming to "American Standard for Nursery Stock" of American Association of Nurserymen (AAN); well-branched, vigorous and balanced root and top growth; free from disease, injurious insects, mechanical wounds, broken branches, decay and other defects.
4. Deciduous plants: Furnish in dormant state, except those specified as container grown.

B. Plants: Species and size identifiable in plant schedule, grown in climatic conditions similar to those in locality of the Work.

2.2 SOIL MATERIALS

A. Topsoil: Imported.

2.3 SOIL AMENDMENT MATERIALS

A. When soil tests indicate soil amendment, apply soil conditioners or fertilizers to amend soil to specified conditions.

B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; pH range of 6 to 7; and moisture content.

C. Bone Meal: Commercial grade, minimum of 3 percent nitrogen and 20 percent phosphorous.

D. Water: Clean, fresh, and free of substances or matter capable of inhibiting vigorous growth of plants.

2.4 MULCH MATERIALS

A. Mulching Material: Composted, shredded hardwood bark, dark brown in color.

2.5 ACCESSORIES

A. Plant Protectors: Rubber sleeves over cable to protect plant stems.

2.6 PLANT SOIL MIX

A. Plant Soil Mix: Uniform mixture of 1 part of peat moss, 1 part of topsoil and 1 part of sand by volume.

2.7 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.

B. Test and analyze imported topsoil.

C. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt and organic matter; pH value.

D. Provide recommendation for fertilizer and soil amendment application rates for specified planting as result of testing.

E. Testing is not required when recent tests are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify prepared planters are ready to receive work.

B. Saturate soil with water to test drainage.

3.2 PLACING TOPSOIL

A. Spread topsoil to minimum depth of 16 inches (see if planters have plenty space for the needed topsoil depth) over area to be planted. Rake smooth.

B. Place topsoil during dry weather and on dry unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.

D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

3.3 FERTILIZING

A. Apply starter fertilizer.

B. Apply after initial raking of topsoil.

C. Mix thoroughly into upper 2 inches of topsoil.

D. Lightly water soil to aid dissipation of fertilizer.

3.4 PLANTING

A. Place plants for best appearance for review and final orientation by Architect.

B. Set plants vertical.

C. Remove non-biodegradable root containers.

D. Set plants in pits or beds, partly filled with prepared plant mix, at minimum depth of 6 inches under each plant. Remove burlap, ropes, and wires, from top half of root ball.

E. Saturate soil with water when pit or bed is half full of topsoil and again when full.

3.5 PLANT RELOCATION AND RE-PLANTING

A. Relocate plants as indicated by Architect.

B. Ball or pot removed plants when temporary relocation is required.

C. Replant plants in pits or beds, partly filled with prepared topsoil mixture, at minimum depth of 6 inches under each plant. Remove burlap, ropes, and wires, from top half of root ball.

D. Saturate soil with water when pit or bed is half full of topsoil and again when full.

3.6 PLANT SUPPORT

A. Brace plants vertically with plant protector wrapped guy wires and stakes to the following:

Tree Caliper	Tree Support Method
1 inch (25 mm)	1 stake with one tie
1 - 2 inches (25 - 50 mm)	2 stakes with two ties
2 - 4 inches (50 - 100 mm)	3 guy wires [with eye bolts and turn buckles]
Over 4 inches (100 mm)	4 guy wires [with eye bolts and turn buckles]

3.7 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Plants will be rejected when ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

3.8 SCHEDULE

A. Plant Schedule:

Key	Botanical Name	Common Name	Size	Remarks
H-1	Ocimum basilicum	Sweet Basil	Height: 2 – 2.5 feet	
H-2	Rosmarinus officinalis	Rosemary	Height: 5 – 7feet	
H-3	Petroselinum crispum	Parsley	Height: 12-18 inches	
H-4	Origanum vulgare	Oregano	Height: 1-3 feet	
S-1	Solanum lycopersicum var. cerasiforme	Cherry Tomato	Height: 1-3 feet	

END OF SECTION

SECTION 48 11 00

FOSSIL FUEL PLANT ELECTRICAL POWER

GENERATION EQUIPMENT

PART 1 GENERAL

1.1 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit dimensions, ratings, and performance data.

1.2 QUALIFICATIONS

A. Manufacturer: PRAMAC group develops and manufactures a wide range of power generation equipment, materials handling equipment and photovoltaic components. PRAMAC uses its global network to supply these products to markets throughout the World.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.

C. Store and protect products in accordance with manufacturers' instructions.

D. Store with seals and labels intact and legible.

PART 2 PRODUCT

2.1 PORTABLE GENERATOR

A. Manufacturers: Pramac, Model : PRAMAC S 7500 Item code: PD722MHB002 5-digit code: 05018

1. PRAMAC de Puerto Rico Inc.
Carretera Estatal #2 Km, 15.8 Barrio Hato Tejas,
00961 Bayamón
Phone: +1 787 787 8700
Fax : +1 787 740 5362
Web Site: http://pramac.com/United-States/ie/default.asp
Technical Data: http://www.pramac.com/United-States/ie/portable-generator-s-7500-PD722MHB002-USA.asp

B. Manufacturers: Pramac, Model : PRAMAC ES 8000 Item code: PE712MHI000 5-digit code: 04303

PRAMAC de Puerto Rico Inc.
Carretera Estatal #2 Km, 15.8 Barrio Hato Tejas,
00961 Bayamón
Phone: +1 787 787 8700
Fax : +1 787 740 5362
Web Site: http://pramac.com/United-States/ie/default.asp
Technical Data: http://www.pramac.com/United-States/ie/portable-power-generators-es-series.asp

1. Substitutions: Section 01 60 00 - Product Requirements.

2.2 PRODUCT OPTIONS

1. Product Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

2.3 PRODUCT SUBSTITUTION PROCEDURES

1. Substitutions: Architect/Engineer will consider requests for Substitutions as needed.

2. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.

3.2 INSTALLATION

A. Install portable generator in accordance with manufacturers' installation manuals.

END OF SECTION

2009 SOLAR DECATHLON COMPETITION

UNIVERSITY OF PUERTO RICO
SCHOOL OF ARCHITECTURE

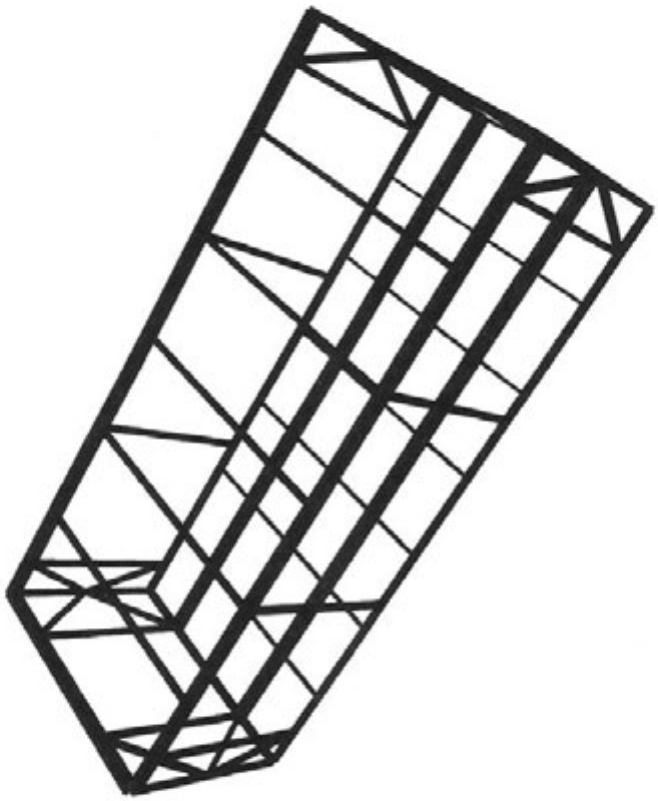
UPR SOLAR HOUSE 2009

STRUCTURAL CALCULATIONS

BY

LUIS G. DAZA Ph.D., MECE, PE

November, 2008



DAZA STRUCTURAL ENGINEERING SRVICES P.SC.
Luis G. Daza-Duarte

UPR-2009-SOLAR HOUSE

Mon Dec 01 13:19:12 2008

STRUCTURAL CALCULATIONS

UNDER SERVICE CONDITIONS

DAZA STRUCTURAL ENGINEERING SERVICES P.S.C.
Consulting Structural Engineer
Condado 605, Suite 619, San Juan, PR 00907-3811 • Phone: (787) 723-0433

TITLE UPR - SOLAR HOUSE
DATE _____ PROJECT # _____ SHEET _____ OF _____
BY LOBD. PAGE NO. _____

LOAD CRITERIA

Dead Load:

FLOOR SYSTEM:
- structural steel system — 4 psf
- Very clad panel system — 5 psf
- finish (wood) — 2 psf
- Mechanical + Electrical — 5 psf

16 psf

ROOF SYSTEM
- structural system — 3 psf
- Veri-clad panels — 5 psf
- plafón — 5 psf
- Mechanical + Electrical — 8 psf

21 psf

LIVE LOAD:

FLOOR SYSTEM: 40 psf (Residential use)

ROOF SYSTEM: 30 psf (including foto voltaic - panels) + construction load.

WIND LOAD

ASCE 7-2005
V = 90 mph (Washington DC)
Exposure = C
Importance f. I = 1.0

OTHER LOADS:

WOOD DECKING:
- DEAD LOAD = { 2 psf substructure / 4 psf decking.
- LIVE LOAD = 100 psf.

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DATE PROJECT # SHEET OF
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TOTAL DEAD LOAD

- Roof = 24 psf (14.5')(35') = 10,658 Lbs
- floor = 16 psf (14.5)(35) = 8,120 Lbs
- Envelope = 3 psf (99' x 9') = 2,673 Lbs

"Empty house" → 21,451 Lbs

TOTAL LIVE LOAD

- Roof = 30 psf x 14.5 x 35' = 15,225 Lbs
- floor = 40 psf x 14.5 x 35 = 20,300 Lbs

Total live load 35,525 Lbs.

MAXIMUM D+L = 59,676 Lbs

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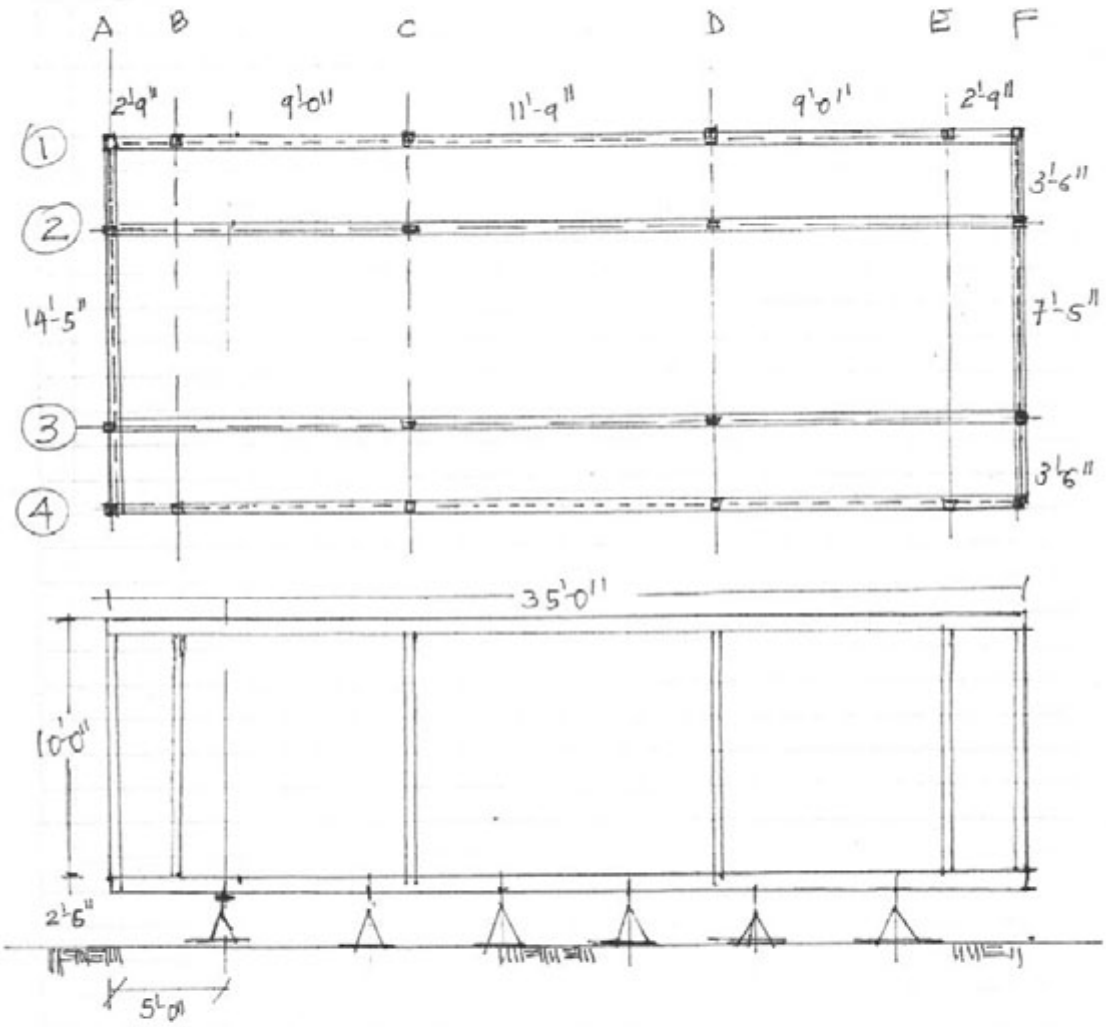

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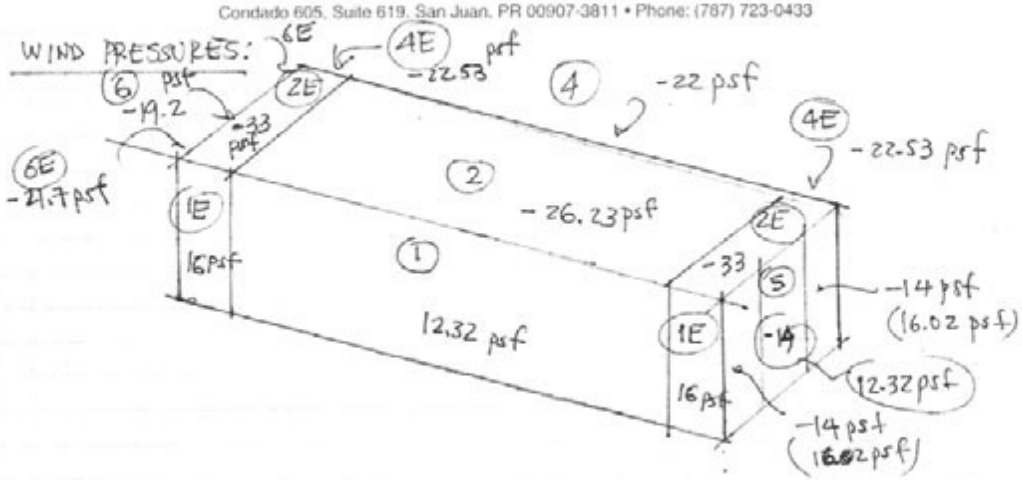
BY LGDD PAGE NO. _____

WIND PRESSURES:



Loads acting on structural system may be estimated as lateral loads action along columns:

FRONT

COL AXIS (A) & (F) $w = \left(\frac{2.75'}{2}\right)(16\,psf) = 22\ plf.$

COL AXIS (B) & (E) $A_T = \left(\frac{2.75}{2} + 4.5'\right) \therefore\ 1.38'(16\,psf) + 4.5'(12.32\,psf)$

TRIBUTARY WIDTH

$w = 77.52\ plf$

COL AXIS (C) & (D): $A_T = 4.5' + 11'\text{-}9''/2 = 10.38'$

$w = 10.38' \times 12.32\,psf = 127.8\ plf$

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TITLE UPR SOLAR HOUSE
DATE ____ PROJECT # ____ SHEET ____ OF ____
BY LOAD ____ PAGE NO. ____

REAR

COL AXIS (A) & (F) $w = 1.38'(-22.53\ psf) = -31.1\ plf$

COL AXIS (B) & (E) $w = 1.38'(-22.53) + 4.5'(-22) = -130\ plf$

COL AXIS (C) & (D) $w = 10.38'(-22\ psf) = -228.36\ plf.$

EAST

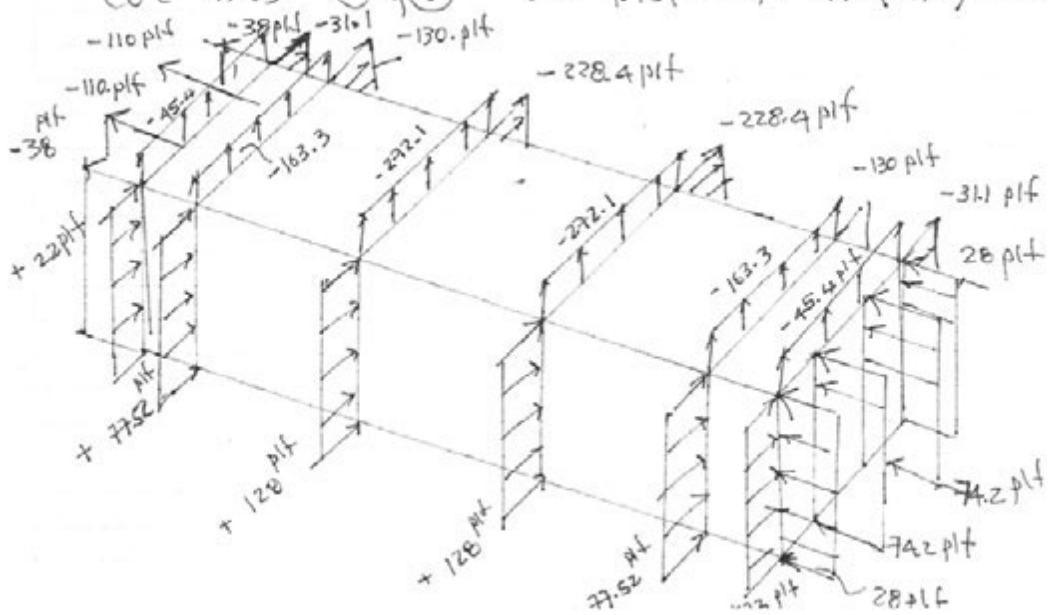
COL AXIS (1) & (4) $w = 1.75' \times 16\ psf = 28\ plf$

COL AXIS (2) & (3) $w = 1.75 \times 16^{psf} + 3.75'(12.32) = 74.2^{plf}$

WEST

COL AXIS (1) & (4) $w = 1.75'(-21.7) = -37.98\ plf$

COL AXIS (2) & (3) $w = 1.75'(-21.7) + 3.75'(-19.2) = -110\ plf$



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DATE _____ PROJECT # _____ SHEET _____ OF _____
BY LGDD. PAGE NO. _____

ROOF BEAMS:

AXIS (A) & (F) $\omega = \frac{2.75'}{2}(-33\,psf) = -45.4$ plf

AXIS (B) & (E) $\omega = \frac{2.75'}{2}(-33) + 4.5' \times (-26.2) = -163.3$ plf

AXIS (C) & (D) $\omega = 10.38'(-26.23) = -272.1$ plf

FORCES ON STRUCTURES

LOW-RISE BUILDINGS

MAIN WIND-FORCE RESISTING SYSTEM

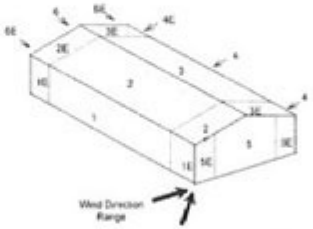
DESCRIPTION: UPR -2009 SOLAR DECATHLON

BASIC DATA	
Basic Wind Velocity [mph]	90.00
Exposure type C	
Coefficient Kzt	1.00
Importance Factor	1.00
Roof Angle [deg]	0.00
Plan width [Ft]	14.50
plan length [Ft]	35.00
Total Exposed Height [Ft]	12.50
Increments [Ft]	2.50
qz/Kz =	20.74
Coefficient =	9.50
Coefficient Zg	900.00
dimensions	3.00

ZONE	CASE A GCpf	CASE B GCpf	Gcpi (+)	Gcpi (-)	CASE A (GCpf-Gcpi)	(GCpf-Gcpi)	CASE B (GCpf-Gcpi)	(GCpf-Gcpi)	maximum values pressure	suction
1	0.40	-0.45	0.80	-0.30	-0.40	0.70	-1.25	-0.15	0.70	-1.25
1E	0.6	-0.48	0.80	-0.30	-0.19	0.91	-1.28	-0.18	0.91	-1.28
2	-0.69	-0.69	0.80	-0.30	-1.49	-0.39	-1.49	-0.39	-0.39	-1.49
2E	-1.07	-1.07	0.80	-0.30	-1.87	-0.77	-1.87	-0.77	-0.77	-1.87
3	-0.37	-0.37	0.80	-0.30	-1.17	-0.07	-1.17	-0.07	-0.07	-1.17
3E	-0.53	-0.53	0.80	-0.30	-1.33	-0.23	-1.33	-0.23	-0.23	-1.33
4	-0.29	-0.45	0.80	-0.30	-1.09	0.01	-1.25	-0.15	0.01	-1.25
4E	-0.43	-0.48	0.80	-0.30	-1.23	-0.11	-1.28	-0.18	-0.13	-1.28
5		0.40	0.80	-0.30	-0.80	0.30	-0.40	0.70	0.70	-0.80
5E		0.61	0.80	-0.30	-0.80	0.30	-0.19	0.91	0.91	-0.80
6		-0.29	0.80	-0.30	-0.80	0.30	-1.09	0.01	0.30	-1.09
6E		-0.43	0.80	-0.30	-0.80	0.30	-1.23	-0.13	0.30	-1.23

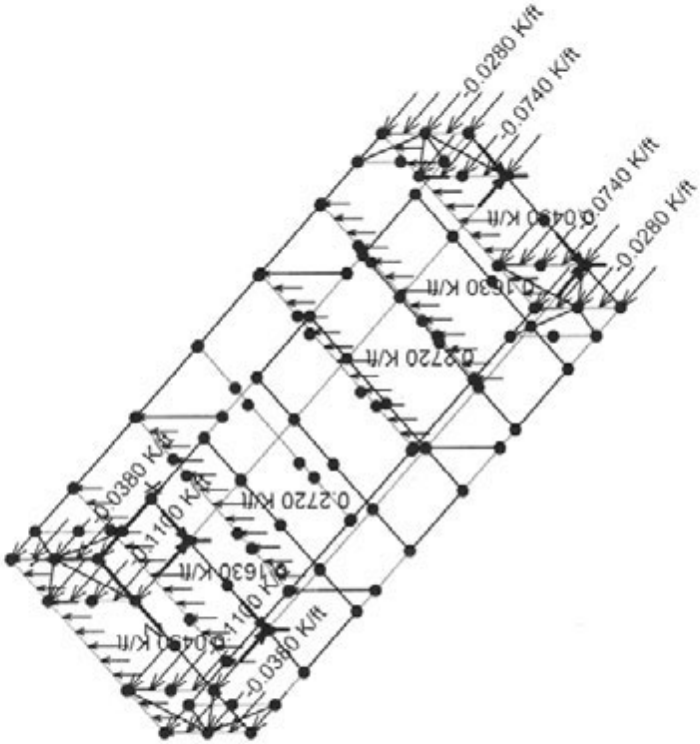
MAIN WIND-FORCE RESISTING SYSTEM

Height [Ft]	Kz	qz		1 pressure	1 suction	1E pressure	1E suction	2 pressure	2 suction	2E pressure	2E suction	3 pressure	3 suction	3E pressure	3E suction
				0.70	-1.25	0.91	-1.28	-0.39	-1.49	-0.77	-1.87	-0.07	-1.17	-0.23	-1.33
12.5	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
10	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
7.5	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
5	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
2.5	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41
0	0.85	17.60	12.32	-22.00	16.02	-22.50	-6.86	-26.23	-13.55	-32.92	-1.23	-20.59	-4.05	-23.41



4		4E		5		5E		6		6E	
pressure	suction	pressure	suction	pressure	suction	pressure	suction	pressure	suction	pressure	suction
0.01	-1.26	-0.13	-1.26	0.70	-0.80	0.91	-0.80	0.30	-1.09	0.30	-1.23
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65
0.16	-22.00	-2.29	-22.53	12.32	-14.08	16.02	-14.08	5.28	-19.19	5.28	-21.65

Visual Analysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 17:32:05 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-[
Wind +X loads



Visual Analysis (version 5.50) -
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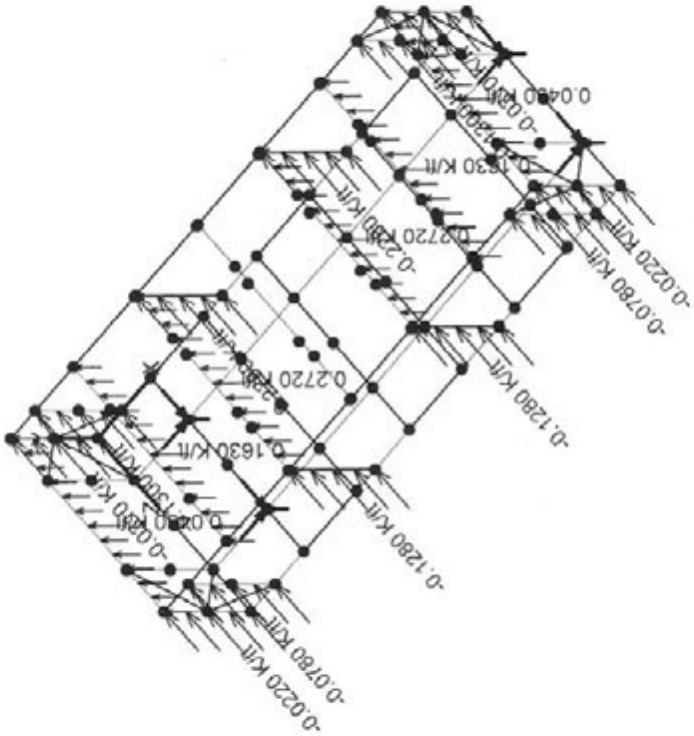
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Dua
Wind +Z loads



VisualAnalysis (version 5.50) -
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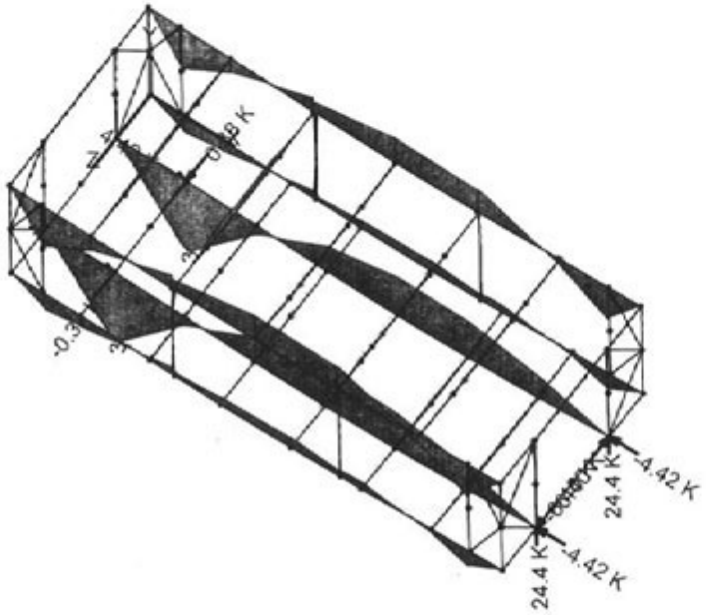
D+L service

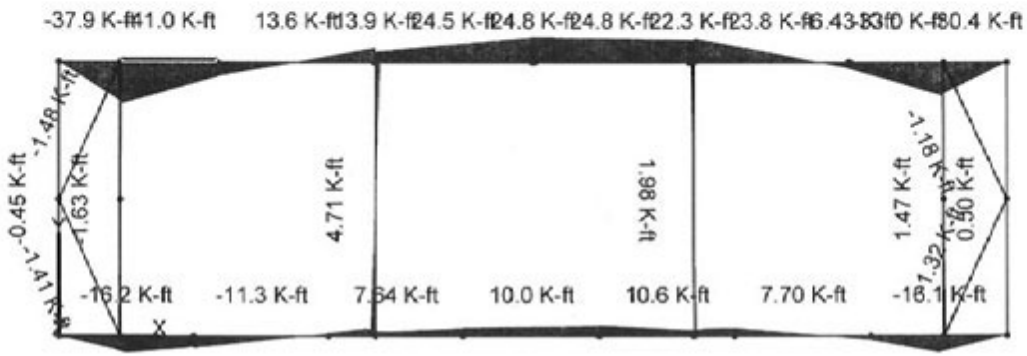


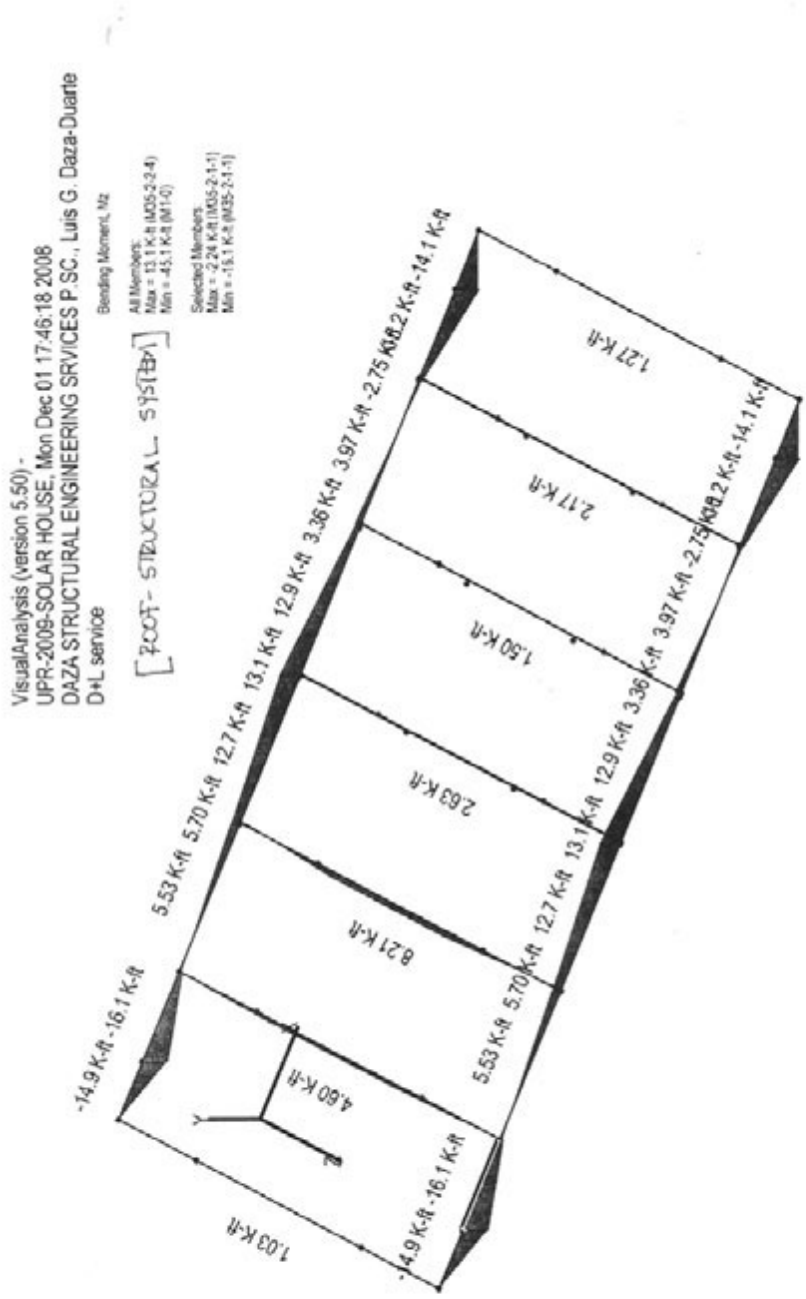
Bending Moment: Mz

All Members:
Max = 39.1 K-ft (M1-0)
Min = -71.5 K-ft (M1)

Selected Members:
Max = -14.3 K-ft (M34-2-1-1)
Min = -41.0 K-ft (M34-2-1-1)

VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 17:38:09 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-I
D+L service




VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 17:46:18 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L service
Bending Moment, Mz
ROOF - STRUCTURAL SYSTEM
All Members:
Max = 13.1 K-ft (M35-2-2-4)
Min = -45.1 K-ft (M1-0)
Selected Members
Max = -2.24 K-ft (M35-2-1-1)
Min = -15.1 K-ft (M35-2-1-1)
-14.9 K-ft -16.1 K-ft
5.53 K-ft 5.70 K-ft 12.7 K-ft 13.1 K-ft 12.9 K-ft 3.36 K-ft 3.97 K-ft -2.75 K-ft -8.2 K-ft -14.1 K-ft
1.03 K-ft
4.60 K-ft
8.21 K-ft
2.63 K-ft
1.50 K-ft
2.17 K-ft
1.27 K-ft
Y
Z

Bending Moment, Mz

All Members:
Max = 13.1 K-ft (M35-2-2-4)
Min = -45.1 K-ft (M1-0)

Selected Members:
Max = 11.8 K-ft (M1-0)
Min = -45.1 K-ft (M1-0)

VisualAnalysis (version 5.50) -
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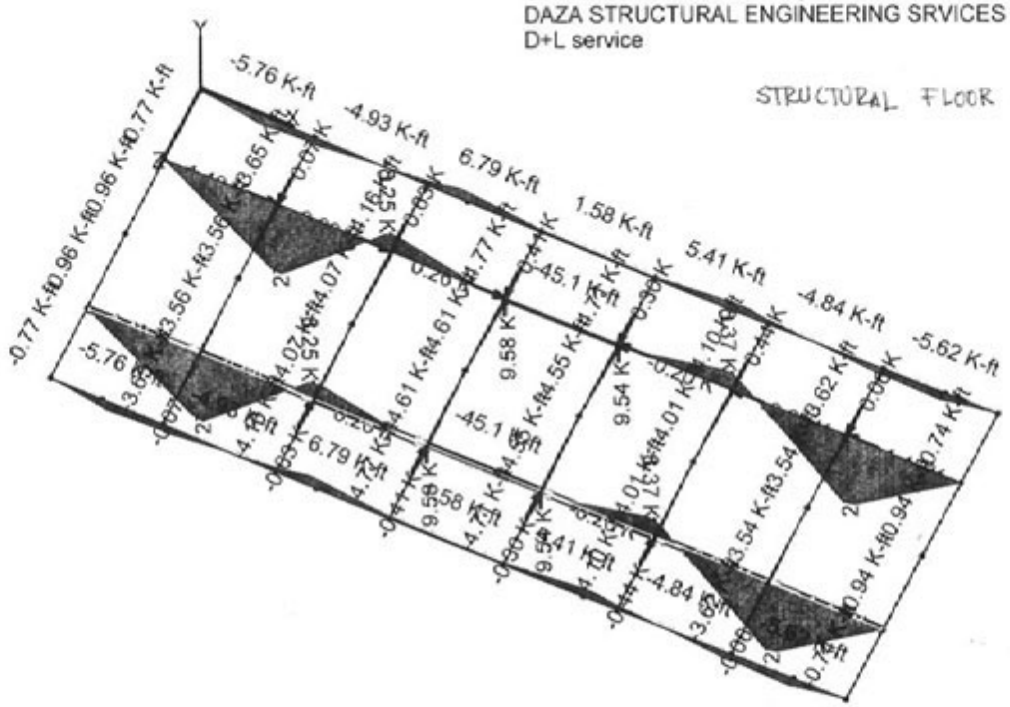
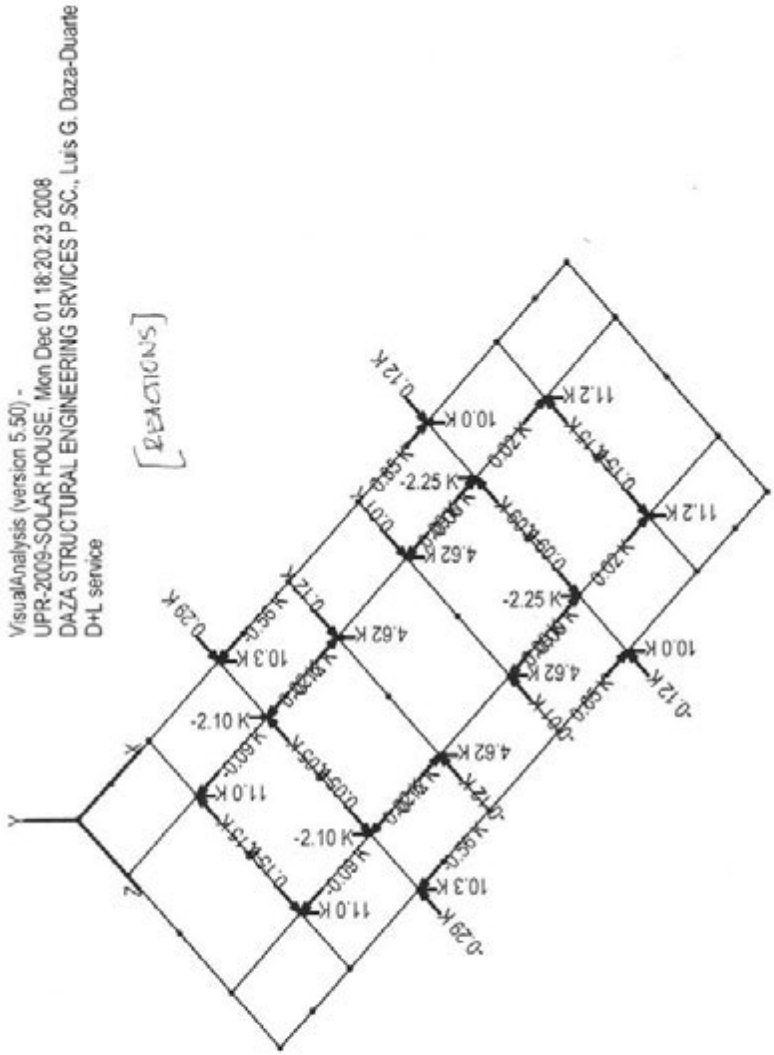
D+L service

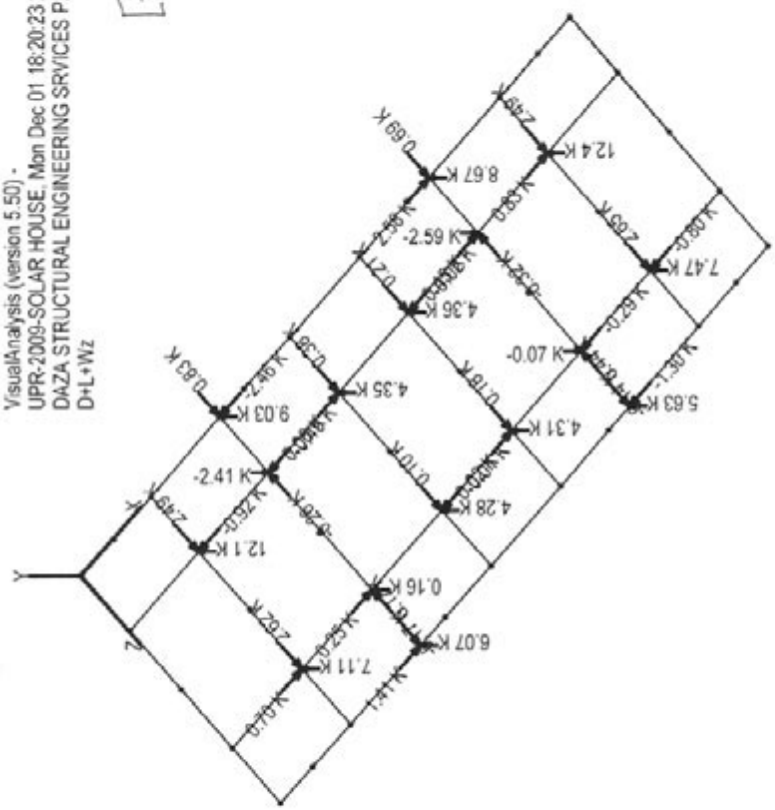
STRUCTURAL FLOOR SYSTEM




VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:20:23 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L service
[REACTIONS]
Y
Z
X
0.29 K
10.3 K
0.56 K
11.0 K
0.15 K
-2.10 K
0.05 K
0.60 K
4.62 K
0.12 K
0.07 K
-2.25 K
0.09 K
0.20 K
11.2 K
0.15 K
10.0 K
0.12 K
0.29 K
10.3 K
0.56 K
11.0 K
0.15 K
-2.10 K
0.05 K
0.60 K
4.62 K
0.12 K
0.07 K
-2.25 K
0.09 K
0.20 K
11.2 K
0.15 K
10.0 K
0.12 K

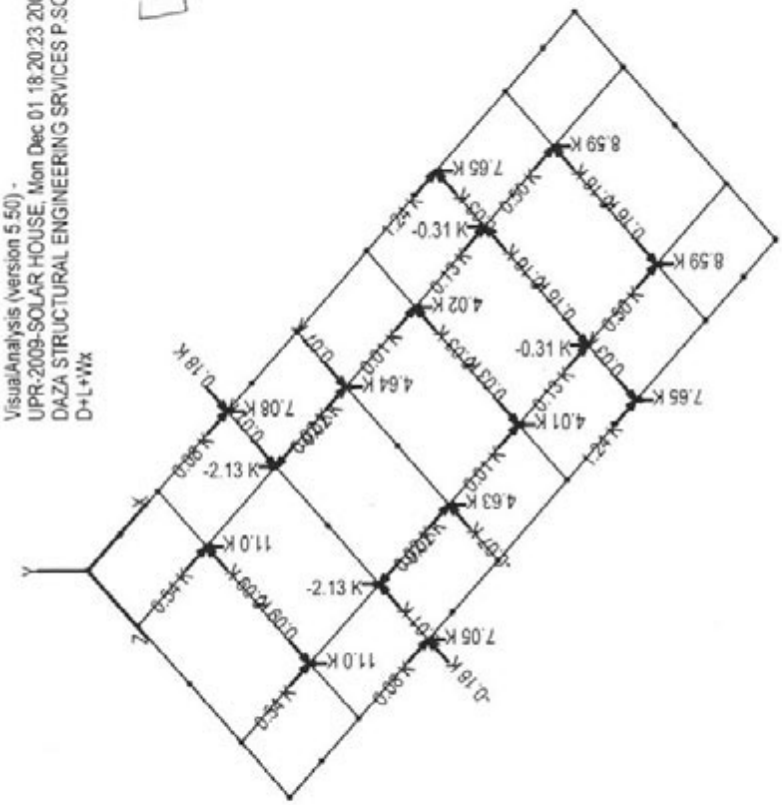
VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:20:23 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L+Wz

[REACTIONS]

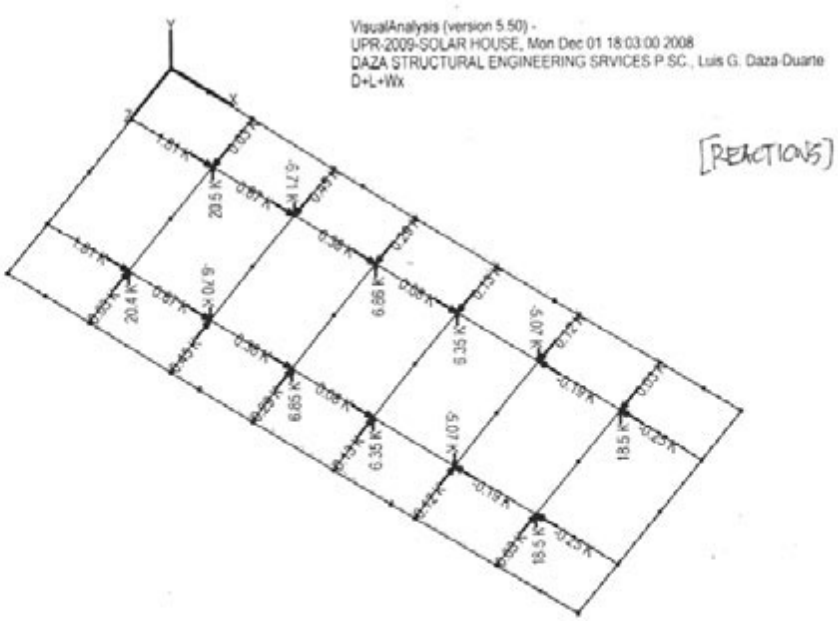


Visual Analysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:20:23 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L+Wx

[REACTIONS]


Y
X
Z
0.18 K
7.08 K
0.01 K
0.00 K
0.00 K
0.54 K
11.0 K
0.09 K
0.54 K
11.0 K
-2.13 K
0.02 K
4.64 K
0.01 K
0.01 K
0.07 K
0.00 K
0.00 K
0.00

VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:03:00 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L service
REACTIONS
Y
X
Z
24.5 K
24.5 K
24.5 K
24.5 K
24.5 K
24.5 K
7.79 K
7.79 K
7.75 K
7.75 K
-0.20 K
-0.20 K
-0.62 K
-0.62 K
-1.40 K
-1.40 K
-1.30 K
-1.30 K
0.61 K
0.61 K
0.25 K
0.25 K
0.20 K
0.62 K
0.62


VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:03:00 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L+Wx
[REACTIONS]
Y
X
Z
1.61 K
0.67 K
20.4 K
0.67 K
1.61 K
0.67 K
29.5 K
0.67 K
0.30 K
6.85 K
0.05 K
6.35 K
0.05 K
6.35 K
0.05 K
6.85 K
0.30 K
0.19 K
18.5 K
0.25 K
0.19 K
18.5 K
0.25 K

VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:03:00 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L+Wz

[REACTIONS]

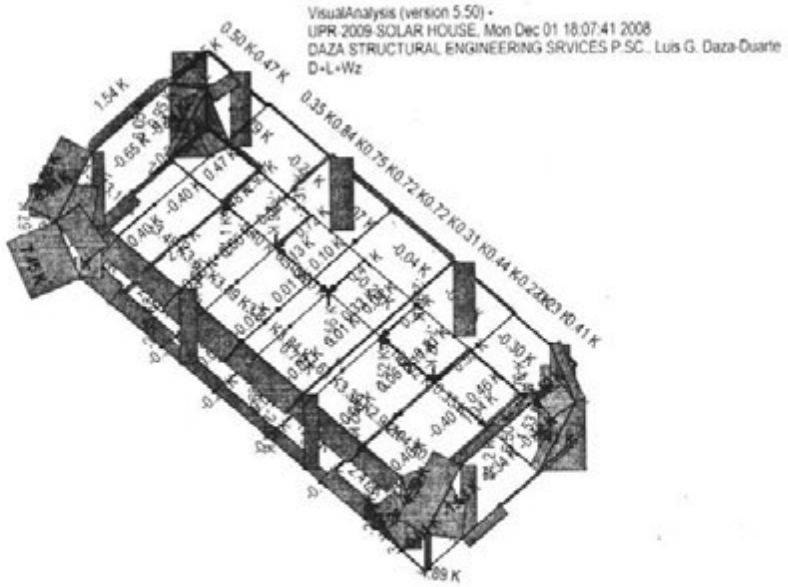
VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:03:00 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
Wind +Z loads
[REACTIONS]
Y
X
Z
0.31 K
2.87 K
-1.16 K
2.10 K
9.64 K
2.87 K
0.04 K
1.28 K
-0.91 K
0.22 K
-0.01 K
4.21 K
-0.18 K
0.28 K
0.28 K
4.15 K
-0.05 K
-2.11 K
0.14 K
-2.11 K
-0.24 K
-0.08 K
0.87 K
0.07 K
1.28 K
1.75 K
0.37 K
2.87 K
-0.03 K
0.53 K
4.14 K
-0.38 K
9.69 K
2.87 K
-0.87 K

VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:03:00 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
Wind +X loads

[REACTIONS]

Axial Force, Fx

All Members:
Max = 7.45 K (M67)
Min = -6.80 K (M68)



VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:07:41 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L+Wx

Axial Force, Fx

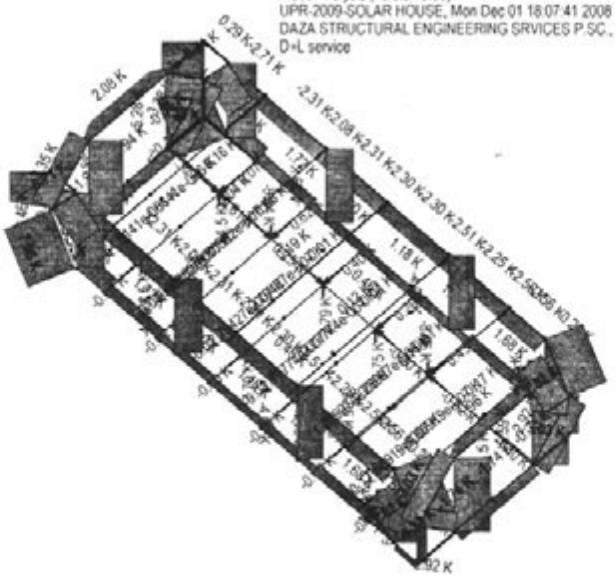
All Members:
Max = 6.85 K (M61)
Min = -5.26 K (M62)

VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 18:07:41 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L service

Axial Force, Fx

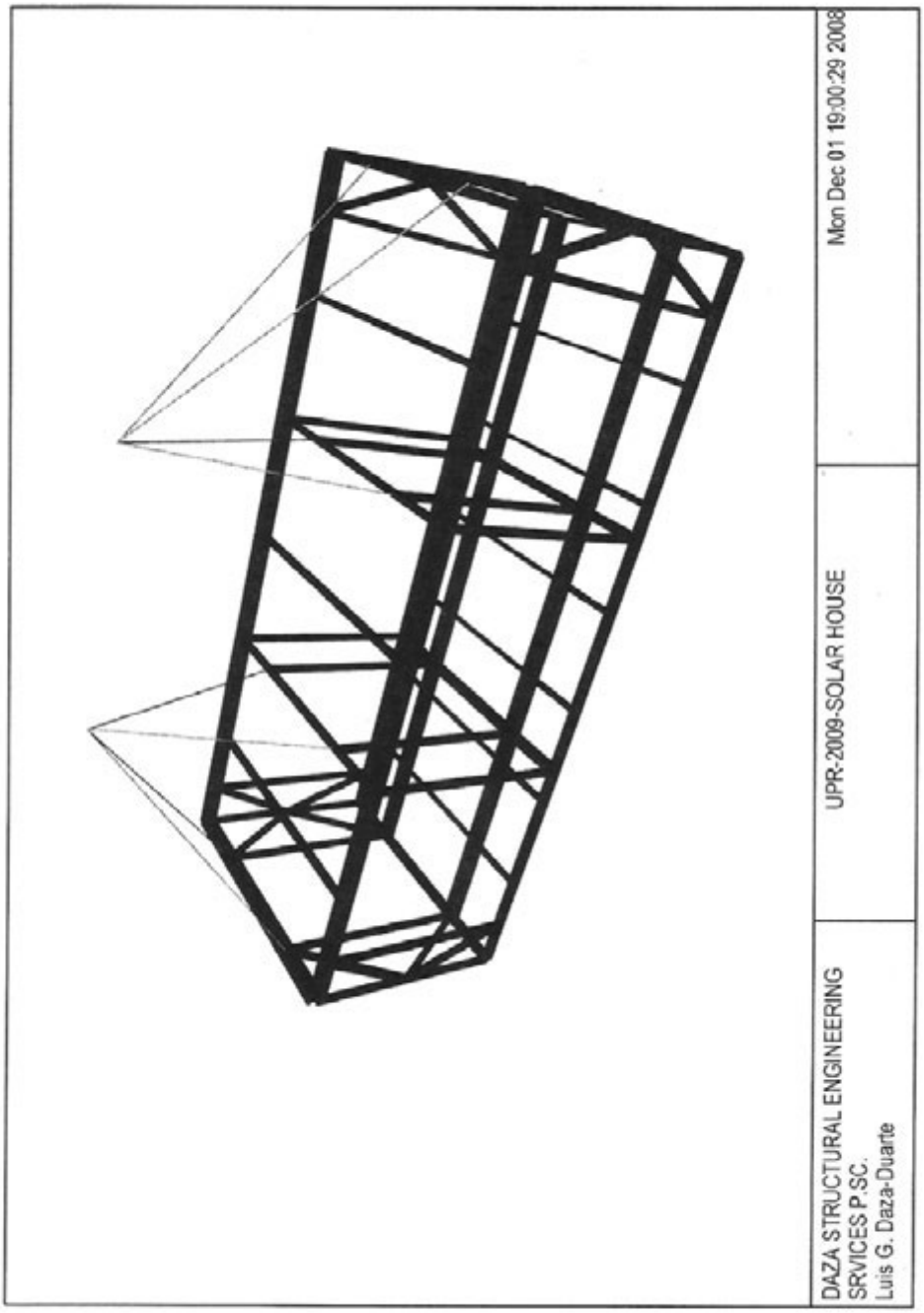
All Members:
Max = 7.96 K (M61)
Min = -6.71 K (M62)

Selected Members:
Max = 7.96 K (M67)
Min = 7.93 K (M67)



STRUCTURAL CALCULATIONS

(TRANSPORTATION)


DAZA STRUCTURAL ENGINEERING
SRVICES P.SC.
Luis G. Daza-Duarte
UPR-2009-SOLAR HOUSE
Mon Dec 01 19:00:29 2008

VisualAnalysis (version 5.50) -
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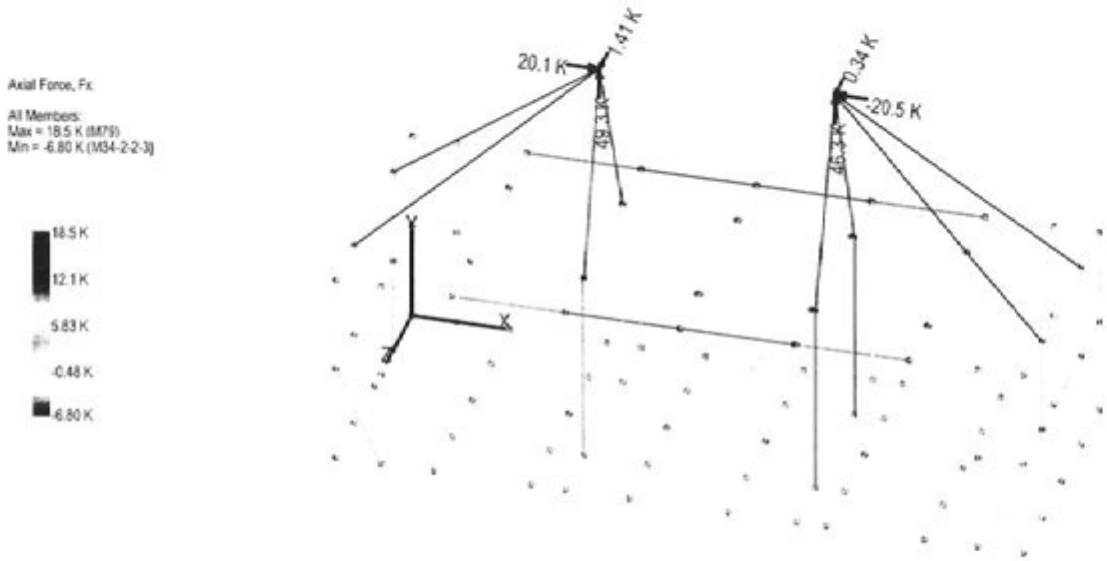
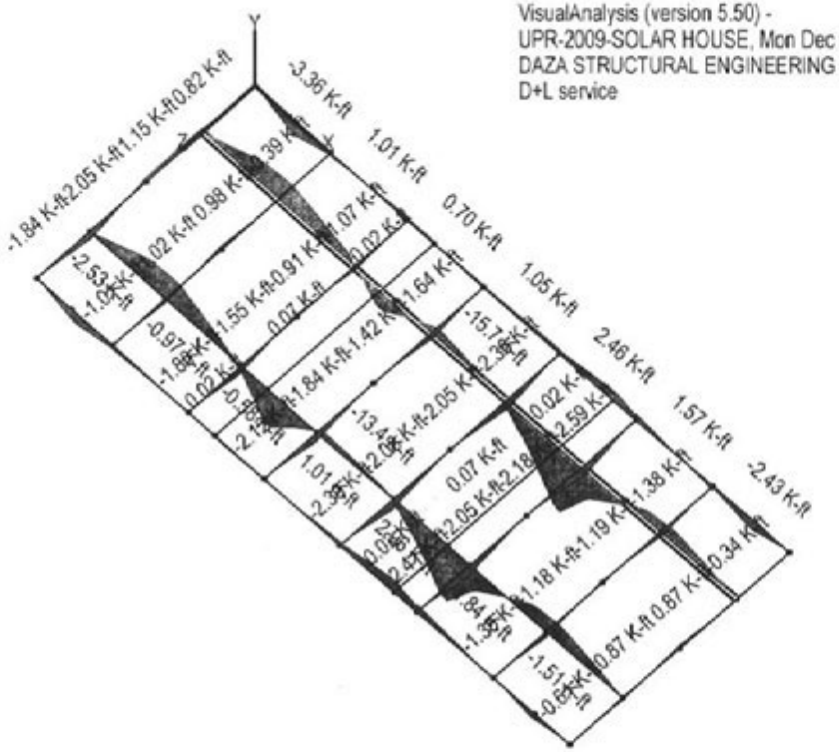
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L service



VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 19:02:06 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-D
D+L service



Bending Moment, Mz

All Members:
Max = 7.54 K-ft (M1-0)
Min = -16.7 K-ft (M1)

Selected Members:
Max = 6.44 K-ft (M1)
Min = -15.7 K-ft (M1)

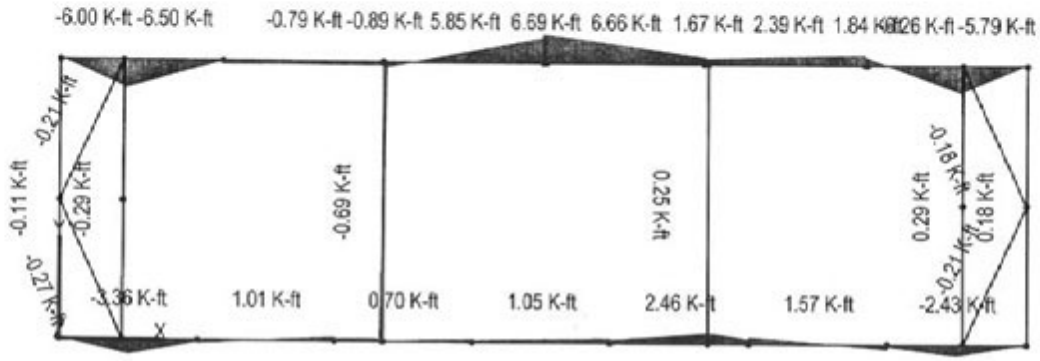
VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 19:02:06 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-D
D+L service

Bending Moment, Mz

All Members:
Max = 7.54 K-ft (M1-6)
Min = -16.7 K-ft (M1)

Selected Members:
Max = 6.66 K-ft (MD4-2-2-5)
Min = 1.64 K-ft (MD4-2-2-5)

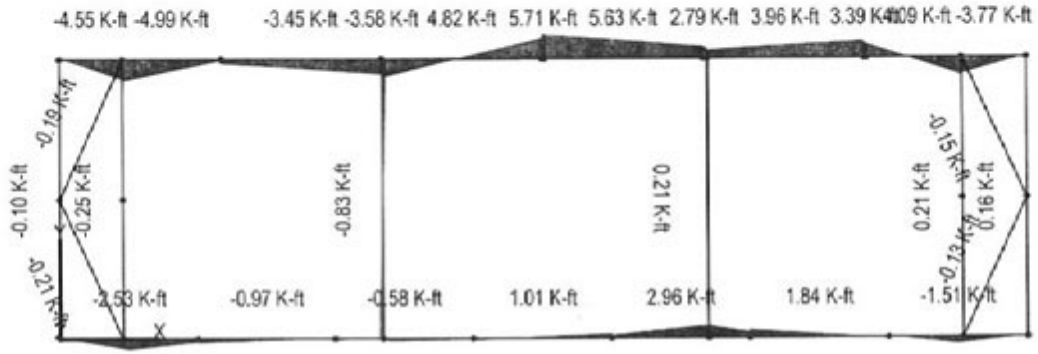
VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 19:02:06 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L service



Bending Moment, Mz

All Members:
Max = 7.54 K-ft (M1-0)
Min = -16.7 K-ft (M1)

VisualAnalysis (version 5.50) -
UPR-2009-SOLAR HOUSE, Mon Dec 01 19:02:06 2008
DAZA STRUCTURAL ENGINEERING SRVICES P.SC., Luis G. Daza-Duarte
D+L service



Bending Moment, Mz

All Members:
Max = 7.54 K-ft (M1-0)
Min = -16.7 K-ft (M1)

Basic Water Budget for Competition Purpose

Water Consumption

Contests	Sub-Contests	Number of tasks	Appliance/Fixture or related task	Flow Rate of Fixture (gpm)	Time (mins)[1]	Gallons per tasks[2]	Total Minimum Gallons Usage[3]	Total Maximum Gallons Usage[4]
Hot Water		20	11" Rain Showerhead	2.5	10	15	300	500
Appliances	Clothes Washer	10	EWFLW65HSS			13	130	130
	Dishwasher	5	EWDW6505G S			8.5	42.5	42.5
Home Entertainment	Cooking	4	(boiling water)			0.6	2.4	2.4
	Dining	2	(2 dishwasher loads)			8.5	17	17
					Total Consumed		**491.9**	**691.9**

Water Tanks Collection Capacity

Water Storage	Quantity	Tank Capacity	Total Gallons			Water Surplus[5]	Water Surplus[5]
Potable Water	1	702	702	Total Collection Capacity	**802**	210.1	10.1
Irrigation Water	1	100	100			310.1	110.1
						Unused storage[6]	Unused storage[6]
Waste Water	1	300	300	Total Waste Water Capacity	**700**	208.1	8.1
Waste Water	2	200	400				

If precipitation was to be collected:

Competition Water Budget considering Precipitation (@Washington DC)

Average October Precipitation: 3 inches

Rainwater Collection Capacity

A x R x 0.5 gallons = G

Catchment Area of Building, sq.ft. (**A**)	Inches of Rain (**R**)	Total Amount of Collected Rainwater, month average gallons (**G**)	Competition Average Rainwater, 5 days (gallons)
750	3	1,125	187.50

			Min. Usage Water Surplus	Max. Usage Water Surplus
Potable Water Tank	502	gallons		
Total Water Supply	**689.5**	**gallons**	197.6	-2.4

Annual Water Budget at Puerto Rico with Precipitation Average

Location: Caguas, Puerto Rico

Average Monthly Precipitation: 4.70 inches

A x R x 0.5 gallons = G

Catchment Area of Building, sq.ft. (**A**)	Inches of Rain (**R**)	Total Amount of Collected Rainwater, monthly average gallons (**G**)	Annual Average Rainwater Collected (gallons)	Min. Gallons, Monthly Usage[7]	Max. Gallons, Monthly Usage[7]
750	4.7	2,115	25,380	1475.7	2075.7

Water Surplus	Water Surplus
639	39

Notes:

(1) Maximum time allowed to perform the task, which affects the amount of water used.

(2) The amount of gallons used per task is determined by the appliance or fixture specifications.

(3) Minimum gallon usage is calculated based on performing the task perfect.

(4) Maximum gallon usage is calculated based on the maximum amount of time allowed to perform the task.

(5) Water Surplus is the amount of unused water gallons still available in the tank.

(6) The waste water tanks have an unused space of storage available.

(7) Monthly usage is determine by using the competition usage data and adjusting it to a month period.

SUMMARY OF UNLISTED ELECTRICAL COMPONENTS

None used. All our electrical components are listed.

RETAIL PV PRICE QUOTE

Revolución Solar

Tamaño de Sistema y el Estimado

Cliente: UPR - Solar Decathlon 2009

Cantidad de Paneles Solares		**34**
Vatios de Capacidad de Cada Panel	305	
Capacidad (Tamaño) del Sistema en kW DC (= numero de paneles X numero de vatios de cada panel / 1000)		**10.4**
Estimado de Energia Solar Neto Generado con este sistema en kWh AC **por dia** (= la capacidad del sistema X 5.3 horas del sol por dia X .80 eficiencia)		**41.9**
Su Uso Actual en kWh Por Dia		**33**
Su Porciento de **Ahorros de Energía** con este sistema (=Energia Solar / su uso actual en kWh)		**129%**
Espacio Fisica Requerido en el Techo en Pies Cuadrados		**622**

Incluido en este estimado:

- Diseño
- Paneles solares fotovoltaicos - con garantía de 25 años
- Inversor - con garantia de 10 años
- Materiales de montaje
- Tubería y cables
- Conectores, panel eléctrica, breaker switch, etc.
- Entrega de materiales
- AEE Permisos y Inspecciones
- Instalación certificado por AAE (Administración De Asuntos de Energía) y AEE

Precio total del sistema con Instalación	**$**	**91,085**
Precio Por Vatio DC de Capacidad de la Sistema (= el precio total / (la capacidad del sistema en kW X 1000))	**$**	**8.78**

El Mejor Precio en el Mercado por Vatio con el mejor servicio!!

Menos: los deducciones en la Planilla por LEY 248 (75% del costo)

Precio del sistema con su incentivo de 75%	**$**	**22,771**
Sus **Ahorros Anuales** promedios durante los proximos 10 años	**$**	**13,060**

Notas:
Este precio es aproximado y depende de los condiciones actuales en su lugar, su selección del equipos especifico, etc.

Un porción de los ingresos de todas las ventas seria donada a una escuela, un hogar y a una casa de una familia que sin este donación, no podrian comprarla. Eso es nuestro forma de repagar la comunidad.

Ven conmigo de ser miembros orgullosos del **TEAM EARTH** - pro ambiente!

Preparado Por: Steve Major
Revolución Solar

Página 1 of 1

10/11/2008

Revolución Solar

VIA EMAIL June 1, 2009

SOLAR DECATHLON

Prof. Sonia M. Miranda Palacios, AIA
Gerente de Proyecto
CASH: Caribbean Affordable Solar House
Casa Solar 2009 - UPR

Re: Photovoltaic Solar Panel Array Proposal

Sonia,

As we have discussed, I am pleased to provide you and the University of Puerto Rico with the following proposal for your 2009 Solar Decathlon project solar array.

Included in this quote are the following:

34 Sunpower 305W modules, SPR-305-WHT
2 Sunny Boy 6000US inverters, SB 6000US
Unirac SolarMount PV mounting system, including adjustable strut legs, L-brackets, heavy duty rails, mounting clamps, bolts, etc.
Fat Spaniel Insight Manager PV Monitoring
Cabling
Connectors
Conduit
Design
Installation labor

Total Cost $76,138.00

P.O. Box 79223, Carolina, Puerto Rico 00984-9223 • Tel: (787) 637-9950 • Fax: (787) 726-5907 • emajor@revolucion-solar.com

Movable closet with Murphy bed

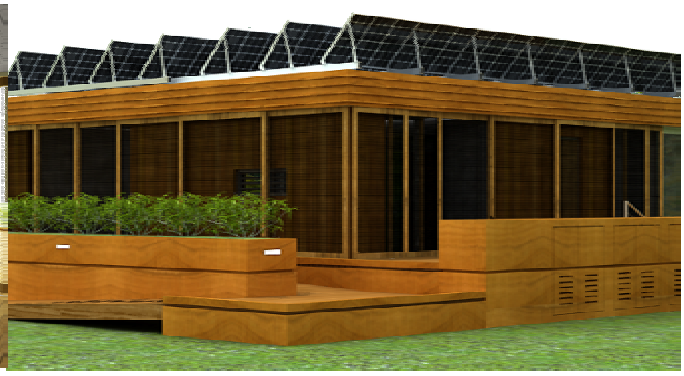
The house's movable closet is an important element in CASH. It expresses the flexibility in the use of space as it divides the bedroom area from the bathroom. Located in the core of the main area, with a hierarchical position and color, this closet relates directly with every other space in the house. With this element, the bathroom can be enlarged or reduced depending on the user's space needs. When this movable closet is retracted, the bedroom's space is expanded, and vice versa. This transformation can be made by sliding the closet using a system similar to the mechanisms used for retracting bookshelves at libraries. By integrating this mechanism to the closet, it is allows to easily move within the floor rails it is attached to. Both bathroom and bedroom are affected by the positioning of the closet.

Dining table

When the kitchen is not in use, the dining table becomes part of the cabinet top and hides the sink. The purpose is to maximize the open space, allowing an unobstructed view of the spaces as it liberates the dining space for other multiple uses. This dining table, with its integrated wheels allows for easy manipulation of its positioning. Its mobility allows it to be placed either inside the conditioned space, in the naturally ventilated screened porch or at the deck on a clear sunny day.

Screens

Another important element of the house, which has both aesthetical and functional characteristics, are the sliding screens that cover the façade. They function as barriers against insects, while keeping the interior CASH cool by preventing the direct entrance of the Sun's rays. These "KoolShade" sliding screens can be moved to an open or closed position, casting a shadow on the facades. Also, when one screen is placed in front of the other, they produce an effect called "moré", which talk about the poetics of sun, shadow, movement and light; they also simultaneously provide the user with privacy and natural ventilation.



Clothes Line

Coming from a sunny Island like ours, we are used to having solar dryers…. What's this? A sunny clotheslines right in the backyard! This is very common, taking advantage of the sun to dry the laundry. The use of a passive system allows an opportunity to conserve energy bringing us to a more efficient level of energy use. This passive cloth dryer consists of a movable element (string) that can be mounted in the multipurpose area or other places. Ours is located right next to the mechanical closet on the north side of the deck.

04-Dec-2008

Solar Decathlon 2009

INTERCONNECTION APPLICATION FORM

TEAM PUERTO RICO

team name and lot number

PV SYSTEMS

Module Manufacturer	Short Description of Array	DC Rating of Array (sum of the DC ratings)
SUNPOWER	(34) SUNPOWER 305W	10,370 W

Total DC power of all arrays is 10.4 kW (in tenths).

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

INVERTERS

Inverter Manufacturer	Model Number	Voltage	Rating (kVA or kW)	Quantity
SMA	SB 6000 US	600V	6 KW	2

Total AC power of all inverters is 12 KW kVA or kW (in whole numbers).

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Please include the following in the Project Manual:

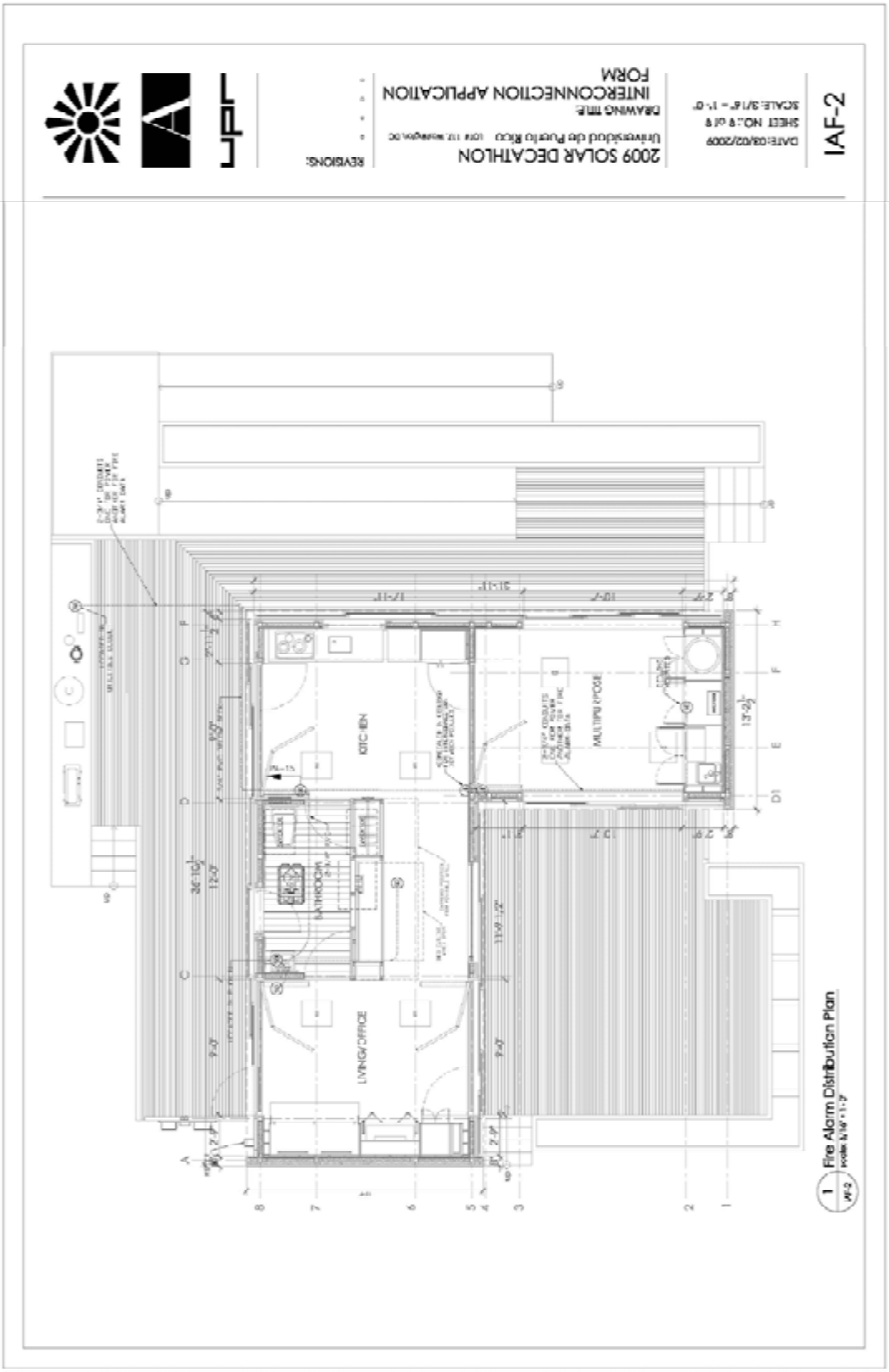
1) One-line electrical schematic – the loads do not have to be detailed.
2) Calculations of service/feeder net computed load and neutral load (NEC 220)
3) Plan view of the lot showing the house, decks, ramps, tour paths and the service point.
4) Elevation view(s) showing the terminal box (contains the service point), meter, and other service equipment (such as the distribution panel or load center).

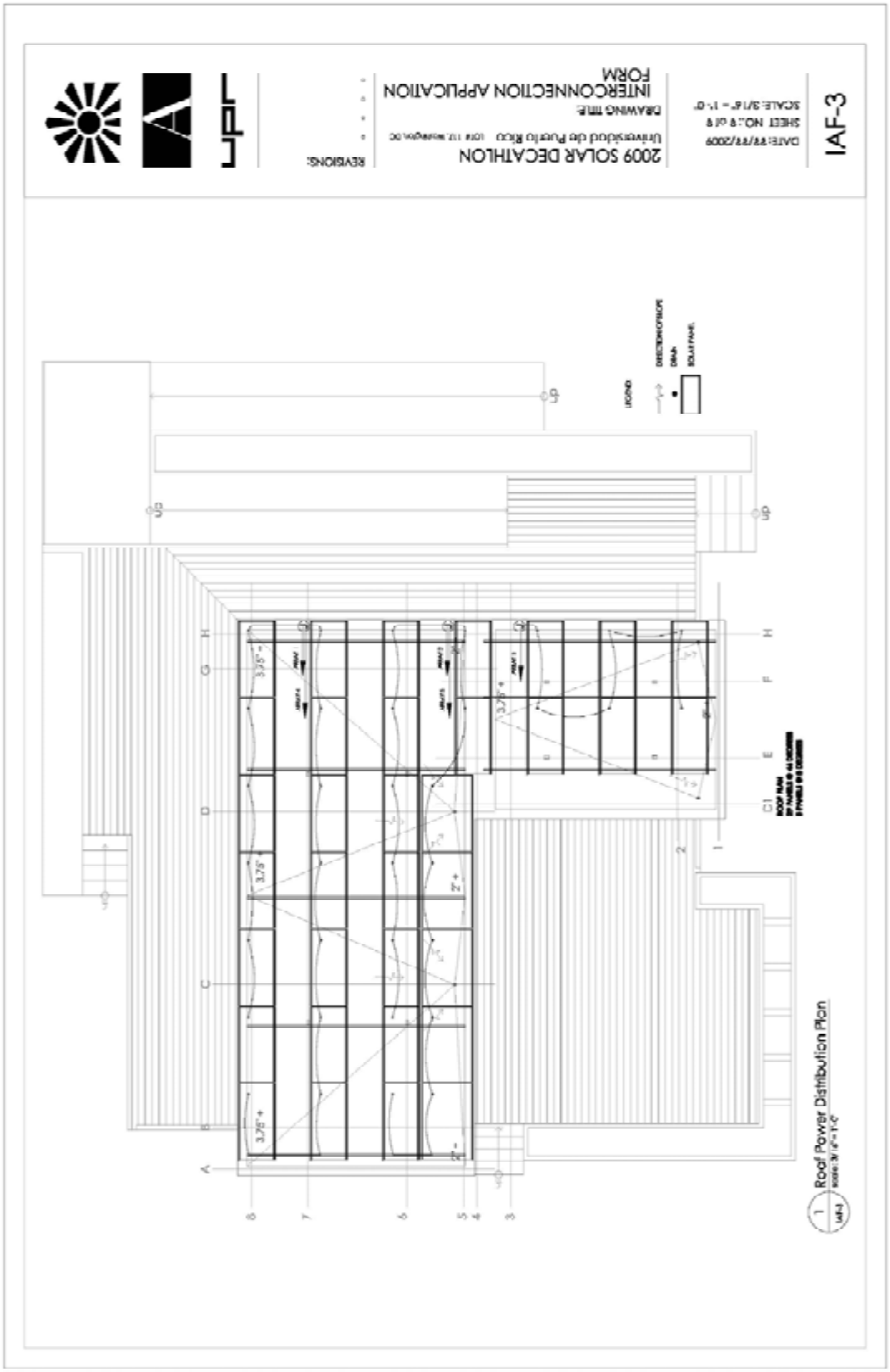
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

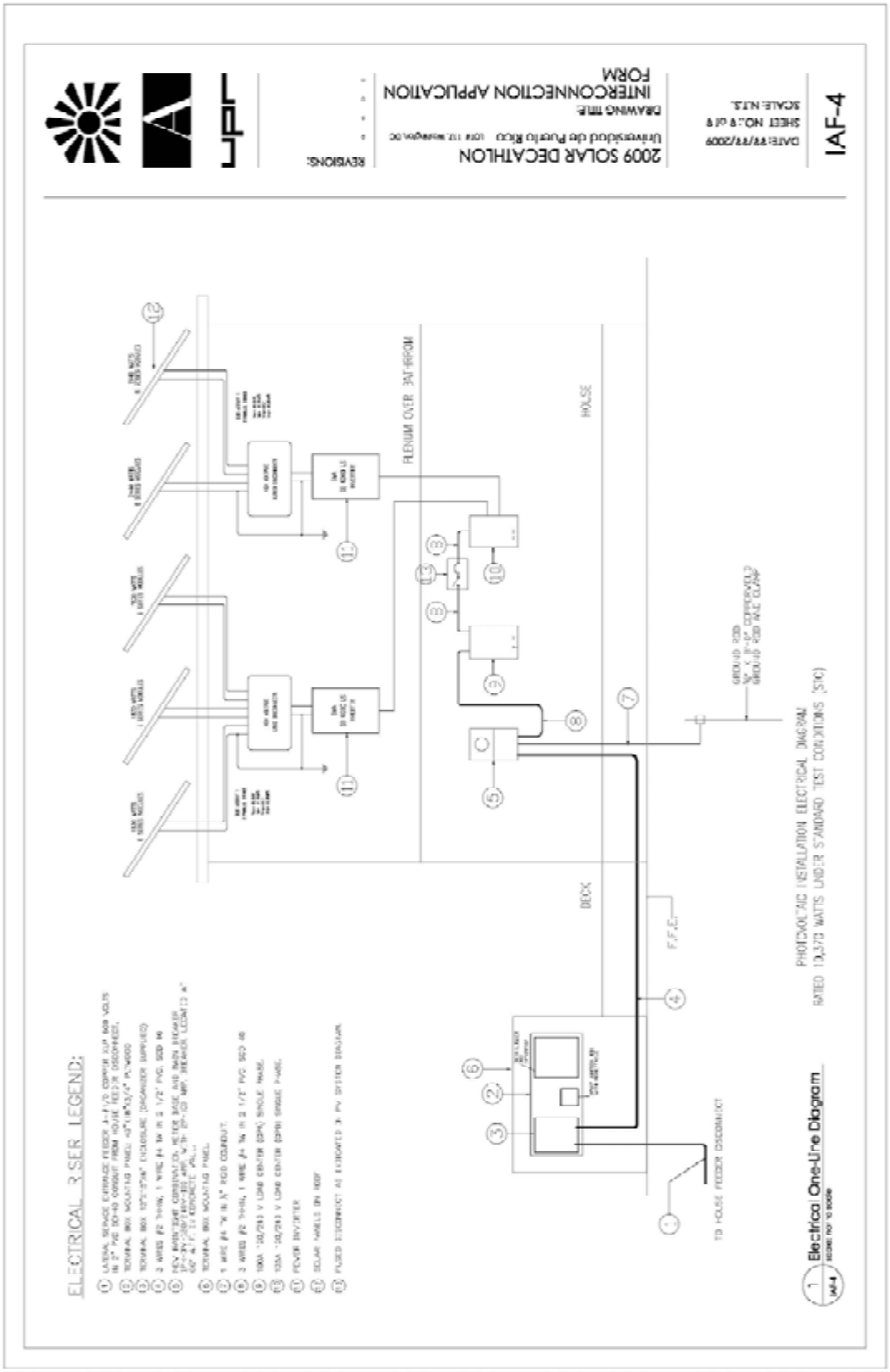
Provide the Team's "Electrical Engineer" contact info in the "Team Officer Contact Info" database on the Yahoo Group. See Rule 3-2.

Please see the "Grid Interconnection Process for Teams" file on the Yahoo Group for more details on the interconnection process and the Terminal Box Mounting Panel.

IAF-1
DATE: 8/8/8/2009
SHEET NO.: 8 of 8
SCALE: Varies
2009 SOLAR DECATHLON
Universidad de Puerto Rico
DRAWING TITLE
INTERCONNECTION APPLICATION FORM
REVISIONS:
1 Electrical Site Plan
2 Public Tour Routes
3 North Elevation
4 Mounting Panel Detail


IAF-2
DATE:03/02/2009
SHEET NO.: 4 of 8
SCALE: 3/16" = 1'-0"
2009 SOLAR DECATHLON
Universidad de Puerto Rico
DRAWING TITLE
INTERCONNECTION APPLICATION FORM
REVISIONS:
UPR
LIVING/OFFICE
BATHROOM
KITCHEN
MULTIPURPOSE
Fire Alarm Distribution Plan


IAF-3
DATE: 99/99/2009
SHEET NO.: 4 of 8
SCALE: 3/16" = 1'-0"
2009 SOLAR DECATHLON
Universidad de Puerto Rico
DRAWING TITLE
INTERCONNECTION APPLICATION FORM
REVISIONS:
UPR
LEGEND
DISCONNECT/MOVE
DRAIN
SOLAR PANEL
Roof Power Distribution Plan


ELECTRICAL RISER LEGEND:
PHOTOVOLTAIC INSTALLATION ELECTRICAL DIAGRAM
RATED 13,573 WATTS UNDER STANDARD TEST CONDITIONS (STC)
Electrical One-Line Diagram
TO HOUSE FEEDER DISCONNECT
F.F.E.
DECK
HOUSE
FLENUM OVER SATIRFOM
2009 SOLAR DECATHLON
Universidad de Puerto Rico
DRAWING TITLE
INTERCONNECTION APPLICATION FORM
REVISIONS:
IAF-4

LOAD CALCULATION ELECTRICAL

PROJECT: UPR SOLAR HOUSE 2009

GENERAL LIGHTING (CONTINUOUS LOAD)

AREA (Ft²)	SPACE	VA / Ft²	
798.41	House	3	2395.242
		TOTAL	2395.242

TABLE 212.12 NEC
ART. 210.20 NEC

2395.24 @ 125% = 2.99 KVA

MINIMUM NUMBER OF BRANCH CIRCUITS

ART. 210.11A NEC

LOAD	POWER	VOLTAGE	AMPS	CB	CKTS
GEN. LIGHTING LOAD	2.99 KVA	120 V	24.95 A	20.00 A	2
SMALL APPLIANCES	2 TWO WIRE, 20 A. CIRCUITS (NEC 210.11(C)(1))				
LAUNDRY	1 TWO WIRE, 20 A. CIRCUITS (NEC 210.11(C)(2))				
BATHROOM	1 TWO WIRE, 20 A. CIRCUITS (NEC 210.11(C)(3))				

MINIMUM SIZE FEEDER

ART. 220.40 NEC

LOAD			POWER
GEN. LIGHTING LOAD			2395.24 VA
SMALL APPLIANCES (NEC 220.52(A))	2 X	1500 VA =	3000.00 VA
LAUNDRY (NEC 220.52(B))	1 X	1500 VA =	1500.00 VA
			6895.24 VA

TABEL 220.42 NEC

TOTAL LOAD				6895.24 VA
LOAD RANGE		DEMAND	PORTION	
0 VA	TO 3,000 VA ->	100%	3000.00 VA	3000.00 VA
3,001 VA	TO 120,000 VA ->	35%	3895.24 VA	1363.33 VA
120,001 VA	TO 999,999 VA ->	25%	0.00 VA	0.00 VA
			NET LOAD =	4363.33 VA

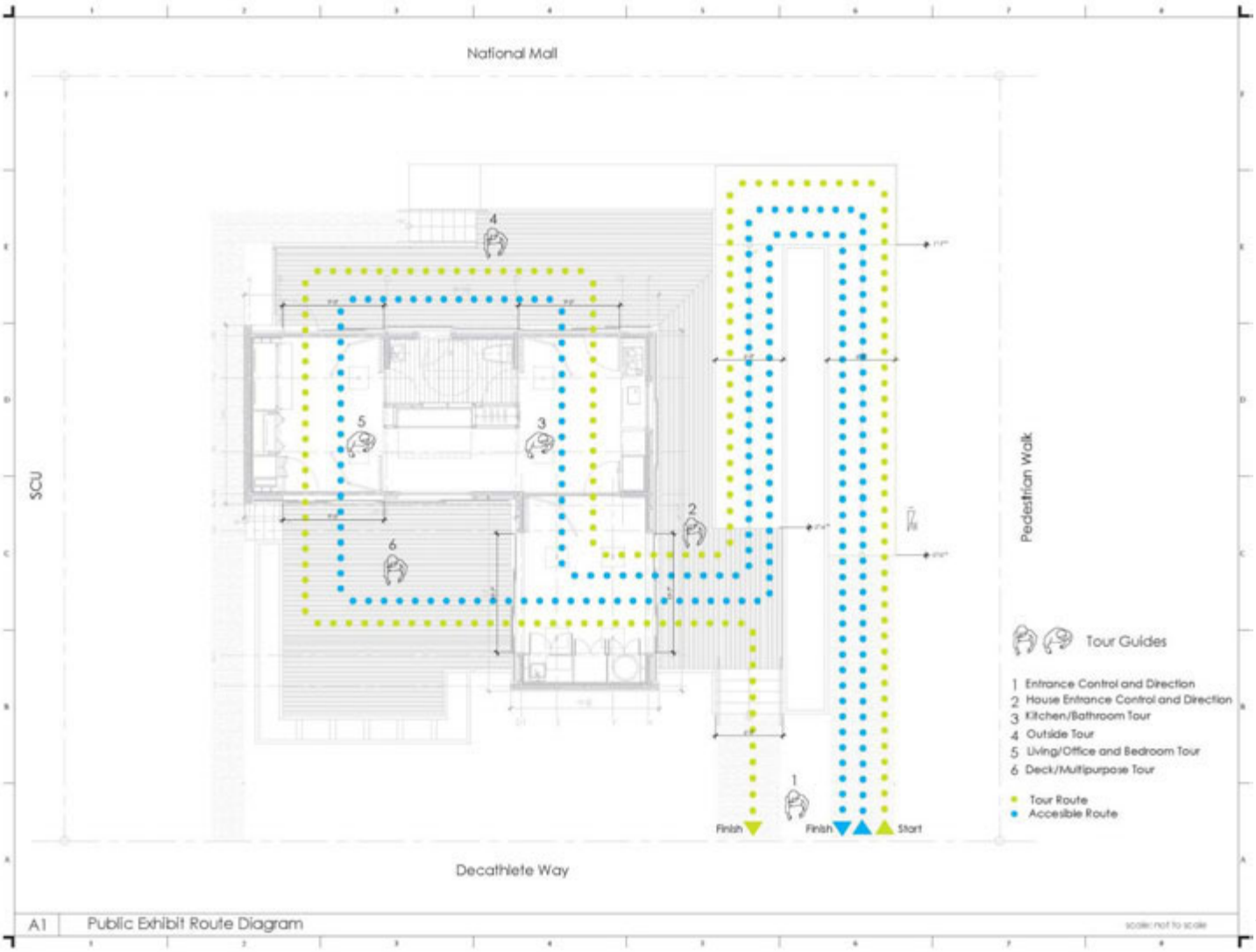
LIGHTING LOAD			4363.33 VA
DISH WASHER	100%	1400.00 VA	1400.00 VA
AIR CONDITIONER	100%	1000.00 VA	1000.00 VA
RANGE (TABLE 220.55 NEC)	80%	3200.00 VA	2560.00 VA
DRYER (TABLE 220.54 NEC)	100%	6480.00 VA	6480.00 VA

NET CALCULATED LOAD = 15803.33 VA

SERVICE VOLTAGE	240 V
FEEDER AMPS	65.85 A
AMPAS USED (NEC 230.42(B) AND 230.79)	**100.00 A**
FEEDER	**#2 AWG**

NEUTRAL CALCULATION

	DEMAND	PORTION	
LIGHT AND SMALL APPLIANCES LOAD			4363.33 VA
DISH WASHER	100%	1400.00 VA	1400.00 VA
AIR CONDITIONER	100%	1000.00 VA	1000.00 VA
RANGE (NEC 220.61)	70%	1400.00 VA	980.00 VA
DRYER (NEC 220.61)	70%	6480.00 VA	4536.00 VA
			12279.33 VA
SERVICE VOLTAGE			240 V
CALCULATED LOAD FOR NEUTRAL			**51.16 A**



ENERGY ANALYSIS RESULTS AND DISCUSSION

PURPOSE

For 2009, the University of Puerto Rico Solar Decathlon Team has designed an energy-efficient, solar-powered house, with a major focus on livability and general comfort. The design of the house intends to exemplify that it is possible to operate a home with the use of solar power. The house is equipped with all the major appliances that can be found in any home in the United States today, with an architectural design that comes from the Caribbean, with a modern twist. The house is highly efficient, functional, and is appealing to the eye and can perform with or without air-conditioning (in Puerto Rico). It has been designed for the Puerto Rico climate and we believe it captures the idea of being inside an open space. We have integrated architectural concepts, functional applications, engineering design and common sense.

Different from houses that strive to be as thermally efficient and closed as possible, we want to make our house feel very open, while being efficient at the same time. Understating that the final location will be in Puerto Rico we think it is possible to design an open / naturally ventilated house. Nevertheless, our house has to perform optimally during the event, so we have incorporated specific systems to let us perform efficiently at Washington D. C. Also, as opposed to most solar-powered houses, the roof is not sloped (it only slopes ¼" per feet for water drainage). For summer months, when cooling loads are highest, a smaller roof area is beneficial. Also, the interior volume of the house is smaller and requires less cooling capacity. The doors and windows in the house provide excellent natural daylight, which can be controlled by exterior "koolshades" screens. The screens act as exterior louvers which reduce the direct sun's radiation and provide privacy when desired.

The house integrates engineering systems which will minimize energy consumption, thus increasing energy efficiency. All systems are equipped with electronic automatic controls that will not require user input. Once installed, all systems in the house are user friendly. The house will operate as any house connected to the power utility grid. Incorrect use of any of the systems could result in a safety hazard. Automatic controls greatly decrease this possibility.

The purpose of this report is to verify the analysis of each system as if the house will be able to operate in the city of San Juan, Puerto Rico, for all seasons in a year. The analysis is expected to provide a general idea of how the house will operate, and what areas of the house require further adjustments. Once the design is finalized, the house will be constructed and tested in San Juan, Puerto Rico. All simulations will be reproduced for Washington D. C. A comparison of the tests with the simulations will provide a better understanding of how the house will really operate. With thorough testing of the house, the team will be able to confirm if simulations are valid.

SYSTEMS ANALYSIS

CLIMATE CONSULTANT 4.0

Before the initial design for the house was conceptualized, the group of students decided to make a thorough analysis of the climate in San Juan, Puerto Rico, the final location for the house. This was very important because even though the competition was going to be at Washington DC, we wanted to work with a local Caribbean model: CASH | Caribbean Affordable Solar House. Thus, it was very important to understand the implications of this decision in terms of design and energy. At the Appendix, you will find several of the windows of the program (images) with a summary of the climate data.

With this information, we made several important decisions that had a strong impact in the architecture of the house. First, we wanted the house to be Caribbean, but did not want to mimic the vernacular. How to be modern? Was one of he questions. The design principles that follow are a summary of the basic ideas we strive to include in our architectural scheme for the SD2009 Puerto Rico house.

PRIMARY DESIGN GUIDELINES EXAMPLES
(Not all included)

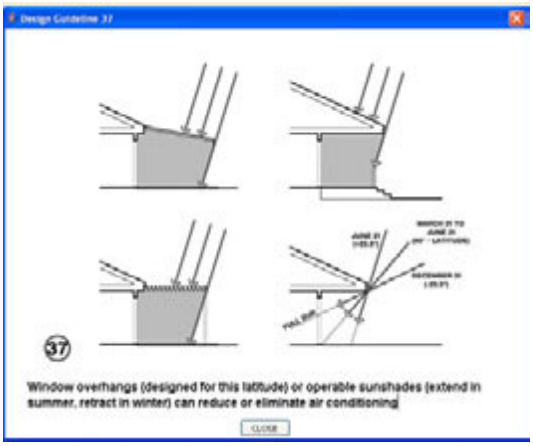


Figure 1

Overhangs or operable sunshades:

This is one of the very basic passive design principles we use in Puerto Rico. But for the SD 2009, we wanted to do something that could alter this notion. With the challenge of having a small footprint of 800 sf, in which all overhangs counted as building area, we had a difficult decision to make. How to deal with direct sun radiation without having to have extensive overhangs?

Figure 2

Screened porches:
Was this a sound idea?

Figure 3
Minimize overheating:
In our Hot and Humid climate, we also have to deal with high humidity levels and thermal mass… How do we insulate our building and deal
with air-tightness for A/C systems, when we also need natural ventilation?

Figure 4
Lightweight construction:
How could we design a modern Caribbean home, without the need of doing a "typical" structure?

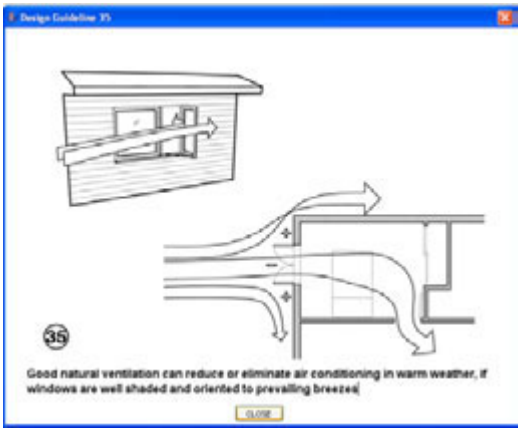


Figure 5
Natural ventilation:
Was it going to be possible to achieve the required thermal comfort without the need of HVAC systems?

Figure 6
Raised structures:
How to deal with humidity and crawl spaces without having stilts?

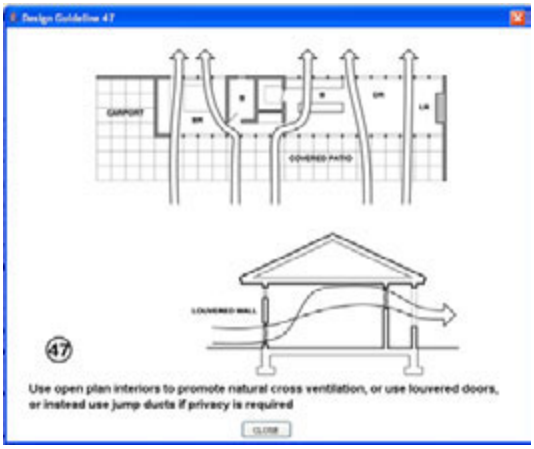


Figure 7
Open plan:
How to offer private areas in a domestic setting?

HEED

After understating our climate very well, and knowing how to work with some of the basic design principles, for our first Energy Analysis we decided that we also had to understand the impact of specific forms and shapes of our house in regards to essential energy consumption. We decided to use a basic energy modeling program, HEED. This program helped us improve the energy efficiency of the design and see the changes from several schemes. Also, this program let us see the impact on cost and greenhouse gas emissions generated from the electricity needed to run the house.

ENERGY CONVERSION

The house has been architecturally designed to take advantage of natural forms of illumination and ventilation, thus reducing greatly the energetic loads of the house. Energy collected from the Sun can also be converted into usable energy by two methods:

- Photo-thermal conversion
- Photovoltaic effect

It is recommended to use photo-thermal conversion for all heating purposes. The method provides an estimated efficiency of 60-80%, and provides energy to the house directly in the form of heat. Photovoltaic panels work at an efficiency of approximately 18%, and provide energy in the form of electric current. Utilizing electric current for heating purposes is a method with very low efficiency as well. Heating with the use of electric current becomes an extremely inefficient method of use of solar energy.

All other applications will operate with energy provided by the photovoltaic panels. Due to the unpredictable weather conditions on any part of the planet, it is highly recommended to install an auxiliary system for energy provision. The system will be tied to the city's power utility grid. In the event that the system cannot produce enough energy as to operate the house, energy from the grid can be used as back-up. Other forms of auxiliary power, such as wind or hydraulic power can also be integrated to the house's power production.

PHOTO THERMAL CONVERSION

Photo-thermal conversion consists of converting solar radiation into heat. Heat obtained from this process will be used to heat water, which will then be used as supply water in the house or as an energy reservoir. For this purpose an array of 20 evacuated solar collector tubes will be installed on the south end of the roof of the house.

Evacuated tubes are the absorber of the solar water heater. They absorb solar energy converting it into heat for use in water heating. Evacuated tubes have already been used for years in Germany, Canada, China and the UK. There are several types of evacuated tubes in use in the solar industry. Apricus collectors use the most common "twin-glass tube". This type of tube is chosen for its reliability, performance and low manufacturing cost.

Figure 8
Monthly Energy Delivered by PV Panels

Each evacuated tube consists of two glass tubes made from extremely strong borosilicate glass. The outer tube is transparent allowing light rays to pass through with minimal reflection. The inner tube is coated with a special selective coating (Al-N/Al) which features excellent solar radiation absorption and minimal reflection properties. The top of the two tubes are fused together and the air contained in the space between the two layers of glass is pumped out while exposing the tube to high temperatures. This "evacuation" of the gasses forms a vacuum, which is an important factor in the performance of the evacuated tubes.

As you would know if you have used a glass lined thermos flask, a vacuum is an excellent insulator. This is important because once the evacuated tube absorbs the radiation from the sun and converts it to heat; we don't want to lose it!! The vacuum helps to achieve this. The insulation properties are so good that while the inside of the tube may be 150°C / 304°F, the outer tube is cold to touch. This means that evacuated tube water heaters can perform well even in cold weather when flat plate collectors perform poorly due to heat loss (during high Delta-T conditions). In order to maintain the vacuum between the two glass layers, a barium getter is used (the same as in television tubes). During manufacture of the evacuated tube this getter is exposed to high temperatures which cause the bottom of the evacuated tube to be

coated with a pure layer of barium. This barium layer actively absorbs any CO, CO_2, N_2, O_2, H_2O and H_2 out-gassed from the evacuated tube during storage and operation, thus helping to maintaining the vacuum. The barium layer also provides a clear visual indicator of the vacuum status. The silver colored barium layer will turn white if the vacuum is ever lost. This makes it easy to determine whether or not a tube is in good condition.

Evacuated tubes are aligned in parallel; the angle of mounting depends upon the latitude of your location. In a North South orientation the tubes can passively track heat from the sun all day. In an East West orientation they can track the sun all year round. The efficiency of a evacuated water heater is dependent upon a number of factors, one important one being the level of evacuated radiation (insolation) in your region.

Evacuated Tube Basic Specifications

Length (nominal)	1500mm /1800mm
Outer tube diameter	58mm
Inner tube diameter	47mm
Glass thickness	1.6mm
Thermal expansion	$3.3x10^{-6}$ °C
Material	Borosilicate Glass 3.3
Absorptive Coating	Graded Al-N/Al
Absorptance	>92% (AM1.5)
Emittance	<8% (80°C)
Vacuum	P<$5x10^{-3}$ Pa
Stagnation Temperature	>200°C
Heat Loss	<0.8W/ (m2°C)
Maximum Strength	0.8MPa

Figure 9

Four our house, we decided to use a system that will be able to heat water and use a tank with a capacity of 40 gallons. The estimate below is just a guide and is based on a average summer performance level of 70%.

Metric Calculation

Insolation:	5.96 kWh/m²/day
Water Volume:*	176 Litres
Temp Rise:**	33 °C
You Require:	
20 Evacuated Tubes	

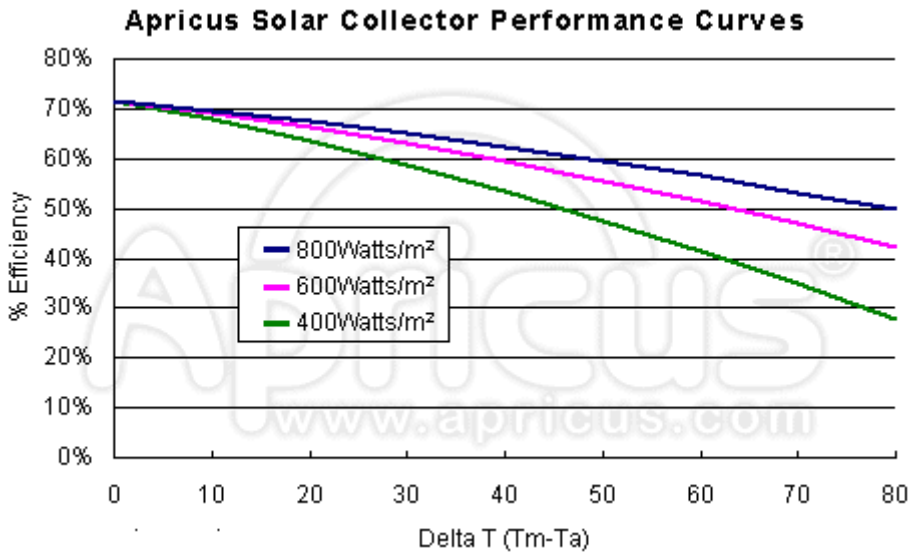


Figure 10

PHOTOVOLTAICS

In order to operate all the electrical appliances within the house, energy from the Sun must be converted into electric power. Photovoltaic panels, which convert sunlight into electric current by the photovoltaic effect, will be placed on a custom built structure above most of the remaining areas of the roof. It was decided that the modules will be installed at an 46° tilt angle facing directly towards the South, with this tilt angle we were able to accommodate up to 34 of the Sunpower 305 W modules which is the maximum number of these modules that can be accommodated in the structure without having shading problems between the modules.

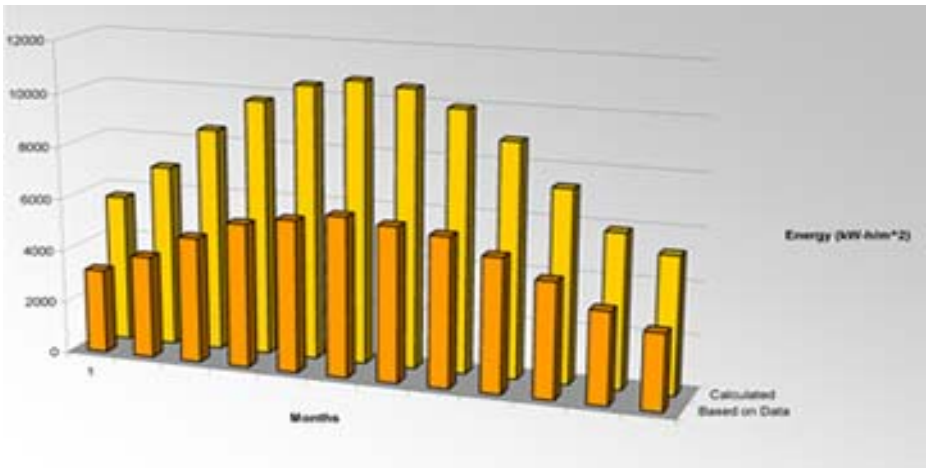


Figure 11
Available Energy

The efficiency of each panel is 18.7%. The expected power output of the panels can be calculated as the product of the expected irradiance, the total area of collection, and the efficiency. The specifications for the photovoltaic modules can be found in appendix 5.

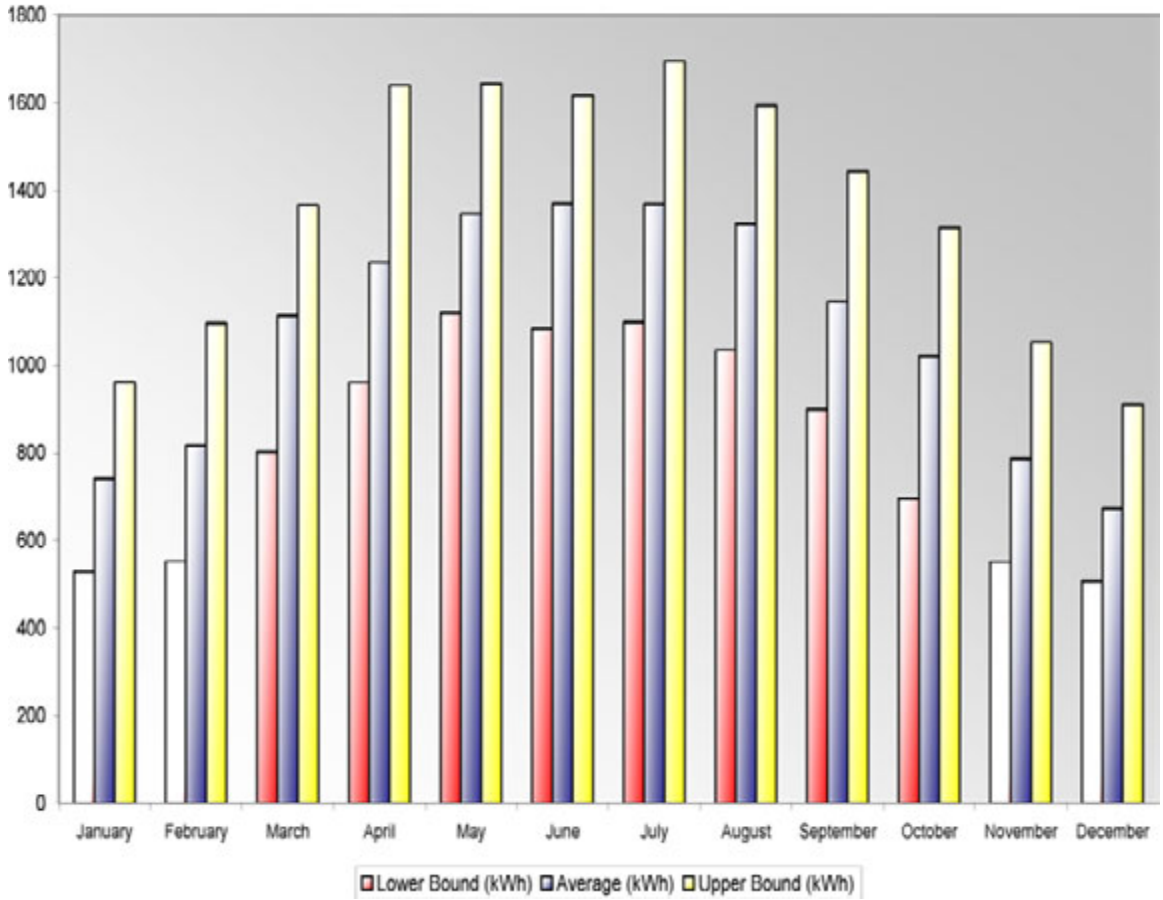


Figure 12
Monthly Energy Delivered by PV Panels

HEED ANALYSIS

We began our schematic energy modeling by indicating the basic parameters for the program: brand new single family house, with one story and 800 sq. feet. The location is San Juan and the weather data is TMY3 785263 WMO Station, at Luis Muñoz Marín International Airport.

With this information, the program runs a simulation and creates two buildings:

1. Scheme 1: just meets the California Energy Code
2. Scheme 2: which is about 30% More Energy Efficient

Scheme 1:

CODE MINIMUM DESIGN

- Square floor plan
- Equal area of glass on each wall
- Windows tinted if required by code
- No window shading
- Stud and Stucco walls
- Raised wood floor
- .35 air changes per hour infiltration

ENERGY EFFICIENT DESIGN

- Rectangular floor plan facing South
- Most glass on South, least on E &W
- Clear glass on South and North *
- Overhangs shading South Windows
- High mass walls, exterior insulation *
- Slab on grade floor, carpet or tile *
- Whole-house Fan, up to 10 air changes

Scheme 2: * Depending on Climate

NOTE: Both schemes have the same floor area, window area, climate, and occupancy schedules.

With this information the program performs an "Hourly Heat Balance Calculation" for all 8760 hours per year, similar to EnergyPlus, and runs a whole-building analysis, integrating loads and systems for a single zone building. We could use this because initially we decided to run the simulation as if the house was an 800 sf structure.

After this initial output, we added more detailed information about our design and made additional simulations for different schemes. The initial results indicated that for a "typical" house with these "general" characteristics (Scheme 1), the electric consumption would be near $864.98 for a year. (In order to compare energy cost, we left the cost of energy the same in all simulations). For a more efficient design, the program simulated some basic changes and developed a second Scheme that had a reduction of 31 % for the cost of energy.

Furthermore, the program correlates the weather data from San Juan, Puerto Rico, and assumes a similar climate from California. In this case, the zone used to make the correlation was the climate zone 6. For this climate zone there can be several passive and efficient energy design strategies to reduce energy consumption. Some of them are included in the following table and do correspond to real options in Puerto Rico. Also, there can be a reduction of the hours when cooling is needed for indoor comfort, for a total of 2,212 hours which represents 25% of the year.

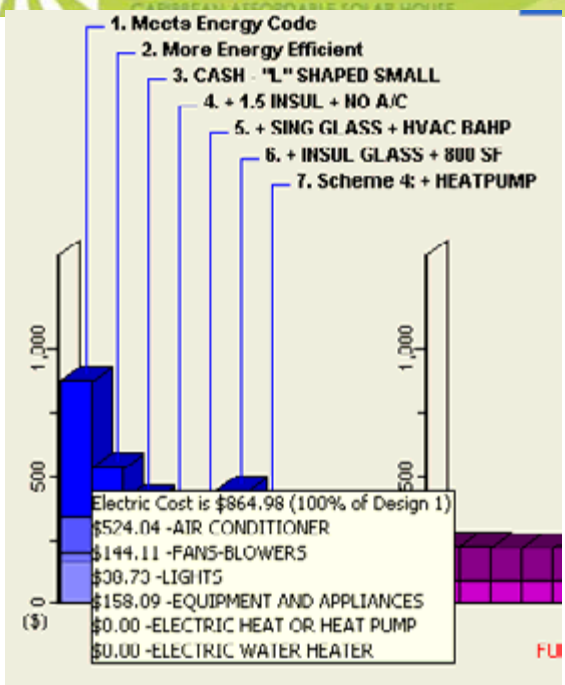


Figure 13
Partial image from Energy Consumption Window, Scheme 1

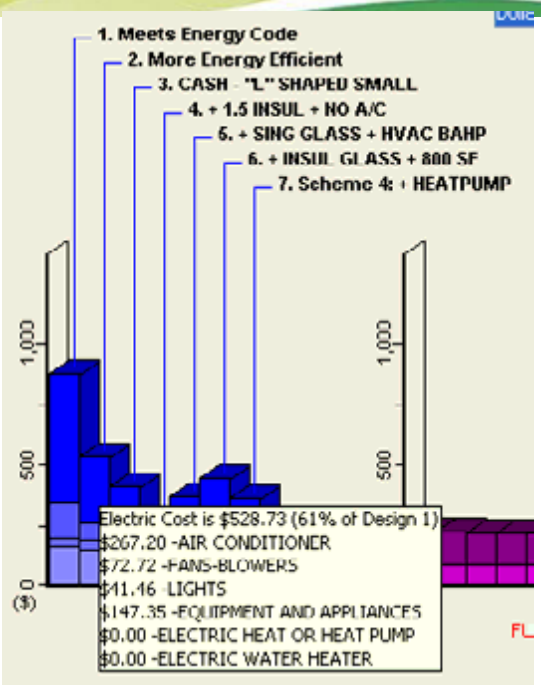


Figure 14
Partial image from Energy Consumption Window, Scheme 2

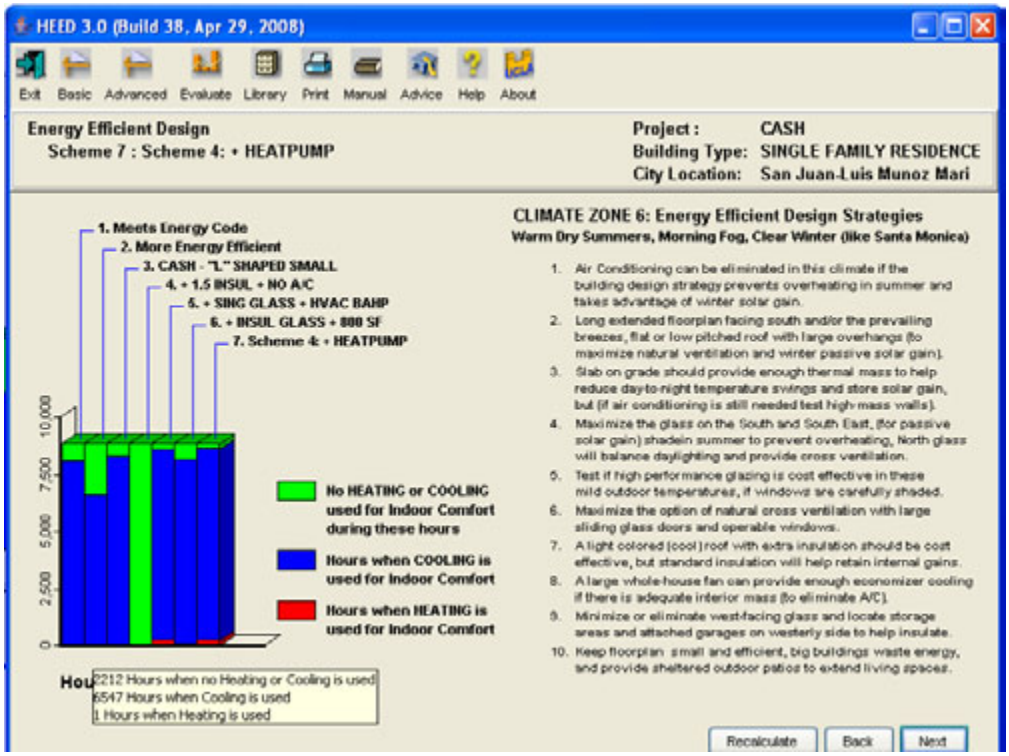


Figure 15
Energy Efficient Design

For the third scheme we specified that from the total 800 sf, there was going to be a garage that took part of that area. Therefore, we changed the building form to simulate our SD2009 house "L" shape, with the shorter leg of the "L" being the "garage", since in our house that area is not air conditioned. This became the Scheme 3: CASH: "L" shaped small.

For this scheme we specified the following:

1. Windows: Aluminum without thermal breaks, operable windows, and clear double pane low –E squared in aluminum frame.
2. Insulation: Current Energy Code (2005) for climate zone 6: R-13 walls, R-30 ceilings, R-19 floors, with radiant barrier installed in flat roof.
3. Walls:
4. Roof: White (cool roof) elastomeric membrane, flat roof.
5. Floor: Wood floor (exposed) over raised vented crawl space.
6. Infiltration and weather stripping: Add sealed ducts (4.4 SLA) required in Title 24 package D, inspected and blower tested.
7. Ventilation: Closed building provides code required 0.35 air changes per hour
8. Heating and cooling: Best available furnace (condensation type) plus best available A/C (split system SEER = 18).
9. Operable shading: Exterior slight slatted blinds.

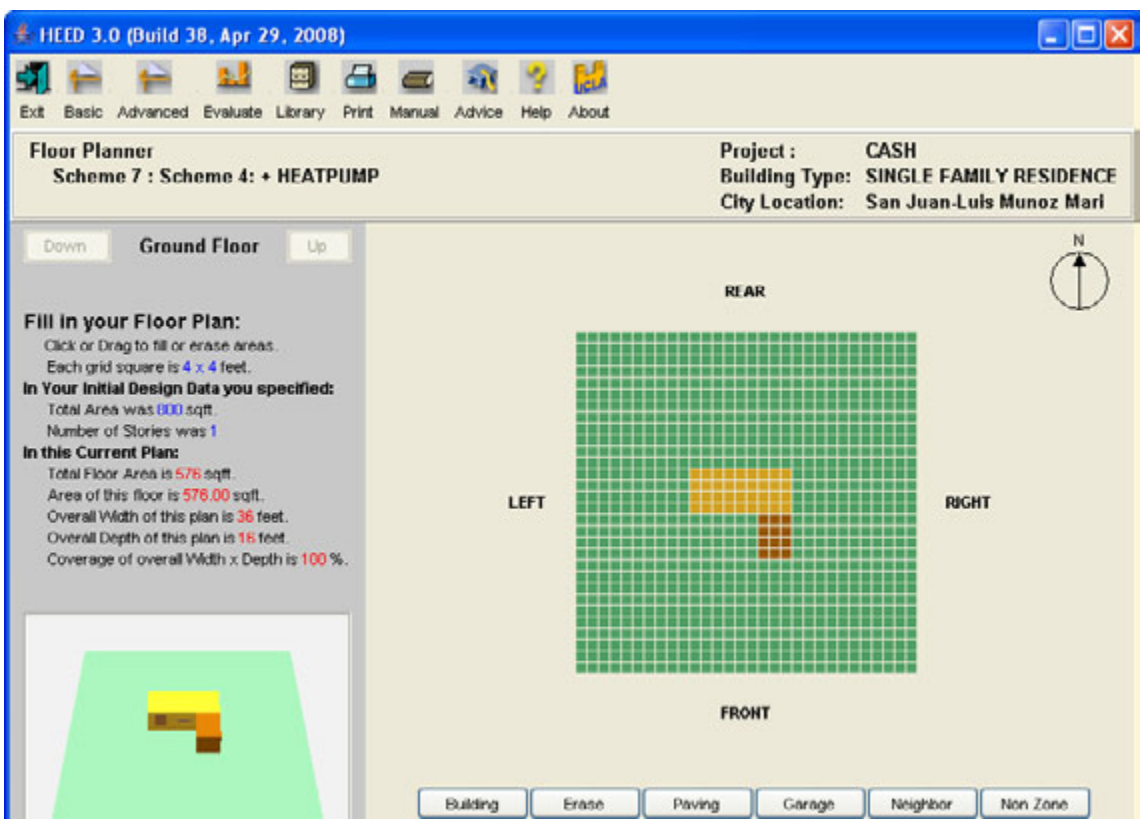


Figure 16
Floor Planner

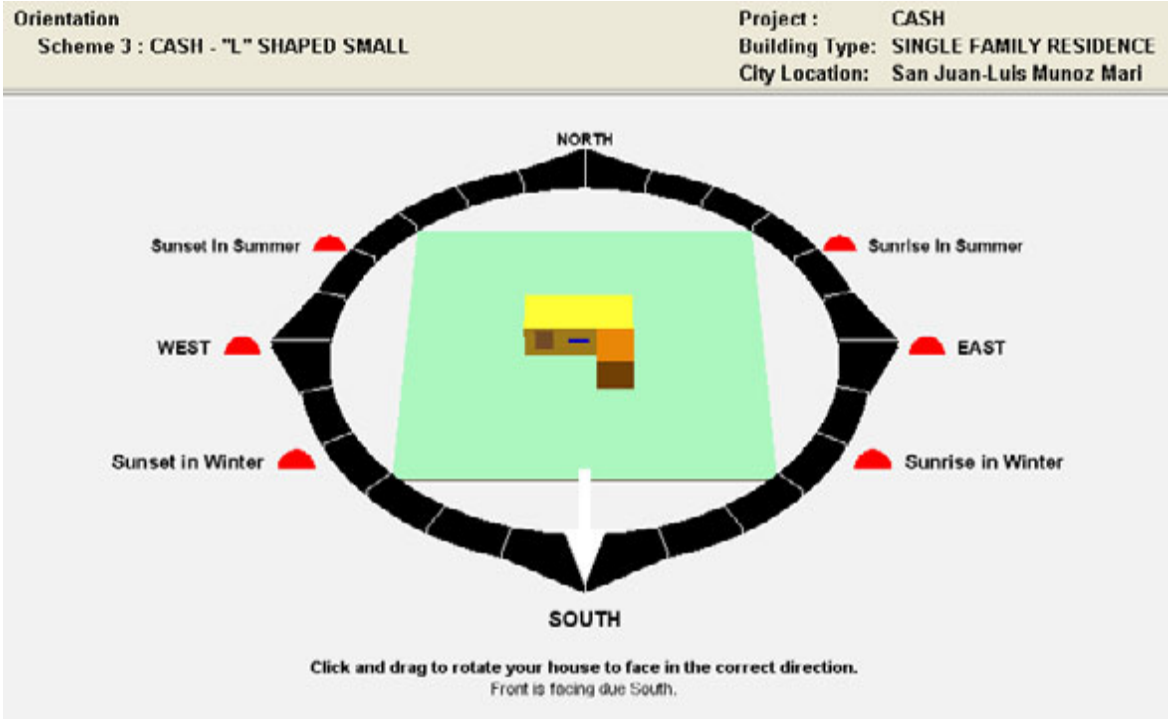


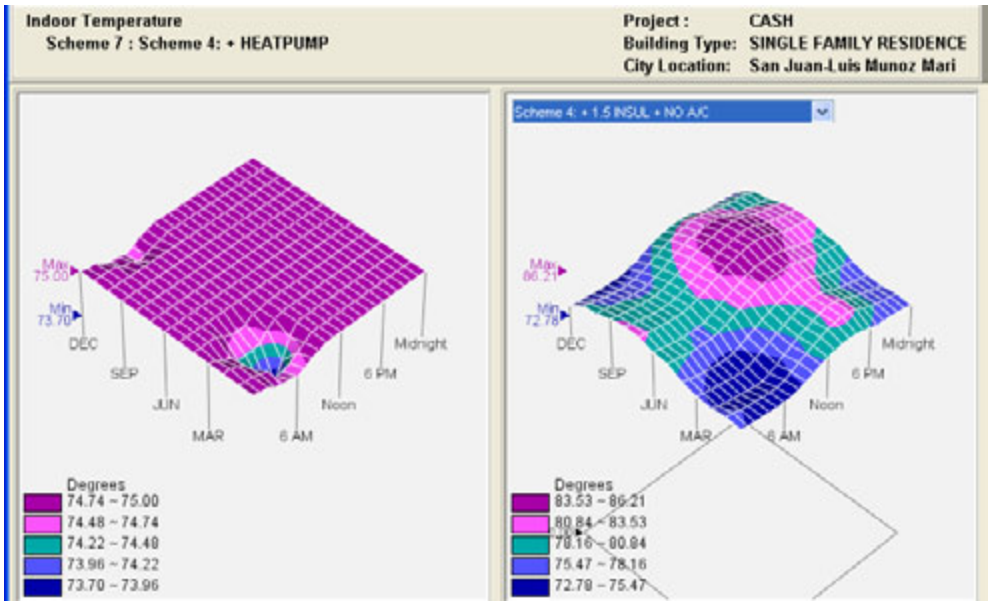
Figure 17
Orientation

With these changes (for Scheme 3) we reduced the initial energy use from Scheme 1, 43%, a dramatic reduction with simple changes.

Afterwards, we made additional changes to get Scheme 4: which included a higher insulation, upgraded to 1.5 times the current code, and eliminated the use of HVAC systems with the use of high natural ventilation, and no furnace and no A/C. This reduced the energy usage 67% from the initial scheme.

In the next image you will see the plotted indoor temperatures for the basic Scheme 1 and the Scheme 4. Because of the elimination of the A/C system, the interior temperatures are raised to 86.21 degrees F from during the summer period at mid day. With good breezes and natural ventilation that help evaporate and move the water in the air, there can be an expansion in the comfort zone area. We understand that these temperatures are not valid for the competition, but represent a good parameter of hat can be possible in the Caribbean.

Figure 18
Partial window for Indoor Temperature Plot, Scheme 1 vs. Scheme 4



Afterwards, to reduce the indoor temperatures to the parameters approved for the event, we decided there was going to be a need for A/C and did the modeling for Scheme 5 adding the best available heat pump in the market.

Also, we rotated the building orientation 180 degrees, so the non heated area (garage) was going to face north. In this case, we also changed the glass for single pane 1/8" glass in aluminum frame. On the next figure you can see the plotted data for indoor temperature for Scheme 5.

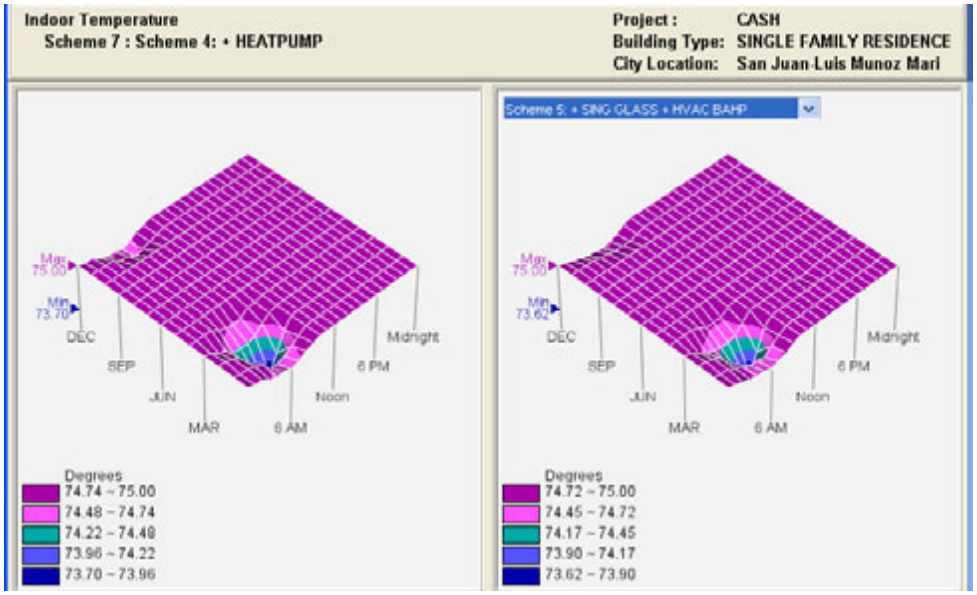


Figure 19 Partial window for Indoor Temperature Plot, Scheme 1 vs. Scheme 5

When we saw the plot graph below, for Scheme 1 and Scheme 5, it was clear that the total loads for this scheme were bigger, and thus we decided to use insulated glass, reorient the building south and use 9" stucco applied insulated concrete filled forms, with plaster board in the interior.

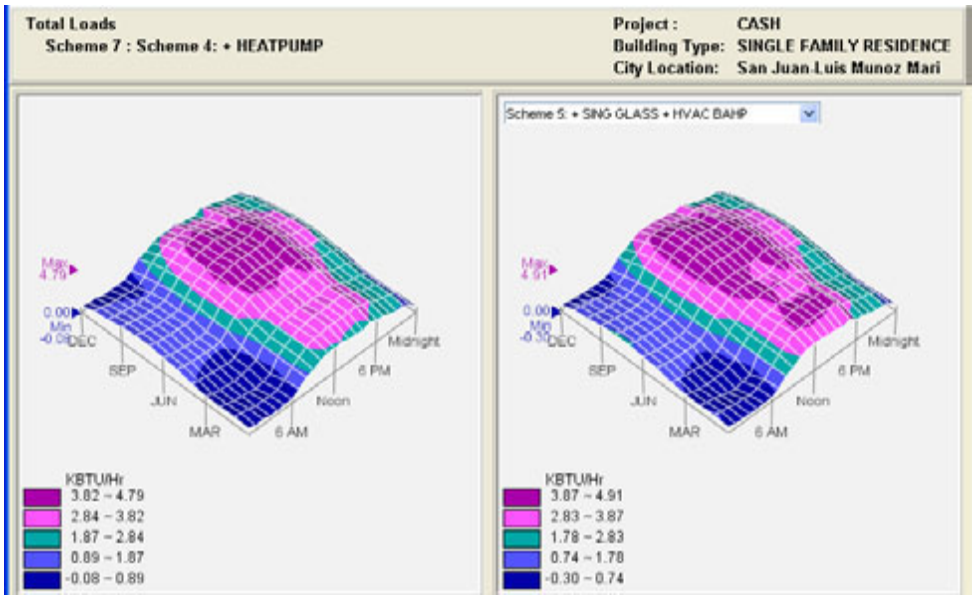


Figure 20
Partial window for Total Loads, Scheme 1 vs. Scheme 5

Also, we wanted to know how much energy we were going to consume if the total 800 sf were A/C. This became the Scheme 6. (See Figure21)

Afterwards, we wanted to know how much of this increment in energy consumption was due to the A/C alone, and decided to make a copy of the Scheme 4 (that had no A/C) and added the heat pump only. This became the Scheme 7. We also wanted to see the difference if we added insulated glass (Scheme 8).

What we found was that the major differences were between the Scheme 4 that had no A/C and the Scheme 5 which had a Heat Pump with single pane glass. By adding insulated glass the economy was not going to be as big as the cost of the new type of glass, so maybe this last one was not a good option. More detailed information is needed in order to evaluate the option for insulated glass.

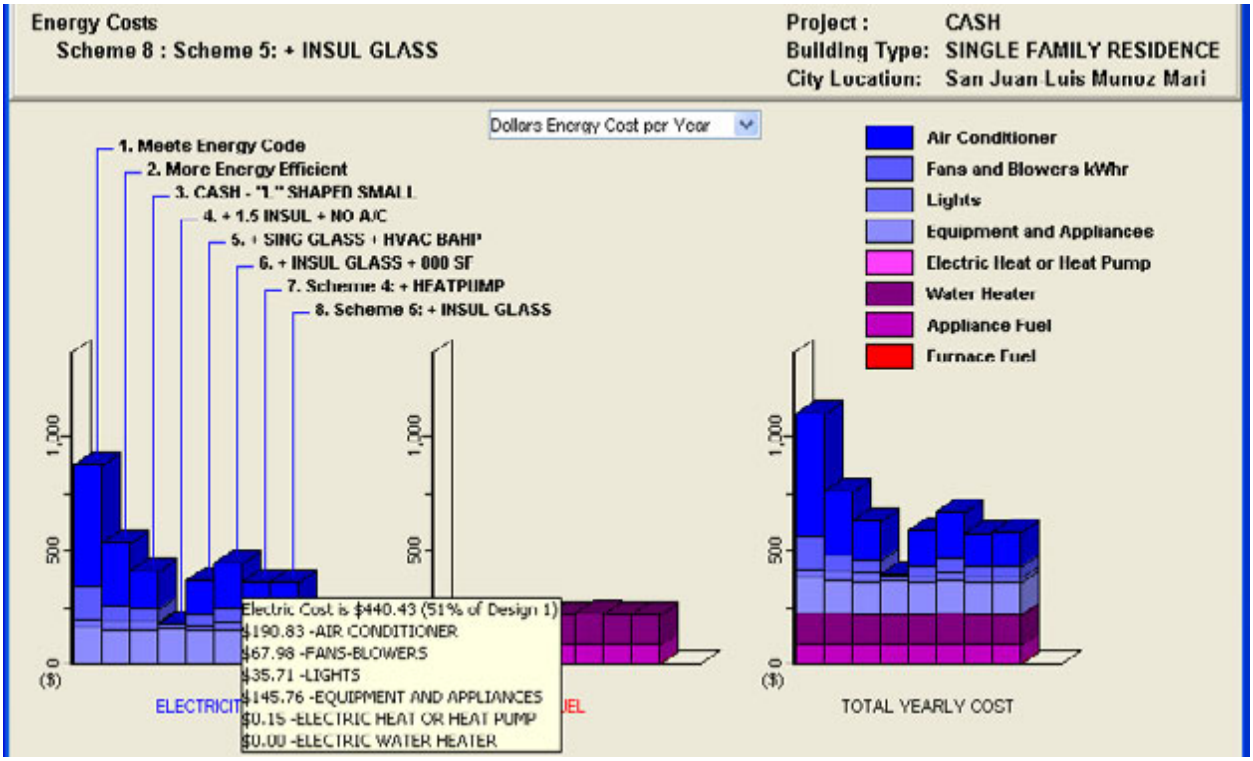


Figure 21
Partial window for Energy Costs, Scheme 6 info included

In the following Figure you can see a summary table for the different options.

Summary Table

Project : CASH
A 576 Square Foot SINGLE FAMILY RESIDENCE in San Juan-Luis Munoz Mari

	Scheme Name	Energy Costs Electricity	Gas	Total	Savings Compared to Scheme 1
1.	Meets Energy Code	$864.98	$224.50	$1,089.47	
2.	More Energy Efficient	$528.73	$224.50	$753.23	31%
3.	CASH - "L" SHAPED SMALL	$404.95	$215.73	$620.68	43%
4.	+ 1.5 INSUL + NO A/C	$176.70	$215.01	$391.71	64%
5.	+ SING GLASS + HVAC BAHP	$365.59	$215.01	$580.60	47%
6.	+ INSUL GLASS + 800 SF	$440.43	$222.36	$662.79	39%
7.	Scheme 4: + HEATPUMP	$355.84	$215.01	$570.85	48%
8.	Scheme 5: + INSUL GLASS	$358.96	$215.01	$573.96	47%
9.					

Estimates only. The California Public Utilities Commission, the Regents of the University of California, and Constructive Technologies Group, make no warranty, expressed or implied, including but not limited to any warranty of merchantability or fitness for any particular use or application.

If you encounter problems or have comments, please email them to:
Energy.Design.Tools@ucla.edu

Figure 22
Summary Table

After doing a schematic analysis using HEED, we understand that our initial architectural scheme is energy efficient and can work four our climate in San Juan, Puerto Rico.

We have designed a home that is 800 sf, of which 477 sf (approximate) have an HVAC system, and the rest is a covered exterior area. As a summary of the energy efficient design strategies we have incorporated in our design are:

1. Long extended floor plan facing south with a flat roof.
    a. Since we want to use the maximum 800 sf area permitted in the competition and have an interior occupied space around 450 sf, (which we decided to use as our maximum interior HVAC area), we decided to use screens instead of overhangs.
2. We have seen that it is indeed possible to minimize or eliminate the use of A/C in the building.
3. We have maximized the glass on the southern façade and have eliminated the glass on the west and minimize the glass on the east.
4. We also have included the storage areas on the west and east shorter facades, thus using the closets as areas to prevent heat gain from the exterior.
5. With the "koolshades" screens, we are minimizing direct radiation in summer and permitting natural illumination. Also, by having windows and doors in the north façade, we are permitting natural ventilation as well as daylight.
6. We have find that if we use high performance glazing we can reduce the initial energy cost by 47%. But we have to see in detail the real cost for this, because apparently the reduction in energy is not as much. Further evaluation is needed in this case.
7. We have maximized the option of natural cross ventilation with large operating sliding glass doors and operable windows.
8. We have a cool roof with insulation.
9. We are looking into the possibility of having a large whole – house fan, when A/C is not in use.
10. We have provided sheltered outdoor space (our multipurpose room) to extend living areas.

ENERGY MODELING SIMULATION: ENERGY PLUS

After performing our schematic energy analysis, we decided to run a model and perform a Simulation. This simulation takes place in Washington DC, to see how our design would perform in a different setting, that of the SD2009 event: The National Mall.

As part of the activities related to the Caribbean Affordable Solar House (CASH) project for the SD2009 Event, an energy analysis was performed. The main objective was to know and account for the total energy production and consumption for the structure. The energy analysis was performed using the simulation software called EnergyPlus.

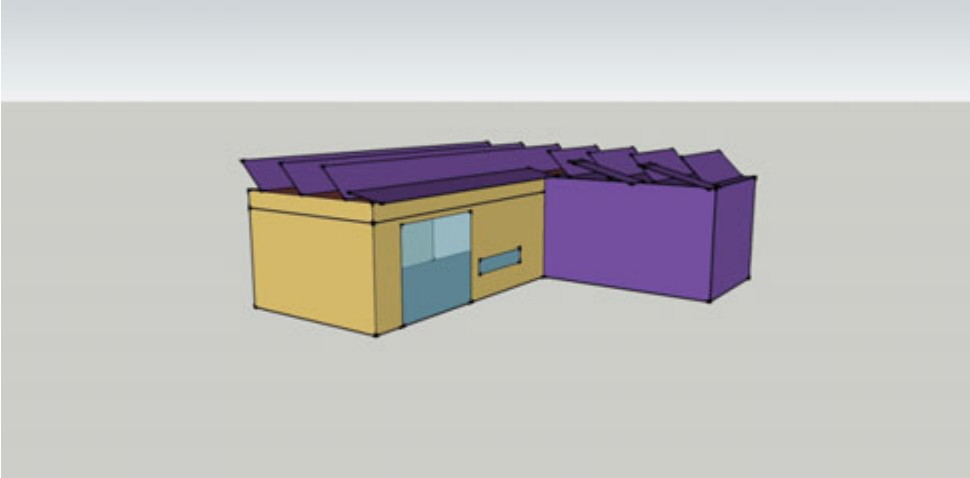


Figure 23 EnergyPlus Rendering

For the simulation the weather file used was for the location of Richmond, VA; the file was obtained from the EnergyPlus website in the TMY2 format and converted to the EPW format using the EnergyPlus weather conversion program. Also during the conversion a statistics file was obtained, this file was used to determine the change of season and cooling/heating mode.

Building Envelope

The building envelope was defined by using the architectural drawings for the building dimensions. The materials used in the surface constructions where obtained from the ASHRAE Handbook of Fundamentals 2005.

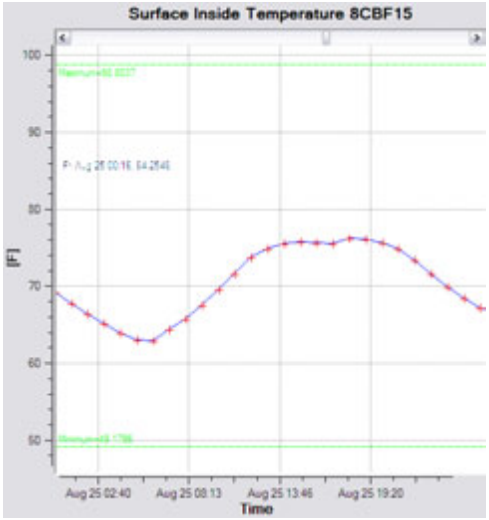


Figure 24 Inside Face West Wall Temperature

The fenestration surfaces represented a big challenge; this was due to the lack of thermal tests on the selected doors and windows. Currently in Puerto Rico local manufacturers have not been keeping up to standards with respect to product energy rating. This situation has surfaced due to the lack of energy codes in Puerto Rico. To overcome this barrier an energy simulation was performed for the glass doors using the program Window 5 in conjunction with Optics 5, which where developed by the Lawrence Berkley National Lab.

The information from this program is below:

Window5 Data File for EnergyPlus
Window 5.2a v5.2.17a
Date : Sat May 30 23:30:12 2009
Window name : CASH_Door_A757D5
Description : Custom Single Vision
Glazing Systems: 1
GLAZING SYSTEM DATA: Height Width nPanes Uval-center SC-center SHGC-center Tvis-center
System1 : 2438 914 2 2.567 0.353 0.302 0.218
FRAME/MULLION DATA: Width OutsideProj InsideProj Cond EdgeCondRatio SolAbs VisAbs Emiss Orient'n (mull)
L Sill : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
R Sill : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
L Head : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90

R Head : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Top L Jamb : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Bot L Jamb : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Top R Jamb : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Bot R Jamb : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Mullion : None
Average frame: 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
DIVIDER DATA : Width OutsideProj InsideProj Cond EdgeCondRatio SolAbs VisAbs Emiss Type #Hor #Vert
System1 : 0.0 0.0 0.0 0.000 0.000 0.000 0.000 0.000 None 0 0
GLASS DATA : Layer# Thickness Cond Tsol Rfsol Rbsol Tvis Rfvis Rbvis Tir EmissF EmissB SpectralDataFile
System1 : 1 5.918 1.000 0.333 0.050 0.050 0.656 0.064 0.064 0.000 0.840 0.840 EVGRN6.LOF
2 9.663 0.714 0.153 0.188 0.195 0.327 0.127 0.118 0.000 0.868 0.840 CASH_Laminate.usr
GAP DATA : Gap# Thick nGasses
System1 : 1 12.70 1
GAS DATA : GasName Fraction MWeight ACond BCond CCond AVisc BVisc CVisc ASpHeat BSpHeat CSpHeat
System1 Gap1 : Air 1.0000 28.97 0.002873 7.76e-005 0 3.723e-006 4.94e-008 0 1002.74 0.012324 0
GLAZING SYSTEM OPTICAL DATA
Angle 0 10 20 30 40 50 60 70 80 90 Hemis
System1

Tsol 0.080 0.080 0.079 0.076 0.073 0.067 0.057 0.040 0.016 0.000 0.063
Abs1 0.644 0.644 0.648 0.656 0.664 0.671 0.666 0.630 0.499 0.000 0.641
Abs2 0.202 0.203 0.201 0.195 0.186 0.172 0.153 0.120 0.059 0.000 0.166
Rfsol 0.073 0.073 0.072 0.073 0.077 0.090 0.124 0.211 0.426 1.000 0.120
Rbsol 0.198 0.191 0.190 0.193 0.202 0.217 0.248 0.327 0.533 0.999 0.240
Tvis 0.218 0.218 0.214 0.208 0.200 0.186 0.159 0.112 0.047 0.000 0.174
Rfvis 0.119 0.116 0.115 0.116 0.122 0.139 0.180 0.279 0.495 1.000 0.170
Rbvis 0.125 0.118 0.116 0.119 0.129 0.147 0.181 0.269 0.494 0.999 0.172

Window5 Data File for EnergyPlus
Window 5.2a v5.2.17a
Date : Mon Jun 01 02:41:24 2009
Window name : CASH_Doors
Description : Custom Single Vision
Glazing Systems: 1
GLAZING SYSTEM DATA: Height Width nPanes Uval-center SC-center SHGC-center Tvis-center

System1 : 2438 2743 2 2.567 0.353 0.302 0.218
FRAME/MULLION DATA: Width OutsideProj InsideProj Cond EdgeCondRatio SolAbs VisAbs Emiss Orient'n (mull)
L Sill : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
R Sill : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
L Head : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
R Head : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Top L Jamb : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Bot L Jamb : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Top R Jamb : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Bot R Jamb : 57.2 25.4 25.4 500.000 1.569 0.900 0.900 0.90
Mullion : None
Average frame: 57.1 25.4 25.4 500.000 1.569 0.900 0.900 0.90
DIVIDER DATA : Width OutsideProj InsideProj Cond EdgeCondRatio SolAbs VisAbs Emiss Type #Hor #Vert
System1 : 15.9 25.4 25.4 0.185 1.321 0.900 0.900 0.900 Suspended 3 1
GLASS DATA : Layer# Thickness Cond Tsol Rfsol Rbsol Tvis Rfvis Rbvis Tir EmissF EmissB SpectralDataFile
System1 : 1 5.918 1.000 0.333 0.050 0.050 0.656 0.064 0.064 0.000 0.840 0.840 EVGRN6.LOF
2 9.663 0.714 0.153 0.188 0.195 0.327 0.127 0.118 0.000 0.868 0.840 CASH_Laminate.usr
GAP DATA : Gap# Thick nGasses
System1 : 1 12.70 1
GAS DATA : GasName Fraction MWeight ACond BCond CCond AVisc BVisc CVisc ASpHeat BSpHeat CSpHeat
System1 Gap1 : Air 1.0000 28.97 0.002873 7.76e-005 0 3.723e-006 4.94e-008 0 1002.74 0.012324 0
GLAZING SYSTEM OPTICAL DATA
Angle 0 10 20 30 40 50 60 70 80 90 Hemis
System1
Tsol 0.080 0.080 0.079 0.076 0.073 0.067 0.057 0.040 0.016 0.000 0.063
Abs1 0.644 0.644 0.648 0.656 0.664 0.671 0.666 0.630 0.499 0.000 0.641
Abs2 0.202 0.203 0.201 0.195 0.186 0.172 0.153 0.120 0.059 0.000 0.166
Rfsol 0.073 0.073 0.072 0.073 0.077 0.090 0.124 0.211 0.426 1.000 0.120
Rbsol 0.198 0.191 0.190 0.193 0.202 0.217 0.248 0.327 0.533 0.999 0.240
Tvis 0.218 0.218 0.214 0.208 0.200 0.186 0.159 0.112 0.047 0.000 0.174
Rfvis 0.119 0.116 0.115 0.116 0.122 0.139 0.180 0.279 0.495 1.000 0.170
Rbvis 0.125 0.118 0.116 0.119 0.129 0.147 0.181 0.269 0.494 0.999 0.172

The utility space at the house was not modeled as a thermal zone. This is due to the fact that the space has no mechanical equipment and it is generally well ventilated. To represent the influence of

the utility space on the house, several shading surfaces where created, thus representing the surfaces for this construction zone.

Internal Loads

The internal loads that thermally affect the zones can be divided into three categories; these are people, lighting and equipment. The internal load due to people presence was calculated by first establishing the activity level for the occupants using ASHRAE Fundamentals 2005; and secondly, an occupancy schedule was established.

For the lighting schedule an audit of all the lighting equipment in the house was performed. Using the Load Calculation Applications Manual, all the loads where established. The usage schedule associated with the lighting operation was completed by establishing the occupant's indoor activities.

The equipment loads where established using the Loads Calculation Applications Manual, the equipment manufacturer's specifications and the EnergyStar registration information. The equipment operation schedules where established from expected times of operation.

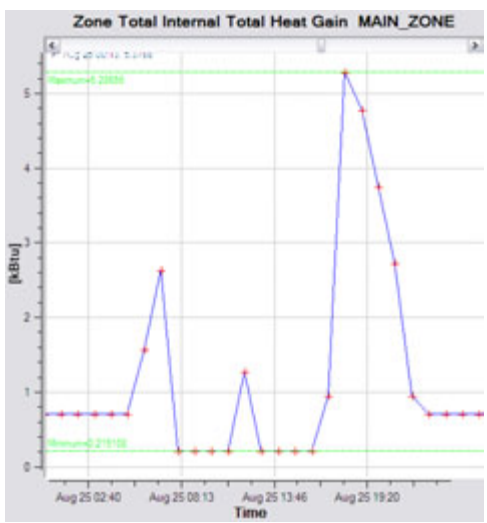


Figure 25 Internal Loads during a Typical Day

HVAC Systems

The CASH design uses an advanced HVAC system to meet the occupant's needs, while maintaining low energy consumption. The building loads are met by a conventional forced air handling unit and

a low energy radiant panel system. The radiant panel system can serve both as a hot surface and a cold surface depending on the space needs. The radiant panel surface also incorporates features to prevent the formation of condensation during high humidity periods.

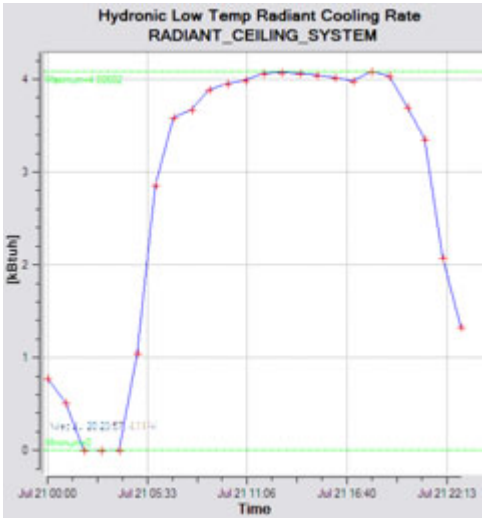


Figure 26 Radiant Ceiling Water Flow

The air handling unit is equipped with a dual purpose coil which serves for heating or cooling and a re-heat coil. When the unit is in cooling mode the cooling coil modulates to control the space humidity and the temperature. If high humidity levels are encountered the systems utilizes the re-heat coil to permit further de-humidification with the cooling coil.

During the heating season the air handling unit utilizes its main coil to provide warm air; also the unit incorporates a humidification unit to control the humidity levels in the house.

For simulation convenience, the cooling/heating coil where modeled as two separate systems with their respective water loops and plant equipment. This separation of components permitted better control over the simulation. Also the simulation has been programmed so the two systems are never operating at the same time.

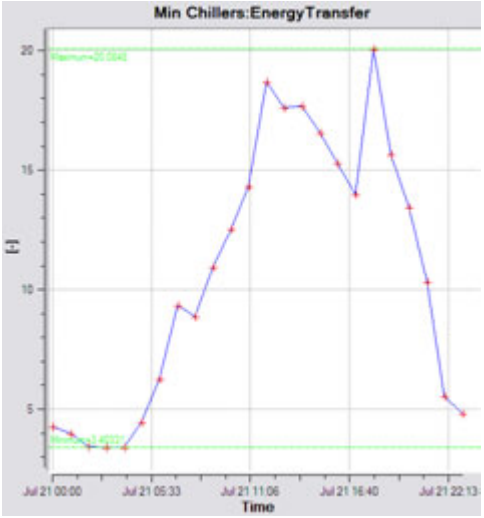


Figure 27 Chiller Cooling (MMBTU)

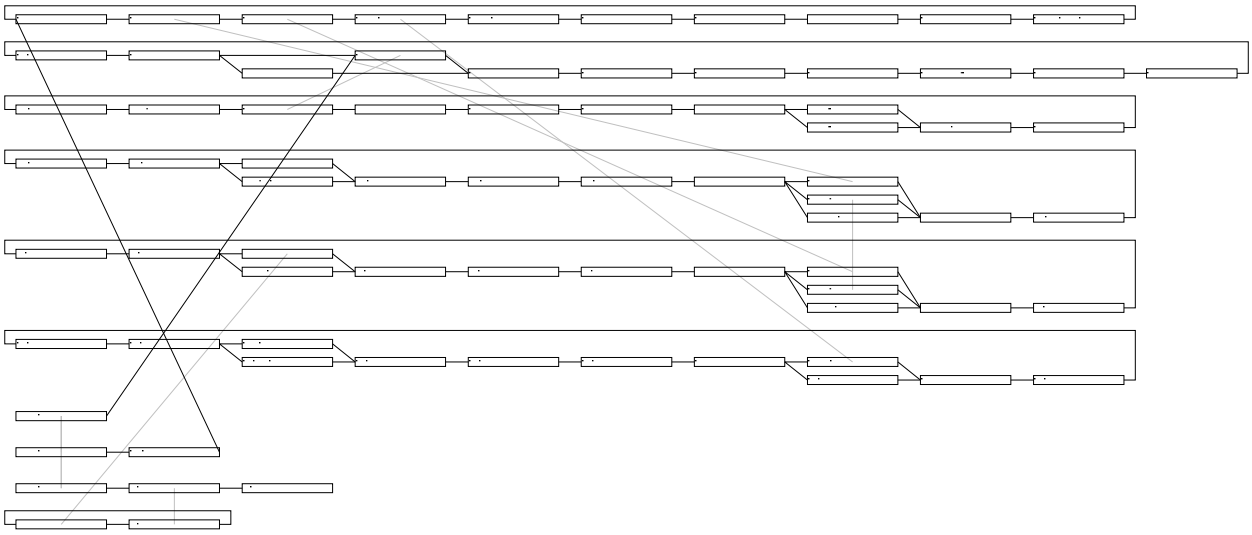


Figure 28 CASH Mechanical Systems Diagram

Potable Water Systems

The potable water systems where simulated as part of the energy simulation. This is important due to the fact that water usage has a direct impact on the house energy consumption. The energy consuming components of this system are the water heater, the potable water pump, the solar water heater circulation pump and the auxiliary water heater resistance.

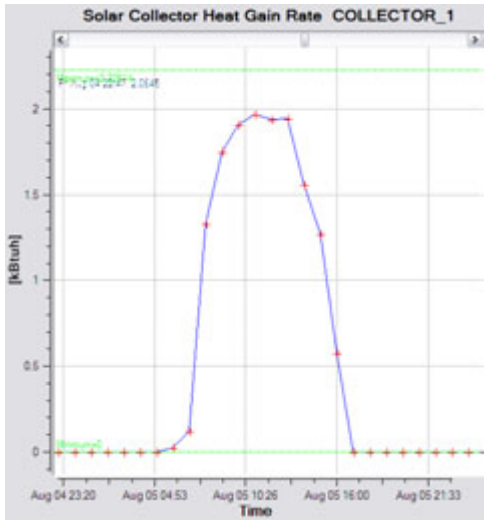


Figure 29 Collector 1 Heat Gain

The domestic water heater consumed a total of 7415.34 kWh during the year in electricity. The solar collectors contributed 1899.75 kWh in heating energy for the domestic hot water system.

Energy Generation Equipment

The CASH design incorporates the use of solar panels in the roof to provide for the house energy use. The total rated power output for the solar cells at standard Test Conditions (STC) is 10.37kW. The solar panels efficiency was modeled using the Sandia model. This model utilizes many external inputs to establish the corresponding cell efficiency. Due to the twin inverter configuration, the specific inverters could not be modeled by the software, instead constant inverter efficiency with a system de-rating was used for the simulation. The total energy produced by the solar panels for the year was 12,387kWh.

The results from the simulation indicates that if the house is placed for an entire year in Richmond, VA the PV system would generate enough power to supply 69% of the required electrical energy needs. An annual power production average graph is presented below.

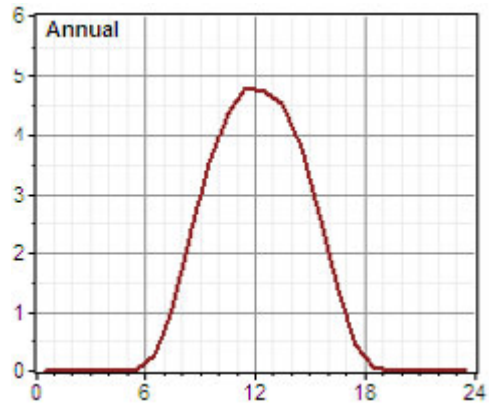


Figure 30 Power (kW) Variation for the Annual Average

SIMULATION REPORT
Table of Contents
Program Version:**EnergyPlus 3.1.0.027, 6/1/2009 6:08 PM**
Tabular Output Report in Format: **HTML**
Building: **Main_Zone_Floor**
Environment: **RICHMOND VA USA TMY2-13740 WMO#=724010**
Simulation Timestamp: **2009-06-01 18:08:38**

Table of Contents
Report: **AnnualBuildingUtilityPerformanceSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**
Values gathered over 8760.00 hours

Site and Source Energy

	Total Energy [kWh]	Energy Per Total Building Area [kWh/m2]	Energy Per Conditioned Building Area [kWh/m2]
Total Site Energy	18009.98	193.67	193.67
Net Site Energy	5622.60	60.46	60.46
Total Source Energy	57037.59	613.34	613.34
Net Source Energy	17806.78	191.48	191.48

Source to Site Energy Converstion Factors

	Source=>Site Conversion Factor
Electricity	3.167
Natural Gas	1.084
District Cooling	1.056
District Heating	3.613
Steam	0.300
Gasoline	1.050
Diesel	1.050
Coal	1.050
Fuel Oil #1	1.050
Fuel Oil #2	1.050
Propane	1.050

Building Area

	Area [m2]
Total Building Area	92.99
Net Conditioned Building Area	92.99
Unconditioned Building Area	0.00

End Uses

	Electricity [kWh]	Natural Gas [kWh]	Other Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	2843.62	0.00	0.00	0.00	0.00	0.00
Cooling	1949.02	0.00	0.00	0.00	0.00	0.00
Interior Lighting	538.74	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	512.74	0.00	0.00	0.00	0.00	0.00
Interior Equipment	2531.64	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	980.50	0.00	0.00	0.00	0.00	0.00
Fans	257.82	0.00	0.00	0.00	0.00	0.00
Pumps	59.01	0.00	0.00	0.00	0.00	0.00

Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	202.05	0.00	0.00	0.00	0.00	4.59
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	8134.83	0.00	0.00	0.00	0.00	180.08
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	18009.98	0.00	0.00	0.00	0.00	184.67

Note: Electricity appears to be the principal heating source based on energy usage.

End Uses By Subcategory

	Subcategory	Electricity [kWh]	Natural Gas [kWh]	Other Fuel [kWh]	District Cooling [kWh]	District Heating [kWh]	Water [m3]
Heating	Boiler	2843.62	0.00	0.00	0.00	0.00	0.00
	Boiler Parasitic	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	General	1949.02	0.00	0.00	0.00	0.00	0.00
Interior Lighting	General	538.74	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	General	512.74	0.00	0.00	0.00	0.00	0.00
Interior Equipment	General	2531.64	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	General	980.50	0.00	0.00	0.00	0.00	0.00
Fans	General	257.82	0.00	0.00	0.00	0.00	0.00
Pumps	General	59.01	0.00	0.00	0.00	0.00	0.00
Heat Rejection	General	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	General	202.05	0.00	0.00	0.00	0.00	4.59
Heat Recovery	General	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	Bathroom	0.00	0.00	0.00	0.00	0.00	124.83
	Kitchen	0.00	0.00	0.00	0.00	0.00	12.09
	General	403.11	0.00	0.00	0.00	0.00	43.16
	Water Heater	7475.46	0.00	0.00	0.00	0.00	0.00

	Water Heater Parasitic	0.00	0.00	0.00	0.00	0.00	0.00
	Other	256.26	0.00	0.00	0.00	0.00	0.00
Refrigeration	General	0.00	0.00	0.00	0.00	0.00	0.00
Generators	General	0.00	0.00	0.00	0.00	0.00	0.00

Normalized Metrics
Utility Use Per Conditioned Floor Area

	Electricity Intensity [kWh/m2]	Natural Gas Intensity [kWh/m2]	Other Fuel Intensity [kWh/m2]	District Cooling Intensity [kWh/m2]	District Heating Intensity [kWh/m2]	Water Intensity [m3/m2]
Lighting	11.31	0.00	0.00	0.00	0.00	0.00
HVAC	144.59	0.00	0.00	0.00	0.00	1.99
Other	37.77	0.00	0.00	0.00	0.00	0.00
Total	193.67	0.00	0.00	0.00	0.00	1.99

Utility Use Per Total Floor Area

	Electricity Intensity [kWh/m2]	Natural Gas Intensity [kWh/m2]	Other Fuel Intensity [kWh/m2]	District Cooling Intensity [kWh/m2]	District Heating Intensity [kWh/m2]	Water Intensity [m3/m2]
Lighting	11.31	0.00	0.00	0.00	0.00	0.00
HVAC	144.59	0.00	0.00	0.00	0.00	1.99
Other	37.77	0.00	0.00	0.00	0.00	0.00
Total	193.67	0.00	0.00	0.00	0.00	1.99

Electric Loads Satisfied

	Electricity [kWh]	Percent Electricity [%]
Fuel-Fired Power Generation	0.00	0.00
High Temperature Geothermal*	0.00	0.00
Photovoltaic Power	12387.37	68.78
Wind Power*	0.00	0.00
Net Decrease in On-Site Storage	0.00	0.00
Total On-Site Electric Sources	12387.37	68.78

Electricity Coming From Utility	13335.02	74.04
Surplus Electricity Going To Utility	7712.42	42.82
Net Electricity From Utility	5622.60	31.22
Total On-Site and Utility Electric Sources	18009.98	100.00
Total Electricity End Uses	18009.98	100.00

On-Site Thermal Sources

	Heat [kWh]	Percent Heat [%]
Water-Side Heat Recovery	0.00	0.00
Air to Air Heat Recovery for Cooling	0.00	0.00
Air to Air Heat Recovery for Heating	0.00	0.00
High-Temperature Geothermal*	0.00	0.00
Solar Water Thermal	1899.75	100.00
Solar Air Thermal	0.00	0.00
Total On-Site Thermal Sources	1899.75	100.00

Water Source Summary

	Water [m3]	Percent Water [%]
Rainwater Collection	0.00	0.00
Condensate Collection	0.00	0.00
Groundwater Well	0.00	0.00
Total On Site Water Sources	0.00	0.00
-	-	-
Initial Storage	0.00	0.00
Final Storage	0.00	0.00
Change in Storage	0.00	0.00
-	-	-
Water Supplied by Utility	184.67	100.00
-	-	-

Total On Site, Change in Storage, and Utility Water Sources	184.67	100.00
Total Water End Uses	184.67	100.00

Comfort and Setpoint Not Met Summary

	Facility [Hours]
Time Set Point Not Met During Occupied Heating	1647.58
Time Set Point Not Met During Occupied Cooling	2938.33
Time Not Comfortable Based on Simple ASHRAE 55-2004	1108.67

Note 1: An asterisk (*) indicates that the feature is not yet implemented.

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Top
Annual Building Utility Performance Summary
Input Verification and Results Summary
Demand End Use Components Summary
Component Sizing Summary
Surface Shadowing Summary
ClimaticDataSummary
EnvelopeSummary
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HVACSizingSummary
SystemSummary
OutdoorAirSummary
ObjectCountSummary
Tariff Report
| AEE |
Economics Results Summary Report
| Entire Facility |

Table of Contents
Report: **InputVerificationandResultsSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

General

	Value
Program Version and Build	EnergyPlus 3.1.0.027, 6/1/2009 6:08 PM
Weather	RICHMOND VA USA TMY2-13740 WMO#=724010

Latitude [deg]	37.50
Longitude [deg]	-77.3
Elevation [m]	50.00
Time Zone	-5.0
North Axis Angle [deg]	0.00
Rotation for Appendix G [deg]	0.00
Hours Simulated [hrs]	8760.00

ENVELOPE

Window-Wall Ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)
Gross Wall Area [m2]	92.20	33.02	13.08	33.02	13.08
Window Opening Area [m2]	32.83	17.21	0.58	15.04	0.00
Window-Wall Ratio [%]	35.61	52.13	4.44	45.54	0.00

Skylight-Roof Ratio

	Total
Gross Roof Area [m2]	46.50
Skylight Area [m2]	0.00
Skylight-Roof Ratio [%]	0.00

PERFORMANCE

Zone Summary

	Area [m2]	Conditioned (Y/N)	Volume [m3]	Multipliers	Gross Wall Area [m2]	Window Glass Area [m2]	Lighting [W/m2]	People [m2] per person	Plug and Process [W/m2]

MAIN_ZONE	46.50	Yes	120.47	1.00	78.37	29.37	7.2649	23.25	84.8652
MAIN_ZONE_PLENNUM	46.50	Yes	21.26	1.00	13.83	0.00	0.6710		0.0000
Total	92.99		141.72		92.20	29.37	3.9680	46.50	42.4326
Conditioned Total	92.99		141.72		92.20	29.37	3.9680	46.50	42.4326
Unconditioned Total	0.00		0.00		0.00	0.00			

Table of Contents
Report: **DemandEndUseComponentsSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

End Uses

	Electricity [W]	Natural Gas [W]	Propane [W]	District Cooling [W]	Steam [W]	Water [m3/s]
Time of Peak	15-FEB-19:49	-	-	-	-	-
Heating	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	0.00	0.00	0.00	0.00	0.00	0.00
Interior Lighting	369.00	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	288.69	0.00	0.00	0.00	0.00	0.00
Interior Equipment	1246.00	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	6480.00	0.00	0.00	0.00	0.00	0.00
Fans	3.18	0.00	0.00	0.00	0.00	0.00
Pumps	7.30	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	28.09	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	9860.71	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00

Total End Uses	18282.98	0.00	0.00	0.00	0.00	0.00

End Uses By Subcategory

	Subcategory	Electricity [W]	Natural Gas [W]	Propane [W]	District Cooling [W]	Steam [W]	Water [m3/s]
Heating	Boiler	0.00	0.00	0.00	0.00	0.00	0.00
	Boiler Parasitic	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	General	0.00	0.00	0.00	0.00	0.00	0.00
Interior Lighting	General	369.00	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	General	288.69	0.00	0.00	0.00	0.00	0.00
Interior Equipment	General	1246.00	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	General	6480.00	0.00	0.00	0.00	0.00	0.00
Fans	General	3.18	0.00	0.00	0.00	0.00	0.00
Pumps	General	7.30	0.00	0.00	0.00	0.00	0.00
Heat Rejection	General	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	General	28.09	0.00	0.00	0.00	0.00	0.00
Heat Recovery	General	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	Bathroom	0.00	0.00	0.00	0.00	0.00	0.00
	Kitchen	0.00	0.00	0.00	0.00	0.00	0.00
	General	4318.18	0.00	0.00	0.00	0.00	0.00
	Water Heater	5542.53	0.00	0.00	0.00	0.00	0.00
	Water Heater Parasitic	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	General	0.00	0.00	0.00	0.00	0.00	0.00
Generators	General	0.00	0.00	0.00	0.00	0.00	0.00

Table of Contents
Report: **ClimaticDataSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

SizingPeriod:DesignDay

	Maximum Dry Bulb [C]	Daily Temperature Range [C]	Humidity Value	Humidity Type	Wind Speed [m/s]	Wind Direction
RICHMOND ANN HTG 99% CONDNS DB	-7.00	0.00	-7.00	WETBULB	3.10	0.00
RICHMOND ANN CLG 1% CONDNS DB=>MWB	33.40	10.60	24.20	WETBULB	4.50	230.00

Weather Statistics File

	Value
Reference	USA_VA_Richmond_TMY2
Site:Location	RICHMOND VA USA
Latitude	N 37° 30'
Longitude	W 77° 19'
Time Zone	GMT -5.0 Hours
Elevation	50m above sea level
Standard Pressure at Elevation	100726Pa
Data Source	TMY2-13740
WMO Station	724010
Design Conditions	Climate Design Data 2005 ASHRAE Handbook
Heating Design Temperature 99.6% (C)	-9.6
Heating Design Temperature 99% (C)	-7
Cooling Design Temperature 0.4% (C)	34.8
Cooling Design Temperature 1% (C)	33.4
Cooling Design Temperature 2% (C)	32
Maximum Dry Bulb Temperature (C)	34.4°

Maximum Dry Bulb Occurs on	Jun 24
Minimum Dry Bulb Temperature (C)	-16.1°
Minimum Dry Bulb Occurs on	Jan 17
Maximum Dew Point Temperature (C)	25.6
Maximum Dew Point Occurs on	Jul 28
Minimum Dew Point Temperature (C)	-21.1
Minimum Dew Point Occurs on	Feb 1
Heating Degree-Days (base 10°C)	806
Cooling Degree-Days (base 18°C)	744
Köppen Classification	Cfa
Köppen Description	Humid subtropical (mild with no dry season, hot summer, lat. 20-35°N)
Köppen Recommendation	
ASHRAE Climate Zone	4A
ASHRAE Description	Mixed-Humid

Table of Contents
Report: **EnvelopeSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Opaque Exterior

	Construction	Reflectance	U-Factor with Film [W/m2-K]	U-Factor no Film [W/m2-K]	Gross Area [m2]	Azimuth [deg]	Tilt [deg]	Cardinal Direction
92D24C	WALL	0.30	0.135	0.14	19.12	180.00	90.00	S
497374	WALL	0.30	0.135	0.14	28.07	0.00	90.00	N
8CBF15	WALL	0.30	0.135	0.14	11.12	270.00	90.00	W
831A72	WALL	0.30	0.135	0.14	11.12	90.00	90.00	E
F16389	WALL	0.30	0.135	0.14	8.95	180.00	90.00	S

MAIN_ZONE_FLOOR	FLOOR	0.30	0.111	0.11	46.50	180.00	180.00	
5366BE	WALL	0.30	0.135	0.14	3.37	180.00	90.00	S
8599DB	WALL	0.30	0.135	0.14	1.58	180.00	90.00	S
AE1D0B	WALL	0.30	0.135	0.14	1.96	90.00	90.00	E
9D3363	WALL	0.30	0.135	0.14	4.95	0.00	90.00	N
BC4C10	WALL	0.30	0.135	0.14	1.96	270.00	90.00	W
2C8BEA	MAIN_ROOF	0.70	0.178	0.18	46.50	180.00	0.00	

Fenestration

	Construction	Area of One Opening [m2]	Area of Openings [m2]	U-Factor [W/m2-K]	SHGC	Visible Transmittance	Shade Control	Parent Surface	Azimuth [deg]	Cardinal Direction
DFA23F	CASH_DOORS	7.29	7.29	2.64	0.295	0.217	Yes	92D24C	180.00	S
B3E594	WINDOW_UNIT	0.84	0.84	5.78	0.819	0.881	No	92D24C	180.00	S
A757D5	CASH_DOOR_A757D5	2.63	2.63	2.64	0.295	0.217	No	497374	0.00	N
882329	CASH_DOORS	7.29	7.29	2.64	0.295	0.217	Yes	497374	0.00	N
C7BE21	CASH_DOORS	7.29	7.29	2.64	0.295	0.217	Yes	497374	0.00	N
BAFCE7	WINDOW_UNIT	0.58	0.58	5.78	0.819	0.881	No	831A72	90.00	E
F12345	CASH_DOORS	6.90	6.90	2.64	0.295	0.217	No	F1638 9	180.00	S
Total or Average			32.83	2.78	0.318	0.246				
North Total or Average			17.21	2.64	0.295	0.217				

Non-North Total or Average			15.62	2.93	0.342	0.277				

Table of Contents
Report: **ShadingSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Sunlit Fraction

	March 21 9am	March 21 noon	March 21 3pm	June 21 9am	June 21 noon	June 21 3pm	December 21 9am	December 21 noon	December 21 3pm
DFA23F	0.41	1.00	1.00	0.00	0.80	0.66	0.09	1.00	1.00
B3E594	0.00	0.98	1.00	0.00	1.00	1.00	0.00	0.96	1.00
A757D5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
882329	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.00
C7BE21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BAFCE7	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
F12345	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Window Control

	Name	Type	Shaded Construction	Control	Glare Control
DFA23F	SCREEN_1	Exterior Blind		AlwaysOn	No
882329	SCREEN_1	Exterior Blind		AlwaysOn	No
C7BE21	SCREEN_1	Exterior Blind		AlwaysOn	No

Table of Contents
Report: **LightingSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Interior Lighting

	Zone	Lighting Power Density [W/m2]	Zone Area [m2]	Total Power [W]	End Use Subcategory	Schedule Name	Average Hours/Week [hr]	Return Air Fraction	Conditioned (Y/N)
MAIN_A_B_C	MAIN_ZONE	5.3121	46.50	247.00	General	LIGHTS_USE_MAIN	0.00	0.0000	Y
MAIN_D	MAIN_ZONE	1.5657	46.50	72.80	General	LIGHTS_USE_MAIN	0.00	0.0000	Y
MAIN_F	MAIN_ZONE	0.3871	46.50	18.00	General	LIGHTS_USE_MAIN	0.00	0.0000	Y
MAIN_D_PLENNUM	MAIN_ZONE_PLENNUM	0.6710	46.50	31.20	General	LIGHTS_USE_MAIN	0.00	0.0000	Y
Interior Lighting Total		1.9840	185.99	369.00					

Daylighting

	Zone	Daylighting Type	Control Type	Fraction Controlled	Lighting Installed in Zone [W]	Lighting Controlled [W]
None						

Exterior Lighting

	Total Watts	Astronomical Clock/Schedule	Schedule Name	Average Annual Hours/Week
H_LIGHTS	29.19	AstronomicalClock	EXTERIOR_LIGHTS	98.00
J_LIGHTS	200.00	AstronomicalClock	EXTERIOR_LIGHTS	98.00
L_LIGHTS	59.50	AstronomicalClock	EXTERIOR_LIGHTS	98.00
Exterior Lighting Total	288.69			

Table of Contents
Report: **EquipmentSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Central Plant

	Type	Nominal Capacity [W]	Nominal Efficiency [W/W]
TEST_CHILLER	Chiller:ConstantCOP	7200.00	4.56
BOILER_RHC	Boiler:HotWater	1549.82	1.00

Cooling Coils

	Type	Nominal Total Capacity [W]	Nominal Sensible Capacity [W]	Nominal Latent Capacity [W]	Nominal Sensible Heat Ratio	Nominal Efficiency [W/W]
MAIN_AHU_CC	Coil:Cooling:Water	4468.49	-	-	-	-

Heating Coils

	Type	Nominal Total Capacity [W]	Nominal Efficiency [W/W]
MAIN_AHU_HC	Coil:Heating:Water	5487.10	-
MAIN_AHU_RHC	Coil:Heating:Water	1549.82	-
HP_EVAPORATOR	Coil:WaterHeating:AirToWaterHeatPump	3552.24	3.18

Fans

	Type	Total Efficiency [W/W]	Delta Pressure [pa]	Max Flow Rate [m3/s]	Rated Power [W]	Motor Heat In Air Fraction	End Use
KITCHEN_EXHAUST_FAN	Fan:ZoneExhaust	0.70	62.27	0.01	1.26	1.00	General
MAIN_AHU_FAN	Fan:VariableVolume	0.70	498.18	0.21	147.80	1.00	General
HP_FAN	Fan:OnOff	0.85	169.00	0.25	50.35	1.00	General

Pumps

	Type	Control	Head [pa]	Power [W]	Motor Efficiency [W/W]
PWS_PUMP	Pump:VariableSpeed	INTERMITTENT	45000.00	6.09	0.90
SWH_PUMP	Pump:VariableSpeed	INTERMITTENT	45000.00	1.28	0.90
CHW_PUMP	Pump:VariableSpeed	INTERMITTENT	49000.00	18.00	0.90
HW_PUMP	Pump:VariableSpeed	INTERMITTENT	45000.00	18.00	0.90

RHC_PUMP	Pump:VariableSpeed	INTERMITTENT	45000.00	4.60	0.90

Service Water Heating

	Type	Storage Volume [m3]	Input [W]	Thermal Efficiency [W/W]	Recovery Efficiency [W/W]	Energy Factor
PWS_WH	WaterHeater:Stratified	0.45	4500.00	0.99	4.69	3.71
HEAT_PUMP	WaterHeater:HeatPump	0.30	5030.00	0.99	3.37	3.37

Table of Contents
Report: **HVACSizingSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Zone Cooling

	Design Load [W]	Calculated Design Air Flow [m3/s]	User Design Air Flow [m3/s]	Design Day Name	Date/Time Of Peak	Temperature at Peak [C]	Humidity Ratio at Peak [kgWater/kgAir]
None							

Zone Heating

	Design Load [W]	Calculated Design Air Flow [m3/s]	User Design Air Flow [m3/s]	Design Day Name	Date/Time Of Peak	Temperature at Peak [C]	Humidity Ratio at Peak [kgWater/kgAir]
None							

System Design Air Flow Rates

	Calculated cooling [m3/s]	User cooling [m3/s]	Calculated heating [m3/s]	User heating [m3/s]
None				

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Report: **SystemSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Economizer

	High Limit Shutoff Control	Minimum Outdoor Air [m3/s]	Maximum Outdoor Air [m3/s]	Return Air Temp Limit	Return Air Enthalpy Limit	Outdoor Air Temperature Limit [C]	Outdoor Air Enthalpy Limit [C]
None							

Demand Controlled Ventilation using Controller:MechanicalVentilation

	Controller:MechanicalVentilation Name	Outdoor Air Per Person [m3/s-person]	Outdoor Air Per Area [m3/s-m2]	Air Distribution Effectiveness in Cooling Mode	Air Distribution Effectiveness in Heating Mode	Air Distribution Effectiveness Schedule
None						

Time Not Comfortable Based on Simple ASHRAE 55-2004

	Winter Clothes [hr]	Summer Clothes [hr]	Summer or Winter Clothes [hr]
MAIN_ZONE	1389.50	6084.25	1108.67
MAIN_ZONE_PLENNUM	0.00	0.00	0.00
Facility	1389.50	6084.25	1108.67

Aggregated over the RunPeriods for Weather

Time Setpoint Not Met

	During Heating [hr]	During Cooling [hr]	During Occupied Heating [hr]	During Occupied Cooling [hr]
MAIN_ZONE	2067.75	4216.00	1647.58	2938.33
MAIN_ZONE_PLENNUM	0.00	0.00	0.00	0.00
Facility	2067.75	4216.00	1647.58	2938.33

Aggregated over the RunPeriods for Weather

Table of Contents
Report: **OutdoorAirSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Average Outdoor Air During Occupied Hours

	Average Number of Occupants	Nominal Number of Occupants	Zone Volume [m3]	Mechanical Ventilation [ach]	Infiltration [ach]	Simple Ventilation [ach]
MAIN_ZONE	2.00	2.00	120.47	0.538	0.938	0.000

Minimum Outdoor Air During Occupied Hours

	Average Number of Occupants	Nominal Number of Occupants	Zone Volume [m3]	Mechanical Ventilation [ach]	Infiltration [ach]	Simple Ventilation [ach]
MAIN_ZONE	2.00	2.00	120.47	0.035	0.001	0.000

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Report: **ObjectCountSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Surfaces by Class

	Total	Outdoors
Wall	10	10
Floor	2	1
Roof	2	1
Internal Mass	0	0
Building Detached Shading	32	32
Fixed Detached Shading	0	0
Window	7	7
Door	0	0
Glass Door	0	0
Shading	0	0
Overhang	0	0
Fin	0	0
Tubular Daylighting Device Dome	0	0
Tubular Daylighting Device Diffuser	0	0

HVAC

	Count
HVAC Air Loops	1
Conditioned Zones	2
Unconditioned Zones	0
Supply Plenums	0

Return Plenums	1

Input Fields

	Count
IDF Objects	387
Defaulted Fields	48
Fields with Defaults	811
Autosized Fields	1
Autosizable Fields	100
Autocalculated Fields	22
Autocalculatable Fields	68

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Report: **ComponentSizingSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

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Report: **SurfaceShadowingSummary**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Surfaces (Walls, Roofs, etc) that may be Shadowed by Other Surfaces

	Possible Shadow Casters
COLLECTOR_1	PV_1 | Mir-PV_1 | PV_2 |
Mir-COLLECTOR_1	PV_1 | Mir-PV_1 | PV_2 | PV_3 | PV_4 | PV_5 | PV_6 | PV_7 | PV_ADD | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | COLLECTOR_2 | 92D24C | 5366BE | 2C8BEA |
PV_2	Mir-PV_1 | COLLECTOR_1_HEAD | Mir-COLLECTOR_1_HEAD | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | COLLECTOR_1 | Mir-COLLECTOR_1 |
PV_3	Mir-PV_1 | Mir-PV_2 | Mir-PV_4 | Mir-COLLECTOR_1_HEAD | Mir-COLLECTOR_2_HEAD | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | Mir-COLLECTOR_1 | Mir-COLLECTOR_2 |
PV_4	Mir-PV_1 | Mir-PV_2 | Mir-COLLECTOR_1_HEAD | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | Mir-COLLECTOR_1 | COLLECTOR_2 | Mir-COLLECTOR_2 |

PV_5	Mir-PV_1 | Mir-PV_2 | Mir-PV_3 | Mir-PV_4 | PV_ADD | Mir-PV_ADD | Mir-COLLECTOR_1_HEAD | Mir-COLLECTOR_2_HEAD | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | Mir-COLLECTOR_1 | Mir-COLLECTOR_2 | 2C8BEA |
PV_6	Mir-PV_1 | Mir-PV_2 | Mir-PV_3 | Mir-PV_4 | Mir-PV_5 | Mir-PV_7 | Mir-PV_ADD | Mir-COLLECTOR_1_HEAD | Mir-COLLECTOR_2_HEAD | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | Mir-COLLECTOR_1 | Mir-COLLECTOR_2 | 2C8BEA |
PV_7	Mir-PV_1 | Mir-PV_2 | Mir-PV_3 | Mir-PV_4 | Mir-PV_5 | PV_ADD | Mir-PV_ADD | Mir-COLLECTOR_1_HEAD | Mir-COLLECTOR_2_HEAD | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | Mir-COLLECTOR_1 | Mir-COLLECTOR_2 | 2C8BEA |
PV_ADD	Mir-PV_1 | Mir-PV_2 | Mir-PV_3 | Mir-PV_4 | PV_5 | PV_7 | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | Mir-COLLECTOR_1 | Mir-COLLECTOR_2 |
COLLECTOR_1_HEAD	Mir-PV_1 | PV_2 |
Mir-COLLECTOR_1_HEAD	Mir-PV_1 | PV_2 | PV_3 | PV_4 | PV_5 | PV_6 | PV_7 | PV_ADD | COLLECTOR_2_HEAD | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | COLLECTOR_2 | 92D24C | 5366BE | 2C8BEA |
COLLECTOR_2_HEAD	Mir-PV_1 | Mir-PV_2 | Mir-PV_4 | Mir-COLLECTOR_1_HEAD | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | Mir-COLLECTOR_1 |
COLLECTOR_2	Mir-PV_1 | Mir-PV_2 | PV_4 | Mir-PV_4 | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | Mir-COLLECTOR_1 |
Mir-PV_1	PV_2 | PV_3 | PV_4 | PV_5 | PV_6 | PV_7 | PV_ADD | COLLECTOR_1_HEAD | Mir-COLLECTOR_1_HEAD | COLLECTOR_2_HEAD | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | COLLECTOR_1 | Mir-COLLECTOR_1 | COLLECTOR_2 | 92D24C | 5366BE | 2C8BEA |
Mir-PV_2	PV_3 | PV_4 | PV_5 | PV_6 | PV_7 | PV_ADD | COLLECTOR_2_HEAD | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | COLLECTOR_2 | 92D24C | 5366BE | 2C8BEA |
Mir-PV_4	PV_3 | PV_5 | PV_6 | PV_7 | PV_ADD | COLLECTOR_2_HEAD | Mir-COLLECTOR_2_HEAD | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | COLLECTOR_2 | Mir-COLLECTOR_2 | 92D24C | 5366BE | 2C8BEA |
Mir-COLLECTOR_2_HEAD	PV_3 | Mir-PV_4 | PV_5 | PV_6 | PV_7 | PV_ADD | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | 92D24C | 5366BE | 2C8BEA |
Mir-COLLECTOR_2	PV_3 | PV_4 | Mir-PV_4 | PV_5 | PV_6 | PV_7 | PV_ADD | UTILITY_WALL_1

	| Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | 92D24C | 5366BE | 2C8BEA |
Mir-PV_3	PV_5 | PV_6 | PV_7 | PV_ADD | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | 92D24C | 5366BE | 2C8BEA |
Mir-PV_ADD	PV_5 | PV_6 | PV_7 | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | 92D24C | 5366BE | 2C8BEA |
Mir-PV_5	PV_6 | PV_7 | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_3 | 2C8BEA |
Mir-PV_7	PV_6 | UTILITY_WALL_1 | Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_3 | 2C8BEA |
92D24C	UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 |
5366BE	UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 |
PV_1	Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | UTILITY_ROOF | COLLECTOR_1 | Mir-COLLECTOR_1 |
Mir-UTILITY_WALL_2	Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_3 | 92D24C | 5366BE |
Mir-UTILITY_WALL_3	Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | 92D24C | 5366BE |
Mir-UTILITY_ROOF	Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 | 92D24C | 5366BE |
F16389	Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 |
8599DB	Mir-UTILITY_WALL_1 | Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 |
Mir-UTILITY_WALL_1	Mir-UTILITY_WALL_2 | Mir-UTILITY_WALL_3 |
UTILITY_WALL_1	92D24C | 5366BE |
Mir-PV_6	497374 | 9D3363 | 2C8BEA |

Subsurfaces (Windows and Doors) that may be Shadowed by Surfaces

	Possible Shadow Casters
DFA23F	92D24C |
B3E594	92D24C |
A757D5	497374 |
882329	497374 |
C7BE21	497374 |
BAFCE7	831A72 |

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Report: **Economics Results Summary Report**
For: **Entire Facility**
Timestamp: **2009-06-01 18:08:38**

Annual Cost

	Electric	Gas	Other	Total
Cost ($)	1236.06	0.00	0.00	1236.06
Cost per Total Building Area ($/m2)	13.29	0.00	0.00	13.29
Cost per Net Conditioned Building Area ($/m2)	13.29	0.00	0.00	13.29

Tariff Summary

	Selected	Qualified	Meter	Buy or Sell	Group	Annual Cost ($)
AEE	Yes	Yes	ELECTRICITYNET:FACILITY	Net	(none)	1236.06

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Report: **Tariff Report**
For: **AEE**
Timestamp: **2009-06-01 18:08:38**

	Parameter
Meter	ELECTRICITYNET:FACILITY
Selected	Yes
Group	(none)
Qualified	Yes
Disqualifier	n/a
Computation	automatic
Units	kWh

Categories

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Max
EnergyCharges ($)	348.52	217.03	97.82	-35.9	-44.8	20.83	59.20	28.93	-10.4	7.13	135.10	285.50	1108.95	348.52
DemandCharges ($)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ServiceCharges ($)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	36.00	3.00
Basis ($)	351.52	220.03	100.82	-32.9	-41.8	23.83	62.20	31.93	-7.4	10.13	138.10	288.50	1144.95	351.52
Adjustment ($)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Surcharge ($)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtotal ($)	351.52	220.03	100.82	-32.9	-41.8	23.83	62.20	31.93	-7.4	10.13	138.10	288.50	1144.95	351.52
Taxes ($)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total ($)	351.52	220.03	100.82	3.00	3.00	23.83	62.20	31.93	3.00	10.13	138.10	288.50	1236.06	351.52

Charges

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Max	Category
ENERGYADJUSTMENT ($)	263.76	165.00	75.45	-27.9	-34.7	16.15	45.89	22.43	-8.1	5.52	103.46	216.42	843.46	263.76	EnergyCharges
ENERGYCHARGE ($)	84.76	52.03	22.37	-8.1	-10.1	4.68	13.31	6.50	-2.3	1.60	31.64	69.07	265.49	84.76	EnergyCharges

Corresponding Sources for Charges

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Max
TotalEnergy	1758.43	1099.98	503.02	-185.7	-231.3	107.66	305.96	149.51	-53.9	36.83	689.72	1442.83	5623.05	1758.43

Ratchets

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Max

Qualifies

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Max

Native Variables

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Max
TotalEnergy	1758.43	1099.98	503.02	-185.7	-231.3	107.66	305.96	149.51	-53.9	36.83	689.72	1442.83	5623.05	1758.43
TotalDemand	13.62	13.92	11.82	10.62	10.80	10.83	10.77	10.77	10.74	12.68	11.81	12.59	140.96	13.92
PeakEnergy	1758.43	1099.98	503.02	-185.7	-231.3	107.66	305.96	149.51	-53.9	36.83	689.72	1442.83	5623.05	1758.43
PeakDemand	13.62	13.92	11.82	10.62	10.80	10.83	10.77	10.77	10.74	12.68	11.81	12.59	140.96	13.92
ShoulderEnergy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ShoulderDemand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OffPeakEnergy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OffPeakDemand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MidPeakEnergy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MidPeakDemand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PeakExceedsOffPeak	13.62	13.92	11.82	10.62	10.80	10.83	10.77	10.77	10.74	12.68	11.81	12.59	140.96	13.92
OffPeakExceedsPeak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PeakExceedsMidPeak	13.62	13.92	11.82	10.62	10.80	10.83	10.77	10.77	10.74	12.68	11.81	12.59	140.96	13.92
MidPeakExceedsPeak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PeakExceedsShoulder	13.62	13.92	11.82	10.62	10.80	10.83	10.77	10.77	10.74	12.68	11.81	12.59	140.96	13.92
ShoulderExceedsPeak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

IsWinter	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	12.00	1.00
IsNotWinter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IsSpring	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IsNotSpring	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	12.00	1.00
IsSummer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IsNotSummer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	12.00	1.00
IsAutumn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IsNotAutumn	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	12.00	1.00
PeakAndShoulderEnergy	1758.43	1099.98	503.02	-185.7	-231.3	107.66	305.96	149.51	-53.9	36.83	689.72	1442.83	5623.05	1758.43
PeakAndShoulderDemand	13.62	13.92	11.82	10.62	10.80	10.83	10.77	10.77	10.74	12.68	11.81	12.59	140.96	13.92
PeakAndMidPeakEnergy	1758.43	1099.98	503.02	-185.7	-231.3	107.66	305.96	149.51	-53.9	36.83	689.72	1442.83	5623.05	1758.43
PeakAndMidPeakDemand	13.62	13.92	11.82	10.62	10.80	10.83	10.77	10.77	10.74	12.68	11.81	12.59	140.96	13.92
ShoulderAndOffPeakEnergy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ShoulderAndOffPeakDemand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PeakAndOffPeakEnergy	1758.43	1099.98	503.02	-185.7	-231.3	107.66	305.96	149.51	-53.9	36.83	689.72	1442.83	5623.05	1758.43
PeakAndOffPeakDemand	13.62	13.92	11.82	10.62	10.80	10.83	10.77	10.77	10.74	12.68	11.81	12.59	140.96	13.92
RealTimePriceCosts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AboveCustomerBa	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.00

seCosts				0	0				0	0				
BelowCustomerBaseCosts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AboveCustomerBaseEnergy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BelowCustomerBaseEnergy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Other Variables

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Max
NotIncluded	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Computation - Automatic

ENERGYADJUSTMENT FROM TotalEnergy

ENERGYCHARGE FROM TotalEnergy

EnergyCharges SUM ENERGYADJUSTMENT ENERGYCHARGE

Basis SUM EnergyCharges DemandCharges ServiceCharges

Subtotal SUM Basis Adjustment Surcharge

Total SUM Subtotal Taxes

APPENDIX

SCHEMATIC PV SYSTEM DESIGN SD 2009

Amount of PV panels	34
Watts Capacity per PV Panel	305
Size for the system (kW DC)	10.4
Daily KWh AC (estimated) (= system capacity X 5.3 hours of sun per day X .80 efficiency)	41.9
Daily Estaimated use (kWh per day)	33
% savings with this system (= solar energy / actual use in kWh)	129%
Required area for this system	622

COMPARISON BETWEEN SD2007 AND2009

We also did a comparison between our system for the SD2007 event and the one we are proposing for 2009.

For 2007 we had a system with the following characteristics:

Thirty five (35) 215 W panels that totaled 7.5 kW system capacity with batteries. The panels were tilted at 18 degrees (4.1 kWh / meter insolation factor) for an estimated daily net output of 21.8kWh.

For 2009, we have estimated the following:

Twenty nine (29) 305W panels = 8.8kW capacity, tilted at 46 degrees (4.8 kWh / meter insolation factor) = 33.5kWh / day net estimated, plus five (5) 305W panels = 1.5kW capacity, tilted at 8 degrees (3.5 kWh / meter insolation factor) = 4.2kWh / day net estimate. This totals:

34 panels
10.4kW capacity (increase of 39% compared to 2007)
37.7kWh / day net (increase of 73% compared to 2007)

SUNPOWER

BENEFITS

Highest Efficiency
Panel efficiency of 18.7% is higher than any commercially available competitor panel

More Power
SunPower 305 delivers 50% more power per unit area than conventional solar panels and 100% more than thin film solar panels

Reduces Installation Cost
More power per panel means fewer panels per install. This saves both time and money

Reliable and Robust Design
Proven materials, tempered front glass, and a sturdy anodized frame allow panel to operate reliably in multiple mounting configurations

SPR-305-WHT

305 SOLAR PANEL

EXCEPTIONAL EFFICIENCY AND PERFORMANCE

The SunPower 305 Solar Panel provides today's highest efficiency and performance. Utilizing 96 next generation SunPower all-back contact solar cells, the SunPower 305 delivers an unprecedented total panel conversion efficiency of 18.7%. The 305 panel's reduced voltage-temperature coefficient and exceptional low-light performance attributes provide outstanding energy delivery per peak power watt.

SunPower's High Efficiency Advantage - Up to Twice the Power

Comparable systems covering 1000 m² / 10,750 ft²			
	Thin Film	Conventional	SunPower
Watts / Panel	65	165	305
Efficiency	9.0%	12.0%	18.7%
kWₕ	**90**	**120**	**187**

SUNPOWER

305 SOLAR PANEL

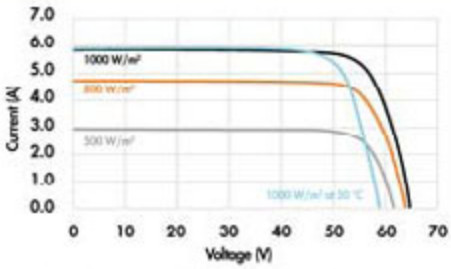
EXCEPTIONAL EFFICIENCY AND PERFORMANCE

Electrical Data

Measured at Standard Test Conditions (STC): irradiance of 1000 W/m², air mass 1.5 g, and cell temperature 25° C

Peak Power (+/-5%)	Pmax	305 W
Rated Voltage	Vmp	54.7 V
Rated Current	Imp	5.58 A
Open Circuit Voltage	Voc	64.2 V
Short Circuit Current	Isc	5.96 A
Maximum System Voltage	IEC, UL	1000 V, 600 V
Temperature Coefficients		
	Power	-0.38% / °C
	Voltage (Voc)	-176.6 mV/°C
	Current (Isc)	3.5 mA/°C
Series Fuse Rating		15 A
Peak Power per Unit Area		187 W/m², 17.4 W/ft²
CEC PTC Rating		282.1 W

IV Curve



Current/voltage characteristics with dependence on irradiance and module temperature

Tested Operating Conditions

Temperature	-40° C to +85° C (-40° F to +185° F)
Max load	50 psf (2400 Pascals) front and back
Impact Resistance	Hail – 25mm (1 in) at 23 m/s (52 mph)

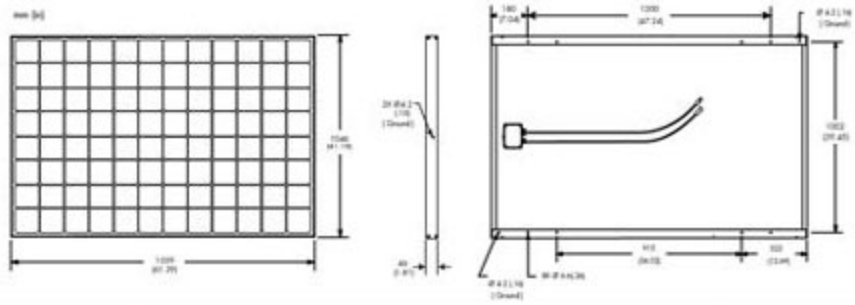
Mechanical Data

Solar Cells	96 SunPower all-back contact monocrystalline
Front Glass	4.0 mm (5/32 in) tempered
Junction Box	IP-65 rated with 3 bypass diodes
Output Cables	900 mm length cables / Multi-Contact connectors
Frame	Clear anodized aluminum alloy type 6063
Weight	24 kg, 53 lbs

Warranty and Certifications

Warranty	25 year limited power warranty
	10 year limited product warranty
Certifications	IEC 61215 , Safety tested IEC 61730; UL listed (UL 1703), Class C Fire Rating

Dimensions



CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT. Go to www.sunpowercorp.com/panels for details

About SunPower

SunPower designs, manufactures and delivers high-performance solar electric technology worldwide. Our high-efficiency solar cells generate up to 50 percent more power than conventional solar cells. Our high-performance solar panels, roof tiles and trackers deliver significantly more energy than competing systems.

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CASH ELECTRICAL SCHEDULE

Thur (Day 8)	Model	Qty	Volts	Amps	Watts	Time (H)	Max. Time (H)	Task Time (H)	KWH	KWH (Max.)	KWH(Task)	Rank
Refrigerator/Freezer	Electrolux EW23CS65G S	1	120	1.00	120.0	16.50	16.50	16.50	1.98	1.98	1.98	3
A/C (Temperature & Humidity)	Daikin EKHBX008AA	1	240	4.17	1000.0	8.50	10.00	8.50	8.50	10.00	8.50	1
Workstation Lighting	Dicolor T8/18W	2	120	0.16	18.8	6.00	7.00	8.00	0.23	0.26	0.30	11
Computer	MacBook Air	1	120	0.38	45.0	13.00	15.00	12.00	0.59	0.68	0.54	8
Electric Cooktop	Electrolux EW30CC55G S	1	240	11.67	2800.0	2.00	2.00	0.50	5.60	5.60	1.40	5
Microwave Oven	Electrolux EI27MO45G S	1	120	8.33	1000.0	0.00	0.00	0.00	0.00	0.00	0.00	14
Hot Water	----------	0	240	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	14
Television	Bravia KDL-32JE1	1	120	0.74	89.0	5.00	6.00	6.00	0.45	0.53	0.53	9
DVD Player	Panasonic DVD-S54K	1	120	0.07	8.0	5.00	6.00	6.00	0.04	0.05	0.05	13
Clothes Washer	Electrolux EWFLW65H SS	1	120	12.00	1440.0	1.50	1.50	1.00	2.16	2.16	1.44	4
Clothes Dryer	Electrolux EWED65H SS	1	240	27.00	6480.0	1.50	1.50	1.00	1.37	1.37	1.37	6
Dishwasher	Electrolux EWDW6505G S	1	120	11.67	1400.0	3.00	3.00	1.50	4.20	4.20	2.10	2
Lighting Fixture-1-int-opt 1	Illusion IL22	5			67.0	3.00	3.00	2.00	1.01	1.01	0.67	7
Lighting Fixture-2-int-opt 2	Dicolor T8/18W	2	120		18.8	3.00	3.00	2.00	0.11	0.11	0.08	12
Lighting Fixture-3-ext	213 15 21/ Genie 90 ROP	25	12		10.0	3.00	3.00	2.00	0.75	0.75	0.50	10
									0			
									Total KWH(RT):	Total KWH(Max.):	al KWH(TT):	
									26.9734	28.696	19.458	

Fri (Day 9)	Model	Qty	Volts	Amps	Watts	Time (H)	Max. Time (H)	Task Time (H)	KWH	KWH (Max.)	KWH(Task)	Rank
Refrigerator/Freezer	Electrolux EW23CS65G S	1	120	1.00	120.0	24.00	24.00	24.00	2.88	2.88	2.88	3
A/C (Temperature & Humidity)	Daikin EKHBX008AA	1	240	3.88	930.0	20.00	24.00	24.00	18.60	22.32	22.32	1
Workstation Lighting	Dicolor T8/18W	2	120	0.16	18.8	9.00	10.50	8.00	0.34	0.39	0.30	11
Computer	MacBook Air	1	120	0.38	45.0	13.00	15.00	12.00	0.59	0.68	0.54	7
Electric Cooktop	Electrolux EW30CC55G S	1	240	11.67	2800.0	1.00	1.00	0.50	2.80	2.80	1.40	5
Microwave Oven	Electrolux EI27MO45G S	1	120	8.33	1000.0	1.00	1.00	0.50	1.00	1.00	0.50	9
Hot Water	----------	0	240	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	14
Television	Bravia KDL-32JE1	1	120	0.74	89.0	4.00	5.00	6.00	0.36	0.45	0.53	8
DVD Player	Panasonic DVD-S54K	1	120	0.07	8.0	4.00	5.00	6.00	0.03	0.04	0.05	13
Clothes Washer	Electrolux EWFLW65H SS	1	120	12.00	1440.0	3.00	3.00	1.00	4.32	4.32	1.44	4
Clothes Dryer	Electrolux EWED65H SS	1	240	27.00	6480.0	3.00	3.00	1.00	19.44	19.44	6.48	2
Dishwasher	Electrolux EWDW6505G S	1	120	11.67	1400.0	0.00	0.00	0.00	0.00	0.00	0.00	14
Lighting Fixture-1-int-opt 1	Illusion IL22	5			67.0	2.00	2.00	2.00	0.67	0.67	0.67	6
Lighting Fixture-2-int-opt 2	Dicolor T8/18W	2	120		18.8	2.00	2.00	2.00	0.08	0.08	0.08	12
Lighting Fixture-3-ext	213 15 21/ Genie 90 ROP	25	12		10.0	2.00	2.00	2.00	0.50	0.50	0.50	9
									Total KWH(RT):	Total KWH(Max.):	al KWH(TT):	
									51.5966	55.56	37.688	

Sat (Day 10)	Model	Qty	Volts	Amps	Watts	Time (H)	Max. Time (H)	Task Time (H)	KWH	KWH (Max.)	KWH(Task)	Rank
Refrigerator/Freezer	Electrolux EW23CS65G S	1	120	1.00	120.0	24.00	24.00	24.00	2.88	2.88	2.88	3
A/C (Temperature & Humidity)	Daikin EKHBX008AA	1	240	4.17	1000.0	12.00	14.00	24.00	12.00	14.00	24.00	1
Workstation Lighting	Dicolor T8/18W	2	120	0.16	18.8	2.00	2.00	8.00	0.08	0.08	0.30	9
Computer	MacBook Air	1	120	0.38	45.0	9.00	10.50	12.00	0.41	0.47	0.54	7
Electric Cooktop	Electrolux EW30CC55G S	1	240	11.67	2800.0	2.00	2.00	0.50	5.60	5.60	1.40	4
Microwave Oven	Electrolux EI27MO45G S	1	120	8.33	1000.0	0.00	0.00	0.00	0.00	0.00	0.00	12
Hot Water	----------	0	240	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	12
Television	Bravia KDL-32JE1	1	120	0.74	89.0	7.00	8.00	8.00	0.62	0.71	0.71	5
DVD Player	Panasonic DVD-S54K	1	120	0.07	8.0	7.00	8.00	8.00	0.06	0.06	0.06	11
Clothes Washer	Electrolux EWFLW65H SS	1	120	12.00	1440.0	0.00	0.00	0.00	0.00	0.00	0.00	12
Clothes Dryer	Electrolux EWED65H SS	1	240	27.00	6480.0	0.00	0.00	0.00	0.00	0.00	0.00	12
Dishwasher	Electrolux EWDW6505G S	1	120	11.67	1400.0	3.00	3.00	1.50	4.20	4.20	2.10	3
Lighting Fixture-1-int-opt 1	Illusion IL22	5			67.0	3.00	3.00	2.00	1.01	1.01	0.67	6
Lighting Fixture-2-int-opt 2	Dicolor T8/18W	2	120		18.8	3.00	3.00	2.00	0.11	0.11	0.08	10
Lighting Fixture-3-ext	213 15 21/ Genie 90 ROP	25	12		10.0	3.00	3.00	2.00	0.75	0.75	0.50	8
									Total KWH(RT):	Total KWH(Max.):	al KWH(TT):	
									27.707	29.8715	33.242	

Sun (Day 11)	Model	Qty	Volts	Amps	Watts	Time (H)	Max. Time (H)	Task Time (H)	KWH	KWH (Max.)	KWH(Task)	Rank
Refrigerator/Freezer	Electrolux EW23CS65G S	1	120	1.00	120.0	24.00	24.00	24.00	2.88	2.88	2.88	2
A/C (Temperature & Humidity)	Daikin EKHBX008AA	1	240	4.17	1000.0	12.00	14.00	24.00	12.00	14.00	24.00	1
Workstation Lighting	Dicolor T8/18W	2	120	0.16	18.8	2.00	2.00	8.00	0.08	0.08	0.30	6
Computer	MacBook Air	1	120	0.38	45.0	9.00	10.50	0.00	0.41	0.47	0.00	9
Electric Cooktop	Electrolux EW30CC55G S	1	240	11.67	2800.0	0.00	0.00	0.00	0.00	0.00	0.00	9
Microwave Oven	Electrolux EI27MO45G S	1	120	8.33	1000.0	0.00	0.00	0.00	0.00	0.00	0.00	9
Hot Water	----------	0	240	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	9
Television	Bravia KDL-32JE1	1	120	0.74	89.0	9.00	10.50	8.00	0.80	0.93	0.71	3
DVD Player	Panasonic DVD-S54K	1	120	0.07	8.0	9.00	10.50	8.00	0.07	0.08	0.06	8
Clothes Washer	Electrolux EWFLW65H SS	1	120	12.00	1440.0	0.00	0.00	0.00	0.00	0.00	0.00	9
Clothes Dryer	Electrolux EWED65H SS	1	240	27.00	6480.0	0.00	0.00	0.00	0.00	0.00	0.00	9
Dishwasher	Electrolux EWDW6505G S	1	120	11.67	1400.0	0.00	0.00	0.00	0.00	0.00	0.00	9
Lighting Fixture-1-int-opt 1	Illusion IL22	5			67.0	0.50	0.50	2.00	0.17	0.17	0.67	4
Lighting Fixture-2-int-opt 2	Dicolor T8/18W	2	120		18.8	0.50	0.50	2.00	0.02	0.02	0.08	7
Lighting Fixture-3-ext	213 15 21/ Genie 90 ROP	25	12		10.0	0.50	0.50	2.00	0.13	0.13	0.50	5
									Total KWH(RT):	Total KWH(Max.):	al KWH(TT):	
									16.5445	18.7575	29.202	

Mon (Day 12)	Model	Qty	Volts	Amps	Watts	Time (H)	Max. Time (H)	Task Time (H)	KWH	KWH (Max.)	KWH(Task)	Rank
Refrigerator/Freezer	Electrolux EW23CS65G S	1	120	1.00	120.0	24.00	24.00	24.00	2.88	2.88	2.88	3
A/C (Temperature & Humidity)	Daikin EKHBX008AA	1	240	4.17	1000.0	19.00	22.00	24.00	19.00	22.00	24.00	1
Workstation Lighting	Dicolor T8/18W	2	120	0.16	18.8	3.00	3.00	8.00	0.11	0.11	0.30	10
Computer	MacBook Air	1	120	0.38	45.0	7.00	8.00	12.00	0.32	0.36	0.54	8
Electric Cooktop	Electrolux EW30CC55G S	1	240	11.67	2800.0	2.00	2.00	1.00	5.60	5.60	2.80	4
Microwave Oven	Electrolux EI27MO45G S	1	120	8.33	1000.0	0.00	0.00	0.00	0.00	0.00	0.00	13
Hot Water	----------	0	240	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	13
Television	Bravia KDL-32JE1	1	120	0.74	89.0	4.00	5.00	8.00	0.36	0.45	0.71	6
DVD Player	Panasonic DVD-S54K	1	120	0.07	8.0	4.00	5.00	8.00	0.03	0.04	0.06	12
Clothes Washer	Electrolux EWFLW65H SS	1	120	12.00	1440.0	3.00	3.00	1.50	4.32	4.32	2.16	5
Clothes Dryer	Electrolux EWED65H SS	1	240	27.00	6480.0	3.00	3.00	1.50	19.44	19.44	9.72	2
Dishwasher	Electrolux EWDW6505G S	1	120	11.67	1400.0	0.00	0.00	0.00	0.00	0.00	0.00	13
Lighting Fixture-1-int-opt 1	Illusion IL22	5			67.0	3.00	3.00	2.00	1.01	1.01	0.67	7
Lighting Fixture-2-int-opt 2	Dicolor T8/18W	2	120		18.8	3.00	3.00	2.00	0.11	0.11	0.08	11
Lighting Fixture-3-ext	213 15 21/ Genie 90 ROP	25	12		10.0	3.00	3.00	2.00	0.75	0.75	0.50	9
									Total KWH(RT):	Total KWH(Max.):	al KWH(TT):	
									53.9236	57.0656	44.422	

Tues (Day 13)	Model	Qty	Volts	Amps	Watts	Time (H)	Max. Time (H)	Task Time (H)	KWH	KWH (Max.)	KWH(Task)	Rank
Refrigerator/Freezer	Electrolux EW23CS65G S	1	120	1.00	120.0	24.00	24.00	24.00	2.88	2.88	2.88	3
A/C (Temperature & Humidity)	Daikin EKHBX008AA	1	240	4.17	1000.0	19.00	22.00	24.00	19.00	22.00	24.00	1
Workstation Lighting	Dicolor T8/18W	2	120	0.16	18.8	6.00	7.00	8.00	0.23	0.26	0.30	9
Computer	MacBook Air	1	120	0.38	45.0	16.50	16.50	12.00	0.74	0.74	0.54	7
Electric Cooktop	Electrolux EW30CC55G S	1	240	11.67	2800.0	0.00	0.00	0.00	0.00	0.00	0.00	11
Microwave Oven	Electrolux EI27MO45G S	1	120	8.33	1000.0	0.00	0.00	0.00	0.00	0.00	0.00	11
Hot Water	----------	0	240	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	11
Television	Bravia KDL-32JE1	1	120	0.74	89.0	4.00	5.00		0.36	0.45	0.00	11
DVD Player	Panasonic DVD-S54K	1	120	0.07	8.0	4.00	5.00		0.03	0.04	0.00	11
Clothes Washer	Electrolux EWFLW65H SS	1	120	12.00	1440.0	1.50	1.50	1.00	2.16	2.16	1.44	5
Clothes Dryer	Electrolux EWED65H SS	1	240	27.00	6480.0	1.50	1.50	1.00	9.72	9.72	6.48	2
Dishwasher	Electrolux EWDW6505G S	1	120	11.67	1400.0	3.00	3.00	1.50	4.20	4.20	2.10	4
Lighting Fixture-1-int-opt 1	Illusion IL22	5			67.0	3.00	3.00	2.00	1.01	1.01	0.67	6
Lighting Fixture-2-int-opt 2	Dicolor T8/18W	2	120		18.8	3.00	3.00	2.00	0.11	0.11	0.08	10
Lighting Fixture-3-ext	213 15 21/ Genie 90 ROP	25	12		10.0	3.00	3.00	2.00	0.75	0.75	0.50	8
									Total KWH(RT):	Total KWH(Max.):	al KWH(TT):	
									41.1839	44.3185	38.986	

Wed (Day 14)	Model	Qty	Volts	Amps	Watts	Time (H)	Max. Time (H)	Task Time (H)	KWH	KWH (Max.)	KWH(Task)	Rank
Refrigerator/Freezer	Electrolux EW23CS65G S	1	120	1.00	120.0	24.00	24.00	24.00	2.88	2.88	2.88	3
A/C (Temperature & Humidity)	Daikin EKHBX008AA	1	240	4.17	1000.0	18.00	21.00	24.00	18.00	21.00	24.00	1
Workstation Lighting	Dicolor T8/18W	2	120	0.16	18.8	8.00	9.50	8.00	0.30	0.36	0.30	11
Computer	MacBook Air	1	120	0.38	45.0	8.00	9.50	12.00	0.36	0.43	0.54	9
Electric Cooktop	Electrolux EW30CC55G S	1	240	11.67	2800.0	2.00	2.00	0.50	5.60	5.60	1.40	5
Microwave Oven	Electrolux EI27MO45G S	1	120	8.33	1000.0	0.00	0.00	0.00	0.00	0.00	0.00	14
Hot Water	----------	0	240	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	14
Television	Bravia KDL-32JE1	1	120	0.74	89.0	5.00	6.00	8.00	0.45	0.53	0.71	7
DVD Player	Panasonic DVD-S54K	1	120	0.07	8.0	5.00	6.00	8.00	0.04	0.05	0.06	13
Clothes Washer	Electrolux EWFLW65H SS	1	120	12.00	1440.0	3.00	3.00	1.50	4.32	4.32	2.16	4
Clothes Dryer	Electrolux EWED65H SS	1	240	27.00	6480.0	3.00	3.00	1.50	19.44	19.44	9.72	2
Dishwasher	Electrolux EWDW6505G S	1	120	11.67	1400.0	3.00	3.00	1.00	4.20	4.20	1.40	5
Lighting Fixture-1-int-opt 1	Illusion IL22	5			67.0	3.00	3.00	2.00	1.01	1.01	0.67	8
Lighting Fixture-2-int-opt 2	Dicolor T8/18W	2	120		18.8	3.00	3.00	2.00	0.11	0.11	0.08	12
Lighting Fixture-3-ext	213 15 21/ Genie 90 ROP	25	12		10.0	3.00	3.00	2.00	0.75	0.75	0.50	10
									Total KWH(RT):	Total KWH(Max.):	al KWH(TT):	
									57.4536	60.6745	44.422	

Thur (Day 15)	Model	Qty	Volts	Amps	Watts	Time (H)	Max. Time (H)	Task Time (H)	KWH	KWH (Max.)	KWH(Task)	Rank
Refrigerator/Freezer	Electrolux EW23CS65G S	1	120	1.00	120.0	22.00	24.00	24.00	2.64	2.88	2.88	3
A/C (Temperature & Humidity)	Daikin EKHBX008AA	1	240	4.17	1000.0	19.00	22.00	24.00	19.00	22.00	24.00	1
Workstation Lighting	Dicolor T8/18W	2	120	0.16	18.8	10.00	11.50	10.00	0.38	0.43	0.38	10
Computer	MacBook Air	1	120	0.38	45.0	14.00	16.00	14.00	0.63	0.72	0.63	8
Electric Cooktop	Electrolux EW30CC55G S	1	240	11.67	2800.0	0.00	0.00		0.00	0.00	0.00	13
Microwave Oven	Electrolux EI27MO45G S	1	120	8.33	1000.0	0.00	0.00		0.00	0.00	0.00	13
Hot Water	----------	0	240	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	13
Television	Bravia KDL-32JE1	1	120	0.74	89.0	4.00	5.00	11.00	0.36	0.45	0.98	6
DVD Player	Panasonic DVD-S54K	1	120	0.07	8.0	4.00		11.00	0.03	0.00	0.09	11
Clothes Washer	Electrolux EWFLW65H SS	1	120	12.00	1440.0	3.00	3.00	1.50	4.32	4.32	2.16	4
Clothes Dryer	Electrolux EWED65H SS	1	240	27.00	6480.0	3.00	3.00	1.50	19.44	19.44	9.72	2
Dishwasher	Electrolux EWDW6505G S	1	120	11.67	1400.0	3.00	3.00	1.00	4.20	4.20	1.40	5
Lighting Fixture-1-int-opt 1	Illusion IL22	5			67.0	3.00	3.00	2.00	1.01	1.01	0.67	7
Lighting Fixture-2-int-opt 2	Dicolor T8/18W	2	120		18.8	3.00	3.00	2.00	0.11	0.11	0.08	12
Lighting Fixture-3-ext	213 15 21/ Genie 90 ROP	25	12		10.0	3.00	3.00	2.00	0.75	0.75	0.50	9
									Total KWH(RT):	Total KWH(Max.):	al KWH(TT):	
									52.8618	56.3052	43.4782	

LOAD CALCULATIONS

LOAD CALCULATION ELECTRICAL

PROJECT: UPR SOLAR HOUSE 2009

GENERAL LIGHTING (CONTINUOUS LOAD)

AREA (Ft²)	SPACE	VA / Ft²	
798.41	House	3	2395.242

TABLE 212.12 NEC
ART. 210.20 NEC

TOTAL 2395.242

2395.24 @ 125% = 2.99 KVA

MINIMUM NUMBER OF BRANCH CIRCUITS

ART. 210.11A NEC

LOAD	POWER	VOLTAGE	AMPS	CB	CKTS
GEN. LIGHTING LOAD	2.99 KVA	120 V	24.95 A	20.00 A	2
SMALL APPLIANCES	2 TWO WIRE, 20 A. CIRCUITS (NEC 210.11(C)(1))				
LAUNDRY	1 TWO WIRE, 20 A. CIRCUITS (NEC 210.11(C)(2))				
BATHROOM	1 TWO WIRE, 20 A. CIRCUITS (NEC 210.11(C)(3))				

MINIMUM SIZE FEEDER

ART. 220.40 NEC

LOAD			POWER
GEN. LIGHTING LOAD			2395.24 VA
SMALL APPLIANCES (NEC 220.52(A))	2 X	1500 VA =	3000.00 VA
LAUNDRY (NEC 220.52(B))	1 X	1500 VA =	1500.00 VA
			6895.24 VA

TABEL 220.42 NEC

TOTAL LOAD				6895.24 VA
LOAD RANGE		DEMAND	PORTION	
0 VA	TO 3,000 VA ->	100%	3000.00 VA	3000.00 VA
3,001 VA	TO 120,000 VA ->	35%	3895.24 VA	1363.33 VA
120,001 VA	TO 999,999 VA ->	25%	0.00 VA	0.00 VA
			NET LOAD =	4363.33 VA

LIGHTING LOAD			4363.33 VA
DISH WASHER	100%	1400.00 VA	1400.00 VA
AIR CONDITIONER	100%	1000.00 VA	1000.00 VA
RANGE (TABLE 220.55 NEC)	80%	3200.00 VA	2560.00 VA
DRYER (TABLE 220.54 NEC)	100%	6480.00 VA	6480.00 VA

NET CALCULATED LOAD = 15803.33 VA

SERVICE VOLTAGE	240 V
FEEDER AMPS	65.85 A
AMPAS USED (NEC 230.42(B) AND 230.79)	**100.00 A**
FEEDER	**#2 AWG**

NEUTRAL CALCULATION

	DEMAND	PORTION	
LIGHT AND SMALL APPLIANCES LOAD			4363.33 VA
DISH WASHER	100%	1400.00 VA	1400.00 VA
AIR CONDITIONER	100%	1000.00 VA	1000.00 VA
RANGE (NEC 220.61)	70%	1400.00 VA	980.00 VA
DRYER (NEC 220.61)	70%	6480.00 VA	4536.00 VA
			12279.33 VA
SERVICE VOLTAGE			240 V
CALCULATED LOAD FOR NEUTRAL			**51.16 A**

SMA STRING SIZING PROGRAM

Solar Calc Data Page

SMA America USA http://america.sma.de/newstringsizing.aspx

STRING SIZING PROGRAM

SMA

Further Instructions
If you are having difficulty with the String Sizing Program, or it is not operating properly, see this Read Me file for the operating instructions and version history of the String Sizing Program.

By using this String Sizing Program you agree that this Program is for approximating PV module string sizes only. Further you agree that SMA America, Inc. makes no claim as to the actual performance of your system, including, but not limited to, the efficiency or power production of the inverter and PV modules based on the information from this Program. Additionally, you agree that it is the responsibility of the system design engineer to ensure that the PV module selection, array configuration, and associated wiring diagrams are appropriate for the system being considered.

NOTE:
For an explanation of any particular entry definition click on the actual term for a glossary.

Design Options

Please Select an Inverter	Please Select a PV Manufacturer	Please Select a PV Module
SB 6000U (240)	Sunpower	SPR-305-WHT

Inverter Data

Design Irradiance (W/m²)	Pac	Pdcmax
1000	6000	6400

Idc Max	Vdc Max ****	Vmpt Max	Vmpt Min	Vmin
25	600	550	250	234

Module Data

Module Pnom (W)	Voc (V)	Vmp (V)	Isc (A)	Imp (A)
305 W	64,2 V	54,7 V	5,96 A	5,58 A

Temperature Coefficient of Voltage	Temperature Coefficient of Current	Temperature Coefficient of Power
- 176,6 mV	+ 3,5 mA	- 0,38 %

Mounting Method

Please select the mounting method for the array: Tilt-angle or ground mount

Temperature Data

If you do not know the hottest and coldest ambient temperatures that you should select for your area please enter the 5-digit postal ZIP code of the address of the installation here: 20001 and then Click Here

Select the coldest record low ambient temperature when sunlight will be on the array | Select the hottest average high ambient temperature when sunlight will be on the array | Imperial units | Metric units

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32 °F 77 °F

Results

1 string configurations	2 string configurations	3 string configurations	4 string configurations
5 in series	5 in series	5 in series	5 in series
6 in series	6 in series	6 in series	
7 in series	7 in series	7 in series	
8 in series	8 in series		

Get Sizes Clear Print Results Predicted Outputs

**** PV Array voltage may exceed 600 Vdc, please refer to NEC table 690.7 to calculate open circuit voltage at low temperature

SMA STRING SIZING PROGRAM

Solar Calc Data Page Max – Min Temp

weather.com - Monthly Climatology for Travel Section http://www.weather.com/weather/climatology/monthly/20001

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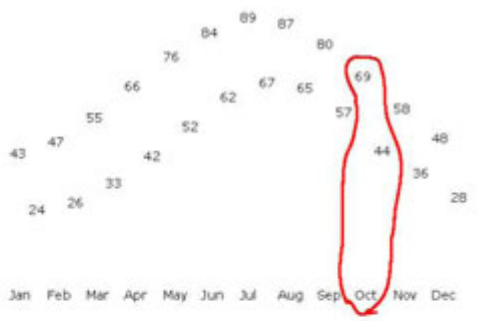
Local Weather for Washington, DC (20001) > AVERAGES & RECORDS for Washington, DC (20001)

Monthly Average | Daily Average

Monthly Averages for Washington, DC (20001)

Average Temperature (°F) High Low
Minimum Period of Record: 30 years



Month	Avg. High	Avg. Low	Mean	Avg. Precip.	Record High	Record Low
Jan	43°F	24°F	33°F	3.57 in.	80°F (1950)	-10°F (1982)
Feb	47°F	26°F	36°F	2.84 in.	82°F (2000)	-1°F (1961)
Mar	55°F	33°F	44°F	3.92 in.	90°F (1998)	9°F (1962)
Apr	66°F	42°F	54°F	3.26 in.	94°F (1976)	18°F (1982)
May	76°F	52°F	64°F	4.29 in.	98°F (2000)	25°F (1966)
Jun	84°F	62°F	73°F	3.63 in.	101°F (1999)	42°F (1984)
Jul	89°F	67°F	78°F	4.21 in.	104°F (1999)	47°F (1988)
Aug	87°F	65°F	76°F	3.90 in.	104°F (1999)	42°F (1986)
Sep	80°F	57°F	69°F	4.08 in.	102°F (1953)	34°F (1989)
Oct	69°F	44°F	57°F	3.43 in.	94°F (1954)	20°F (1966)
Nov	58°F	36°F	47°F	3.32 in.	87°F (1950)	10°F (1987)
Dec	48°F	28°F	38°F	3.25 in.	81°F (1998)	0°F (1983)

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SMA STRING SIZING PROGRAM

Solar Calc Data Page Max – Results

SMA America USA http://america.sma.de/newstringsizing.aspx

STRING SIZING PROGRAM

SMA

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Note: For best printing results, please change page format to "landscape".

Predicted Results from String Sizing V 6.0

Selected Inverter	Selected PV Manufacturer	Selected PV Module
SB 6000U (240)	Sunpower	SPR-305-WHT

1) Estimated PV Array Maximum Open Circuit Voltage vs. Low Temperature (°C/°F)

# of Modules	-40°C -40°F	-35°C -31°F	-30°C -22°F	-25°C -13°F	-20°C -4°F	-15°C 5°F	-10°C 14°F	-5°C 23°F	0°C 32°F	5°C 41°F	10°C 50°F
3	227	224	222	219	216	214	211	208	206	203	201
4	303	299	296	292	289	285	282	278	274	271	267
5	378	374	370	365	361	356	352	347	343	339	334
6	454	449	443	438	433	428	422	417	412	406	401
7	530	524	517	511	505	499	493	486	480	474	468
8	605	598	591	584	577	570	563	556	549	542	535
9	681	673	665	657	649	641	633	625	618	610	602
10	757	748	739	730	721	713	704	695	686	677	668

2) Estimated PV Array Minimum Open Circuit Voltage vs. High Temperature (°C/°F)

# of Modules	5°C 41°F	10°C 50°F	15°C 59°F	20°C 68°F	25°C 77°F	30°C 86°F	35°C 95°F	40°C 104°F	45°C 113°F	50°C 122°F	55°C 131°F
3	185	182	179	177	174	171	169	166	163	161	158
4	246	243	239	236	232	229	225	221	218	214	211
5	308	303	299	295	290	286	281	277	272	268	264
6	369	364	359	353	348	343	338	332	327	322	316
7	431	425	418	412	406	400	394	388	381	375	369
8	492	485	478	471	464	457	450	443	436	429	422
9	554	546	538	530	522	514	506	498	490	482	474
10	616	607	598	589	580	571	563	554	545	536	527

3) Estimated PV Array Minimum Peak Power Voltage vs. High Temperature (°C/°F)

# of Modules	5°C 41°F	10°C 50°F	15°C 59°F	20°C 68°F	25°C 77°F	30°C 86°F	35°C 95°F	40°C 104°F	45°C 113°F	50°C 122°F	55°C 131°F
3	156	154	151	148	146	143	140	138	135	132	130
4	208	205	201	198	194	191	187	183	180	176	173

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5	260	256	251	247	243	238	234	229	225	221	216
6	312	307	302	296	291	286	281	275	270	265	259
7	364	358	352	346	340	333	327	321	315	309	303
8	416	409	402	395	388	381	374	367	360	353	346
9	468	461	453	445	437	429	421	413	405	397	389
10	521	512	503	494	485	476	468	459	450	441	432

4) Estimated Inverter Maximum Output Power vs. High Temperature (°C/°F)

1 String

# of Modules	5°C 41°F	10°C 50°F	15°C 59°F	20°C 68°F	25°C 77°F	30°C 86°F	35°C 95°F	40°C 104°F	45°C 113°F	50°C 122°F	55°C 131°F
3	820	803	787	770	754	737	721	704	688	671	655
4	1093	1071	1049	1027	1005	983	961	939	917	895	873
5	1366	1339	1311	1284	1256	1229	1201	1173	1146	1118	1091
6	1639	1606	1573	1540	1507	1474	1441	1408	1375	1342	1309
7	1913	1874	1836	1797	1758	1720	1681	1643	1604	1566	1527
8	2186	2142	2098	2054	2010	1966	1922	1878	1834	1789	1745
9	2459	2410	2360	2310	2261	2211	2162	2112	2063	2013	1964
10	2732	2677	2622	2567	2512	2457	2402	2347	2292	2237	2182

2 Strings

# of Modules	5°C 41°F	10°C 50°F	15°C 59°F	20°C 68°F	25°C 77°F	30°C 86°F	35°C 95°F	40°C 104°F	45°C 113°F	50°C 122°F	55°C 131°F
3	1639	1606	1573	1540	1507	1474	1441	1408	1375	1342	1309
4	2186	2142	2098	2054	2010	1966	1922	1878	1834	1789	1745
5	2732	2677	2622	2567	2512	2457	2402	2347	2292	2237	2182
6	3279	3213	3147	3081	3015	2948	2882	2816	2750	2684	2618
7	3825	3748	3671	3594	3517	3440	3363	3286	3209	3132	3055
8	4372	4284	4196	4107	4019	3931	3843	3755	3667	3579	3491
9	4918	4819	4720	4621	4522	4423	4324	4225	4125	4026	3927
10	5465	5355	5244	5134	5024	4914	4804	4694	4584	4474	4364

3 Strings

# of Modules	5°C 41°F	10°C 50°F	15°C 59°F	20°C 68°F	25°C 77°F	30°C 86°F	35°C 95°F	40°C 104°F	45°C 113°F	50°C 122°F	55°C 131°F
3	2459	2410	2360	2310	2261	2211	2162	2112	2063	2013	1964
4	3279	3213	3147	3081	3015	2948	2882	2816	2750	2684	2618
5	4099	4016	3933	3851	3768	3686	3603	3520	3438	3355	3273
6	4918	4819	4720	4621	4522	4423	4324	4225	4125	4026	3927
7	5738	5622	5507	5391	5275	5160	5044	4929	4813	4697	4582
8	6558	6425	6293	6161	6029	5897	5765	5633	5501	5368	5236
9	7377	7229	7080	6931	6783	6634	6485	6337	6188	6040	5891
10	8197	8032	7867	7702	7536	7371	7206	7041	6876	6711	6545

4 Strings

# of	5°C	10°C	15°C	20°C	25°C	30°C	35°C	40°C	45°C	50°C	55°C

Modules	41°F	50°F	59°F	68°F	77°F	86°F	95°F	104°F	113°F	122°F	131°F
3	3279	3213	3147	3081	3015	2948	2882	2816	2750	2684	2618
4	4372	4284	4196	4107	4019	3931	3843	3755	3667	3579	3491
5	5465	5355	5244	5134	5024	4914	4804	4694	4584	4474	4364
6	6558	6425	6293	6161	6029	5897	5765	5633	5501	5368	5236
7	7651	7496	7342	7188	7034	6880	6726	6572	6417	6263	6109
8	8743	8567	8391	8215	8039	7863	7686	7510	7334	7158	6982
9	9836	9638	9440	9242	9044	8845	8647	8449	8251	8053	7855
10	10929	10709	10489	10269	10049	9828	9608	9388	9168	8947	8727

5) Estimated Inverter Maximum Output Power vs. Low Temperature (°C/°F)

1 String

# of Modules	-40°C -40°F	-35°C -31°F	-30°C -22°F	-25°C -13°F	-20°C -4°F	-15°C 5°F	-10°C 14°F	-5°C 23°F	0°C 32°F	5°C 41°F	10°C 50°F
3	968	952	935	919	902	886	869	853	836	820	803
4	1291	1269	1247	1225	1203	1181	1159	1137	1115	1093	1071
5	1614	1586	1559	1531	1504	1476	1449	1421	1394	1366	1339
6	1937	1904	1871	1838	1805	1772	1738	1705	1672	1639	1606
7	2259	2221	2182	2144	2105	2067	2028	1990	1951	1913	1874
8	2582	2538	2494	2450	2406	2362	2318	2274	2230	2186	2142
9	2905	2855	2806	2756	2707	2657	2608	2558	2509	2459	2410
10	3228	3173	3118	3063	3008	2953	2898	2842	2787	2732	2677

2 Strings

# of Modules	-40°C -40°F	-35°C -31°F	-30°C -22°F	-25°C -13°F	-20°C -4°F	-15°C 5°F	-10°C 14°F	-5°C 23°F	0°C 32°F	5°C 41°F	10°C 50°F
3	1937	1904	1871	1838	1805	1772	1738	1705	1672	1639	1606
4	2582	2538	2494	2450	2406	2362	2318	2274	2230	2186	2142
5	3228	3173	3118	3063	3008	2953	2898	2842	2787	2732	2677
6	3873	3807	3741	3675	3609	3543	3477	3411	3345	3279	3213
7	4519	4442	4365	4288	4211	4134	4056	3979	3902	3825	3748
8	5165	5076	4988	4900	4812	4724	4636	4548	4460	4372	4284
9	5810	5711	5612	5513	5414	5315	5216	5116	5017	4918	4819
10	6456	6346	6235	6125	6015	5905	5795	5685	5575	5465	5355

3 Strings

# of Modules	-40°C -40°F	-35°C -31°F	-30°C -22°F	-25°C -13°F	-20°C -4°F	-15°C 5°F	-10°C 14°F	-5°C 23°F	0°C 32°F	5°C 41°F	10°C 50°F
3	2905	2855	2806	2756	2707	2657	2608	2558	2509	2459	2410
4	3873	3807	3741	3675	3609	3543	3477	3411	3345	3279	3213
5	4842	4759	4677	4594	4511	4429	4346	4264	4181	4099	4016
6	5810	5711	5612	5513	5414	5315	5216	5116	5017	4918	4819
7	6778	6663	6547	6432	6316	6200	6085	5969	5854	5738	5622
8	7747	7615	7483	7350	7218	7086	6954	6822	6690	6558	6425
9	8715	8566	8418	8269	8121	7972	7823	7675	7526	7377	7229

10	9683	9518	9353	9188	9023	8858	8692	8527	8362	8197	8032

4 Strings

# of Modules	-40°C -40°F	-35°C -31°F	-30°C -22°F	-25°C -13°F	-20°C -4°F	-15°C 5°F	-10°C 14°F	-5°C 23°F	0°C 32°F	5°C 41°F	10°C 50°F
3	3873	3807	3741	3675	3609	3543	3477	3411	3345	3279	3213
4	5165	5076	4988	4900	4812	4724	4636	4548	4460	4372	4284
5	6456	6346	6235	6125	6015	5905	5795	5685	5575	5465	5355
6	7747	7615	7483	7350	7218	7086	6954	6822	6690	6558	6425
7	9038	8884	8730	8575	8421	8267	8113	7959	7805	7651	7496
8	10329	10153	9977	9801	9624	9448	9272	9096	8920	8743	8567
9	11620	11422	11224	11026	10827	10629	10431	10233	10035	9836	9638
10	12911	12691	12471	12251	12030	11810	11590	11370	11150	10929	10709

6) Estimated PV Array Maximum Output Power vs. High Temperature (°C/°F)

1 String

# of Modules	5°C 41°F	10°C 50°F	15°C 59°F	20°C 68°F	25°C 77°F	30°C 86°F	35°C 95°F	40°C 104°F	45°C 113°F	50°C 122°F	55°C 131°F
3	863	845	828	811	793	776	759	741	724	706	689
4	1150	1127	1104	1081	1058	1035	1011	988	965	942	919
5	1438	1409	1380	1351	1322	1293	1264	1235	1206	1177	1148
6	1726	1691	1656	1621	1587	1552	1517	1482	1448	1413	1378
7	2013	1973	1932	1892	1851	1810	1770	1729	1689	1648	1608
8	2301	2255	2208	2162	2115	2069	2023	1976	1930	1884	1837
9	2589	2536	2484	2432	2380	2328	2276	2223	2171	2119	2067
10	2876	2818	2760	2702	2644	2586	2528	2470	2413	2355	2297

2 Strings

# of Modules	5°C 41°F	10°C 50°F	15°C 59°F	20°C 68°F	25°C 77°F	30°C 86°F	35°C 95°F	40°C 104°F	45°C 113°F	50°C 122°F	55°C 131°F
3	1726	1691	1656	1621	1587	1552	1517	1482	1448	1413	1378
4	2301	2255	2208	2162	2115	2069	2023	1976	1930	1884	1837
5	2876	2818	2760	2702	2644	2586	2528	2470	2413	2355	2297
6	3451	3382	3312	3243	3173	3104	3034	2965	2895	2826	2756
7	4027	3945	3864	3783	3702	3621	3540	3459	3378	3296	3215
8	4602	4509	4416	4324	4231	4138	4046	3953	3860	3767	3675
9	5177	5073	4968	4864	4760	4656	4551	4447	4343	4238	4134
10	5752	5636	5520	5405	5289	5173	5057	4941	4825	4709	4593

3 Strings

# of Modules	5°C 41°F	10°C 50°F	15°C 59°F	20°C 68°F	25°C 77°F	30°C 86°F	35°C 95°F	40°C 104°F	45°C 113°F	50°C 122°F	55°C 131°F
3	2589	2536	2484	2432	2380	2328	2276	2223	2171	2119	2067
4	3451	3382	3312	3243	3173	3104	3034	2965	2895	2826	2756
5	4314	4227	4140	4053	3967	3880	3793	3706	3619	3532	3445
6	5177	5073	4968	4864	4760	4656	4551	4447	4343	4238	4134

SUBJECTIVE CONTEST SUPPORT DOCUMENTS

ARCHITECTURAL DESIGN NARRATIVE
MARKET VIABILITY JUSTIFICATION
ENGINEERING DESIGN NARRATIVE
HVAC DESIGN NARRATIVE
LIGHTING DESIGN NARRATIVE

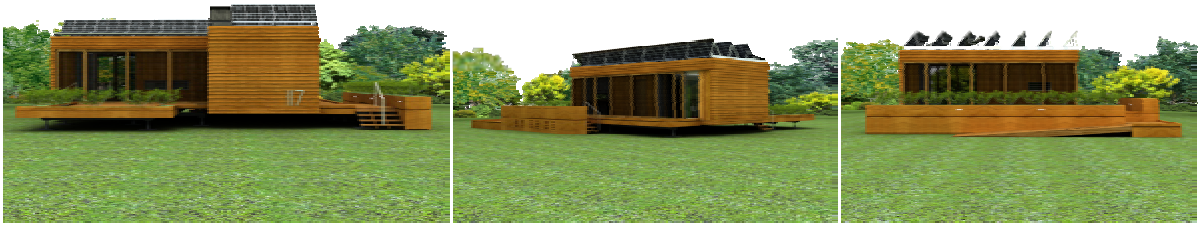
ARCHITECTURAL DESIGN NARRATIVE

To BE GREEN and affordable! That's our tagline. CASH, the *Caribbean Affordable Solar House* is a prototype that raises public awareness about being green in different ways, both sustainably and economically. Our vision is to motivate people in the island and the Caribbean Region to live greener and sustainably, while learning about solar energy and "green" design and technologies.

With our design for CASH, we want to motivate our citizens and educate our public to think locally with a global consciousness, to consider the place they live as their initial scope of action, while recognizing that with small scopes being defined and fulfilled sustainably by every one of us, the whole planets learns to live healthier. We also want to show the economics of living greener and raise public awareness that a solar house is not only a contribution to a healthier and better life for future generations, but also an investment in one's own life. With CASH we will demonstrate that a solar house can be attractive, cost efficient and a viable and real alternative to standard houses. We want to make CASH the new standard.

CASH states that:

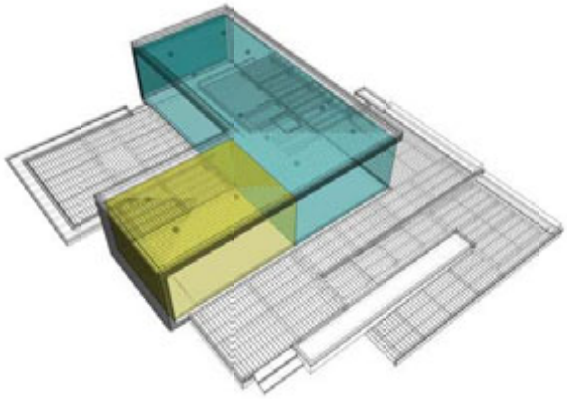
1. We are form the **CARIBBEAN** - Our house identifies our place, the island of Puerto Rico, and more broadly, with the Caribbean climatic region.
2. It is **AFFORDABLE** - In order to have more people thinking about the option of having a solar house we have to address the economic issue as one of our main priorities.
3. **SOLAR** energy is used - Our house runs entirely on solar energy which is captured through photovoltaic panels and solar thermal tubes.
4. Our **HOUSE** is a home - **CASH** rethinks "the domestic" concept and what it means to be tropical in the climate zone we inhabit.

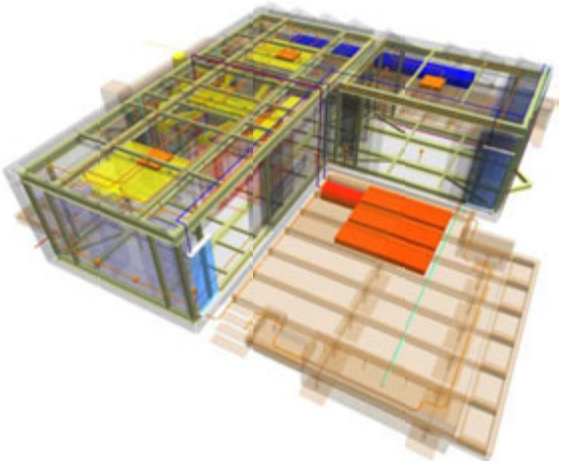


For CASH we have developed 10 strategies. These are:

Strategy 1: FORM: With an "L" shaped plan, we bring a strong connection from the inside to the outside and vice versa, and give hierarchy to the main exterior space, our patio. This way, our house feels bigger as it expands beyond its wall with the views and openings. We have three direct connections to the outside and we use 9'-0" wide openings, each with double pane full glass folding doors. CASH is an 800 square feet house surrounded by a 1430 *sq ft* deck. We strived to connect all the main areas of the house with the outside / exterior spaces, emphasizing the continuity among the areas and creating an unpredictable / transformable space. This scheme favors the house design, and the exterior patio functions as a connector or a space of solace between both conditioned and unconditioned areas. Our focus space / center point is the patio, which if oriented north, could inhabit a grown tree. However, if the patio is oriented north, the house south façade will require an overhanging to protect it from solar radiation.

Strategy 2: LESS CONDITIONED AREA: Not everything has to be air conditioned! Our house only has 484 sq. feet of space that is "Air Conditioned": has an active system to control temperature and humidity….! This way, we have reduced the amount of energy used and thus the CO2 emitted to the atmosphere. And since in the tropics you are used to a higher comfortable temperature, you can use the breezes and the shade to cool yourself. This means that the house should be oriented to the prevailing winds, in order to use the cooling breezes as they enter the space. The conditioned space contains the main living areas, which includes a hide-away bedroom, an expandable bathroom, a kitchen and a living / office area. The unconditioned area serves as a multipurpose room that accommodates the laundry and can also be used, for instance, as an optional dining or living room.



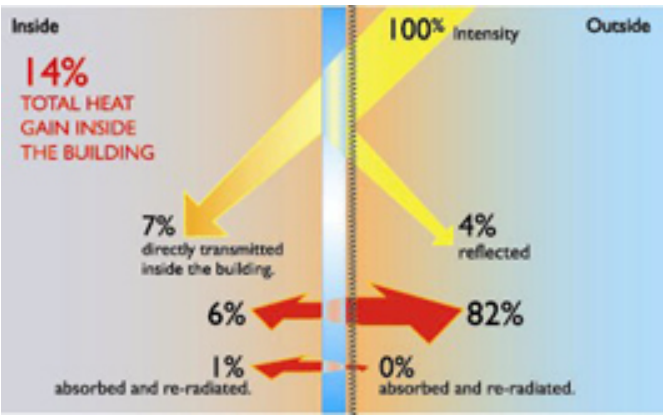


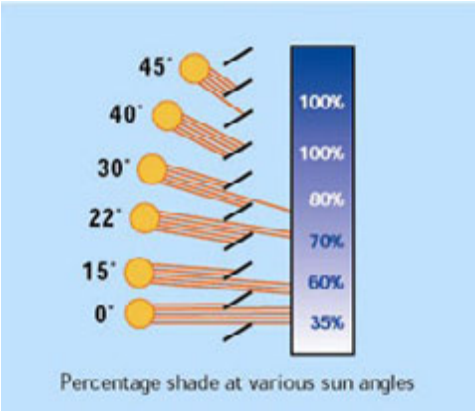
Strategy 3: PLACEMENT: CASH adopts the crawl space, rising up the plan above the ground, making a difference between public and private. This also helps in reducing the humidity levels and promotes the hygiene of the house, making it difficult for the plagues or insects to access the interior. In order to perform properly at the Washington DC location, CASH has to be oriented with its long axis east – west, and with the shorter leg of the "L" towards the south. This way, the laundry wall closet serves as a space that hinders the heat enter into the multipurpose room from the south, as well as the other wall cabinet units located east and west. The PV modules are located facing south at 42 degrees. In Puerto Rico, we have the option of accommodating the house with the short leg of the "L" facing north, which would provide for more shadow at the patio during the summer months.

Strategy 4: SCREENS: We are preventing the incidence of direct solar irradiation to the interior of the house with the use of screens and a screened porch that serves as our main entry. Screens have been extensively used through the tropical region. In our design, we used them to reduce the direct solar radiation, while having the opportunity for cross ventilation, required to keep us cool.

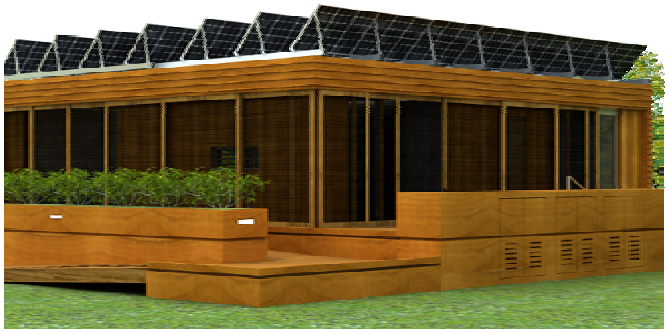
Each Koolshade screen is made up of hundred of tiny louvers, each inclined at 27°. As the sun's rays travel in a straight line at dawn and dusk when the sun is at an angle of 0°, light and heat enter directly into the building, however, as the sun rises in the sky, the screens block out the harmful effects of the sun. Once the sun reaches an angle of 40°, Koolshade blocks 100% of the sun's direct rays. KoolShade improves the comfort of any building by eliminating all the damaging effects of the sun.

- Reduces solar heat gain by 86%
- Eliminates direct glare - Blocks all direct glare, therefore significantly reducing reflection on PC and TV screens.
- Stops entrance of all insects
- Improves the appearance of the building
- Protects against wind and rain while maintains a perfect view to the outside
- Are easy to maintain
- Blocks 100% of UV, reducing damage to furniture, curtains and artwork
- With KoolShade the heat never reaches the window in the first place. Typically KoolShade reduces the temperature between sun exposed glass by **10°c or more** in the Canary Islands (information taken from the manufacturer)
- The reduction in heat gain caused by KoolShade means that for the majority of the year the use of air conditioning will not be necessary as the building will not heat up in the first place.

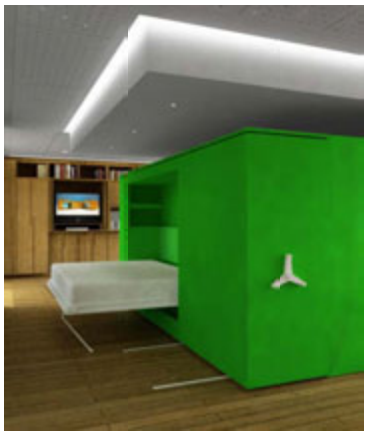


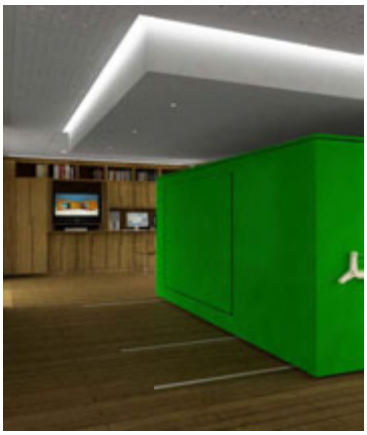


Strategy 5: CROSS VENTILATION and DAYLIGHTING: The tropical aesthetics and functionality of **CASH** are also expressed by the cross ventilation and natural daylight. This is a main strategy to reduce energy use. It is important to feel and experience the direct relationship between the interior and the exterior, as well as the fluidness of the space.



Strategy 6: FLEXIBILITY: Our house can be considered as one main space with transformable features. With a simple movement of a partition, more than one activity is possible at the same space. The flexible aspect of CASH is clearly expressed in the bedroom / bathroom area. These areas can expand or contract in response to the function, as needed. The bed is located inside a movable partition that also works as a closet. This closet can be moved resulting in the reduction or expansion of the bathroom space, hence the north façade exterior entry to the bathroom. It is important to note that even if the bathroom is expanded to its maximum and the bed is open, there is still space to walk between the kitchen and the office / living areas.



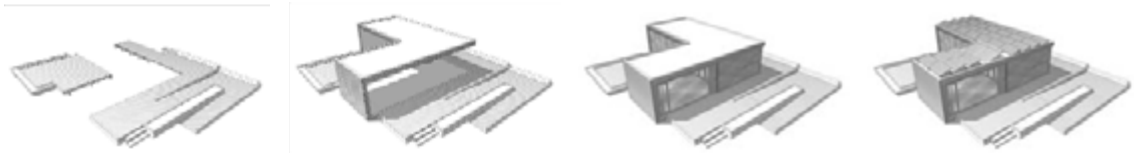


Likewise, the kitchen possess plenty of space to be functional, as it enables the insertion of the dining table, when the kitchen in not in use, permitting more space for other uses. The dining table can be moved from the kitchen area to the screened porch, enabling the spaces serve different purposes.

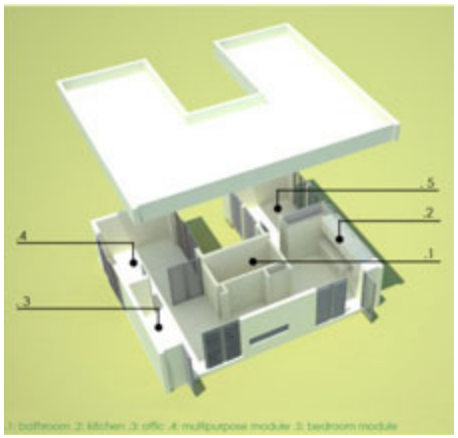
Strategy 7: LAYERING: A reconfigurable skin. Our envelope is made of high R-value walls with double doors and screens. This enables the user to accommodate his or her needs to their thermal comfort zone.

Strategy 8: BUILT IN WALLS and OPEN SPACE: All the cabinets and storage areas are placed at the East and West walls, creating a barrier to reduce the heat from the outside to the interior. With less partitions and a strong connection our house feels bigger! There are two wall / cabinet

units attached at both ends of the main module, and another at the south wall of the multipurpose room. This enables more free space that can be used as ones' needs changes.



Strategy 9: CASH can GROW! We have designed the house to add a third bay, making a "U" shaped plan while keeping the interior patio. This enables the user to have an additional area for a bigger family.



The Team contemplated the idea of designing different volumes similar to the multipurpose room that can expand the house's space. Some of these expansions could be a garage, a salon, a bedroom or a double bedroom. Besides we offer the opportunity to reduce considerably the direct entrance of the sun's rays to the inside of the house, by the addition of a pergola. For this intention we have designed a CASH kit, from which you can choose among a variety of modules to satisfy your needs in house spaces.

Strategy 10: Reclaimed wood and diverse materials

The skin of the house is based on a triple skin system that is distributed among solid and translucent surfaces. The first translucent layer is formed by glass folding doors. They can be closed when the mechanical air conditioning system is working or can be opened to make good use of the natural ventilation. Glass enables a good relationship between the interior and exterior of the house permitting views. There is a second lighter skin layer that is very versatile (aesthetically and functionally). This layer is made by sliding screens that can function as barriers against the insects, while keeping the interior of CASH cool by preventing the heat gain from the sun's rays. The solid cover of the wall consists of a siding of redwood. The principal aspect of the envelope is to reduce the heat transfer to the interior of the house.

Another main aspect is the transportation issue. Because of this, our competition model is made of a steel frame. The competition model of CASH has a high volume of recycled materials. The reclaimed redwood exterior cladding comes from a building at the University Campus in Rio Piedras which is being remodeled.

The teak wood for the floor and bathroom wall is also reclaimed and comes from old benches that were thrown away from a public park in San Juan. The total volume of reclaimed wood is approximately 1,300 sq. ft.

General Studies building at the Rio Piedras Campus, from where redwood was reclaimed

Escofet benches from Parque Central in San Juan, from where teak wood was reclaimed

Our finished wood

Our wood, properly placed and kept at the construction site

MARKET VIABILITY JUSTIFICATION

MARKET I.D. PARAMETER	TARGET MARKET
Location of permanent site	Caribbean
Housing type	Weekend lodge
# of occupants	2
Occupant demographics	Middle-aged investors
Household annual income	$52,000
# of bedrooms	1 (loft type)
Site area minimum required	3,600 sq. ft. (334m²) Minimum required to respect solar envelope
Site characteristics	Open area with direct solar radiation. Maximum slope of site equals to 18" max.
Needs + Desires	Experience Caribbean nature and its surroundings within the comfort and protection of a modern home. Experience living in a solar and sustainable home.

PRODUCT CHARACTERISTICS	
Construction area	800 sq. ft. of house + 1,430 sq. ft. of deck
Conditioned space	484 sq. ft.
Porch area	182 sq. ft.
Access	3 access points through deck (one is ADA compliant), 5 access points through house, plus the bathroom has an alternative exterior entrance.
Naturally ventilated areas	All areas can be naturally ventilated. House has HVAC at main living areas.
Assembly time required	5 days (site preparation, modules coupling, deck assembly, PV panel system, interior finishes)
PV System	34 Sun Power panels, 305 W each
System energy production capacity	41.9 kWh

Average daily energy usage	33 kWh
Energy Surplus	8.9 kWh
Energy savings based on local rate	$277 monthly ($9.24 daily) Puerto Rico has a variable local utility rate, which had a mean of $0.28/kWh for residences, last year.
Average Profit resulting from energy surplus due to Net Metering system	8.9 kWh $2.49 daily = $74.76 monthly
Advantages of Materials (consider Concrete as a comparable due to its dominance in the local construction industry)	Wood veneers: reclaimed eco-friendly redwood and teak, Caribbean aesthetic, insulated walls, craftsmanship and local trades. Steel structure: hurricane resistant, earthquake resistant, transportable. Designed to meet and exceed local codes.
Usability	Readily available products: appliances, electronics, lighting
Advantages of solar system	Quiet, clean, and safe 20-25yrs warranty Carbon footprint reduction CO2 emissions reduction Low maintenance
Annual Carbon Emission	13,528 pounds of CO2*
Annual Carbon Emission reduction by taking energy saving actions **	25,740 pounds of CO2*
Annual Potential dollar savings by taking energy saving actions **	$2,114*

* www.epa.gov, Household Emissions Calculator

** Energy saving actions taken into consideration: setting the air conditioner at 75° F, using cold water in the washing machine for 2 loads per week, enabling sleep feature on computer monitor, air drying 50% of laundry, using 10 20-watts Energy Star lights, and using an Energy Star refrigerator.

Livability

Comfort is an essential aspect in a home. CASH offers an ample space in which you can feel and perceive different aspects of the Caribbean. Its "L" shape floor plan generates a particular connection between its deck and the house. The Koolshade screens used in the house maintains an uninterrupted view with the outside while at the same time it reduces temperature by 10°C. These screens are located all around the house façades to provide a visual connection between the interior and exterior. Meanwhile sliding glass doors are used to maintain interior climate control. With the plan to maximize space efficiently, the house has a minimum required conditioned space with an attached unconditioned area working as a multipurpose space. The movable wall, located in the center of the conditioned module, provides expansion for the bathroom and also gathers space for the bed.

CASH has been designed to conform to a basic but technologically contemporary lifestyle. Its PV panel system has enough efficiency to support kitchen appliances, laundry machines and a HVAC system. The craftsmanship of the reclaimed woods are carefully arranged to respond directly to the architectural design and the placement of the appliances. The open space of the house eases its cleaning process. Open floor plan was possible by installing wall units on every space. An even wider open space is achieved by the movable partition which houses the bed on one side and the bathroom on the other. The woods used on the prototype are reclaimed woods, redwood and teak, which require little maintenance compared to other woods.

Flexibility of space usage
CASH transform its façades and interior spaces in response to usage. All livable spaces can adjust to different usages. A main component in the house is the movable partition which separates the bathroom, allowing for more space in the bathroom or in the hallway. The arrangements of wall unit furniture consume the least space possible and provide for a wider open space. The open spaces welcome the flexibility of usage, for instance the dining table could be easily accommodated in the kitchen, on the hallway next to the movable partition, or in the entrance multipurpose porch. The multipurpose area offers a relatively big space in which many activities can be performed such as dinning or family activities. In the kitchen, a movable table can be placed above the counter, in order to consume less space while not in use.

Caribbean feeling, sliding glass doors and screens around the house enable the option to open the house completely for cross ventilation and make an interaction with the exterior. Also the layering of the screens provides both shade and visual privacy.

Buildability
The steel structure of CASH is designed to create a set of modules or volumes that join in order to form the house. This makes it easier for the transportation of the house; it also allows saving time in the building process. CASH is designed to be assembled on any site. The use of wood is predominant in the building's exterior and interior, such as deck, floor, and furniture of the house. Wood is a commonly known construction material which makes the construction process easy, without the need of costly specialized labor.

CASH is a house designed to be transported anywhere and with the option of adding extra modules to provide the possibility of space for growth. These annex spaces will be equal to the porch area, and can be attached to any of the side entrances: kitchen area and living/office area.

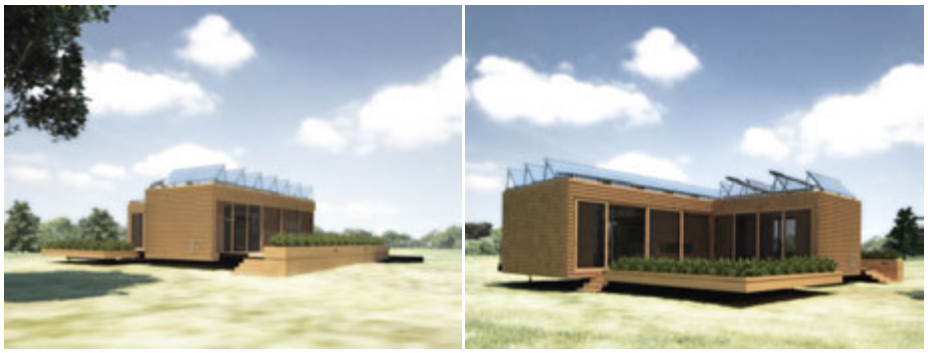
Construction Documents have been developed in direct contact with local contractors so that it's reading and understanding is clear and accurate for any detailed cost estimate and for construction execution. Our construction manager is specialized in wood installations.

Marketability
Puerto Rico as part of the Caribbean has a tropical warm climate all year long. This ease to live and enjoy its nature and its environment has been taken into consideration in our design. An Affordable House enables the option for different people to own a home. To help the environment, solar energy can be an alternative for the auto sufficiency of a home. CASH offers all of these: tropical designed aesthetics, affordable and solar energy production. All of this makes CASH a practical and enjoyable home.

CASH, as an ecological lodge, will expose clients to experience the life in a sustainable home. Therefore it becomes an education tool which will stimulate the usage of solar energy on the Caribbean. By demonstrating the similarity in functions to non ecological-solar house, home buyers

would be more attracted to this product due to its advantages. The most attractive feature CASH has is the advantage of the net metering systems which provides savings and earnings. With this house more people can get a green house for their families and one by one help reduce the fuel dependency and live in an eco-friendly home.

CASH final location: Caguas Municipality Botanic Garden


CASH in its natural setting

CASH north façade with its subtle day lighting

Transportation
One of the biggest challenges we face with CASH is the transportation from Puerto Rico to Washington DC. The abuses that the house may suffer in the transportation by land, sea and when lifted by cranes, compel us to opt for a steel structure. One of the advantages that the "L" design of the house has given us, is the ability to transport the house in two parts containing the pieces that will be our house. The decision of having only two modules was taken to minimize assembly time by only having one joint.

Plumbing
The supply of cold and hot water in the house flows through PEX tubing held in place by the typical copper piping. The advantage of using this system is seen in the tightness of the seams. Using these pipes guarantee that the force of compression on the union is optimal, even at the highest temperatures. The pipelines do not require connections that are usually typical of the copper tubing so the process of assembling the infrastructure will move faster. This condition guarantees us more efficient equipment and less risk of experiencing leak problems.

Solar Thermal Water Heating
An Evacuated Tube Solar Collectors system is used to heat the water. It absorbs thermal energy from the sun converting it into usable heat that is normally absorbed by water. The energy can be used for heating water and for heating and cooling space with the use of an absorption chiller. Also, the crucial location of the hot water tank permits us minimize the loss of water temperatures.

Radiant Ceiling
It is very important that every element of the architectural and engineering systems is designed as a whole. It is our intention not to just simply adhere the engineering systems to the structure. We also want them to play a leading role in the design of the house. One of the integrated systems that join engineering with architecture is the radiant ceiling. We are concerned about several issues in CASH like thermal comfort. A radiant ceiling system is used in the design of the house to provide a pleasant atmosphere. The radiant ceiling system will be used for heating or cooling spaces inside the house.

Radiant ceilings provide us with an accelerated rate of heating, allowing us to create big changes in the heating load. They are extremely efficient and have a fast dissipating energy. The responsiveness of radiant ceilings makes them excellent for modern controls, placing energy where it is needed when it is needed, and achieving superior comfort and efficiency.

Sustainability
The sustainable design of CASH includes the possibility of rainwater recollection, storing the water in tanks for later use in the irrigation system. The stored water will be pumped through a system of pipes that will water the plants on the planters located in the deck of the house. However this system will not be installed for the Solar Decathlon Event.

Energy Use
For CASH we have been able to reduce the energy use with different improvements made to our design at different stages. For more information on this topic refer to the Energy Modeling Report.

HEATING, VENTILATING AND AIR CONDITIONING SYSTEM BASIS OF DESIGN

Design Criteria
Mechanical systems will be designed to provide adequate cooling and ventilation to all required areas of the building. The HVAC system will be design following the American Society of Heating Refrigerating and Air Conditioning Engineers standards and local codes and regulations. The project presents a particular challenge since the competition standards and regulations require that the structure be design and constructed in an extreme efficient manner using, as much as possible, "green" concepts. Special care and coordination is required for the mechanical systems design with an extensive use of innovative designs and renewable energies.

Applicable Codes and Regulations
The mechanical systems will be designed to conform as a minimum, with the following codes, regulations and standards:

1. *National Fire Protection Association (NFPA).*
2. *Uniform Building Code-1997 (UBC).*
3. *American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).*
4. *American Society of Testing Materials (ASTM).*

Design Parameters

1. *Project Location: Washington DC, USA*
2. *Latitude: 38.9 Degrees North*
3. *Elevation Above Sea Level: 66.0 Feet*
4. *External Design Conditions:*
    a. *Dry Bulb: 74.7 Degrees F*
    b. *Wet Bulb: 67.4 Degrees F*
5. *Internal design conditions:*
    a. *Dry Bulb: 74 ± 2 Degrees F*
    b. *Wet Bulb: 64 Degrees F*
6. *Relative Humidity: 55 ± 5%*

Design Occupancy
Density occupancy will be as per competition requirements and as per architect space program.

Occupancy schedules
HVAC system will function during house occupancy period.

Mechanical Ventilation
Ventilation rate shall be as per applicable code. Ventilation will be provided by means of a Heat Recovery Unit, located above hung ceiling, exhausting air directly to the atmosphere from the bathroom at a rate of 90 cubic feet per minute. Said Heat Recovery Unit will recover part of the sensible and latent heat from the exhaust air and will transfer it to the Air Handling Unit's outside air intake to lower the total system heat load thus increasing overall efficiency. An additional Exhaust Fan with a local retractable Canopy Hood will be provided to remove water vapor from the kitchen while cooking.

Outdoor Air Ventilation
Minimum outdoor air ventilation shall be provided as required by ASHRAE Standard 62.1-2004.
System Description

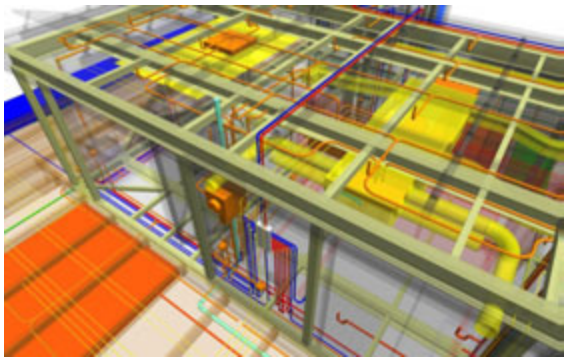
Air Conditioning Unit
Air conditioning system consist on a environment friendly refrigerant based outdoor unit that produce and distributes cold or hot water, depending on weather conditions, throughout other system components. Water is delivered at 40°F in cooling mode and 140°F in heating mode. It also has a hot water tank with a nominal storage capacity of 40 gallons to be used for the delivery-air reheat in summer operation as a means of indoor humidity control.

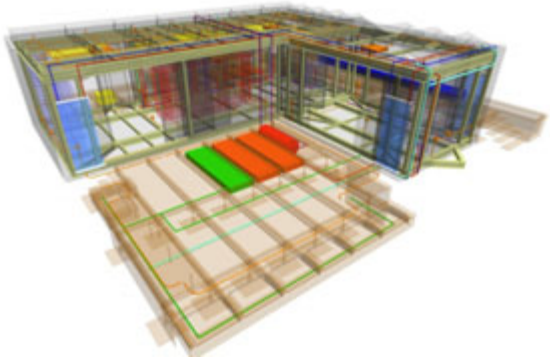
Hydronic Distribution
Cooling and heating will be achieved by providing conditioned air to the spaces using the Fan Coil Unit. Approximately 30% of the sensible cooling or heating load will be handled by means of a radiant ceiling system. Indoor dry bulb temperature and relative humidity set point will be achieved modulating chilled water, reheat water and humidifier control valves as per sequence of operation of attached diagram. The system will deliver chilled or hot water, depending on weather conditions, to the Fan Coil Unit cooling/heating coil and to the radiant cooling/heating ceiling system.

Radiant cooling temperature will be set 2°F above room dew point temperature to avoid condensation. For these matters a circulating chilled water pump will be provided. Also, for further condensation protection a shut-off valve, interlocked with the house entrance doors, will be installed to close chilled water flow to radiant ceiling.

Water distribution piping shall be steel with field applied fiberglass insulation. Weather exposed insulation will have fiberglass mesh, mastic, vapor retardant and aluminum jacket. The system shall have expansion loops, thrust blocks, anchors and pipe supports.

Air System
Generally the HVAC air system will be chilled water based Fan Coil Unit serving the required areas.
A Fan Coil Unit will be custom made double wall construction and will be located above hung ceiling with sufficient space for servicing and maintenance. Air Conditioning will be variable volume type Unit modulating by means of a variable frequency drive responding to a duct mounted pressure sensor. Supply and return plenums will be fabricated out of galvanized sheet metal and ductwork to terminal registers will be flexible. Each supply air diffuser will have an automatic volume damper that will be actuated accordingly to a preset room temperature set point. A constant volume Heat Recovery Ventilator will deliver outside air to the A/C Unit at a rate of 90 cubic feet per minute.



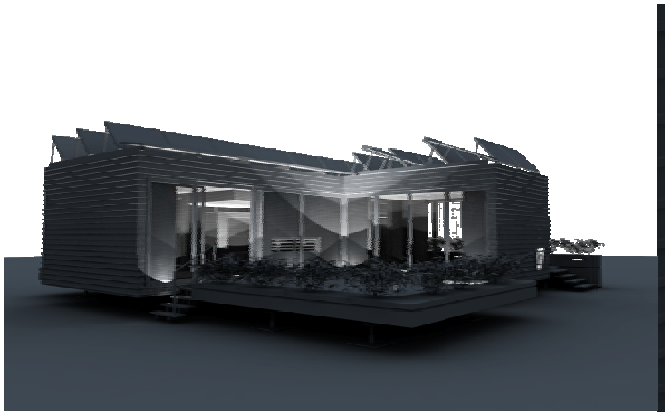


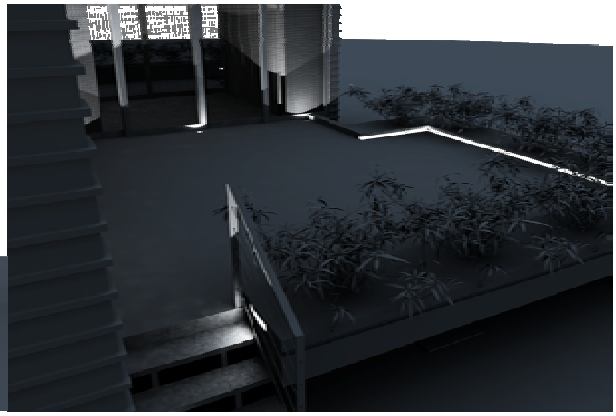
LIGHTING DESIGN NARRATIVE

Any visitors approaching CASH are lured in by its elegant design and its intriguing illumination.

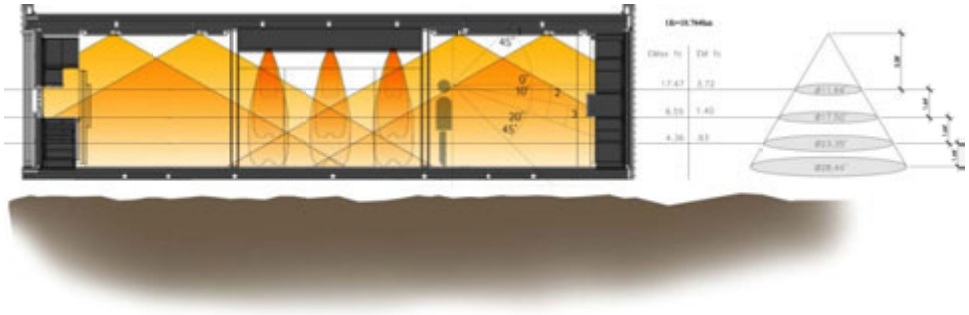
From Dusk…

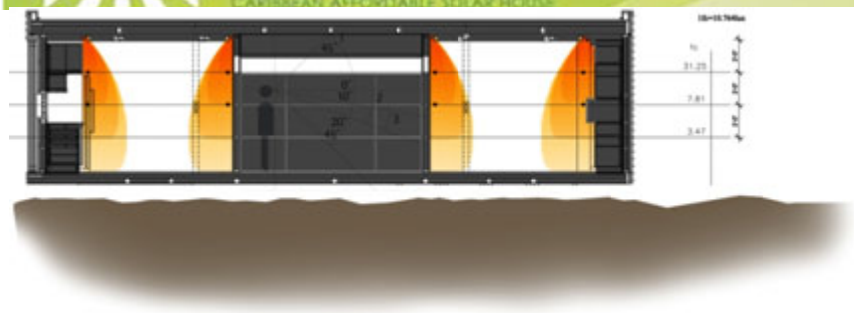
When the Sun sets, CASH provides a very simple and easy access, by using a series of LED lights which illuminate the deck and the ramp guiding the circulation towards the main entrance and secondary entrances with a subtle and tenuous glow. The deck itself transforms the house into an artistic object by surrounding it with several spotlights that produce a theatrical effect while illuminating the façades of the house, very similar to an art exposition or an item showcase. By using these adjustable spotlights we can control and adjust the illumination specifically towards our façades without emitting any rays of light towards the night sky and bringing out the horizontal lecture created by our unique assembly system, made of reclaimed redwood. This is very important due to the fact that meandering light can disrupt and interfere with ecosystems causing serious disorientation to many species and also produce sky glow, a problematic effect caused by over-illumination. This affects and obstructs the views of astronomers and common sky gazers who intend to study, appreciate, and enjoy celestial observation. In addition to this, a strip of LED lights emits a delicate glow, delimiting the boundaries of the main deck.

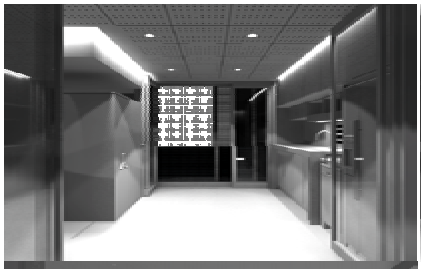


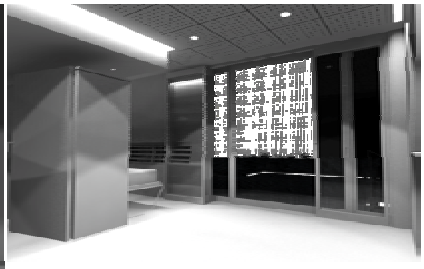


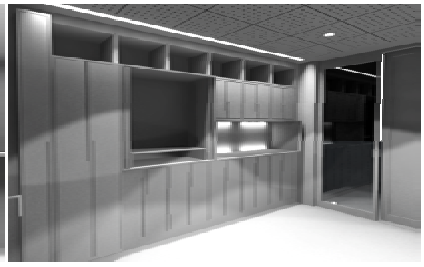
For our interior illumination, our intentions were based on providing two different types of lighting: general lighting and scenic lighting. By measuring the amount of light needed for each space through a series of diagrams and based on the Illuminating Engineering Society (IES) lighting standards, CASH illuminates both common and private areas with dimmable fluorescent fixtures (living, dining and kitchen area), providing efficiency while meeting the specifications mandatory for the proper functionality of the multiple activities.

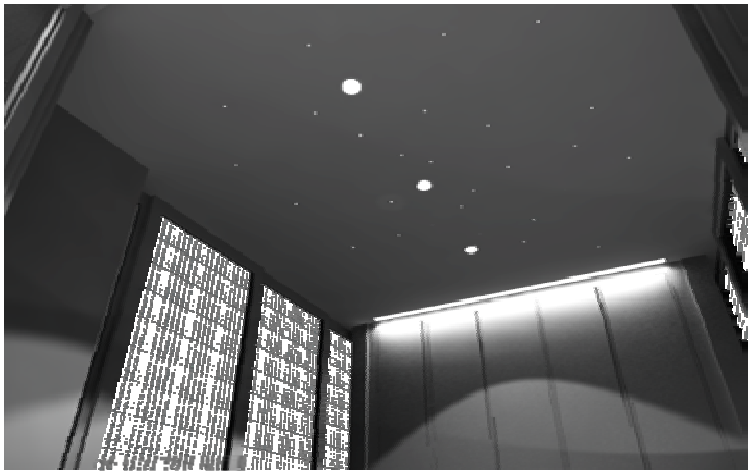












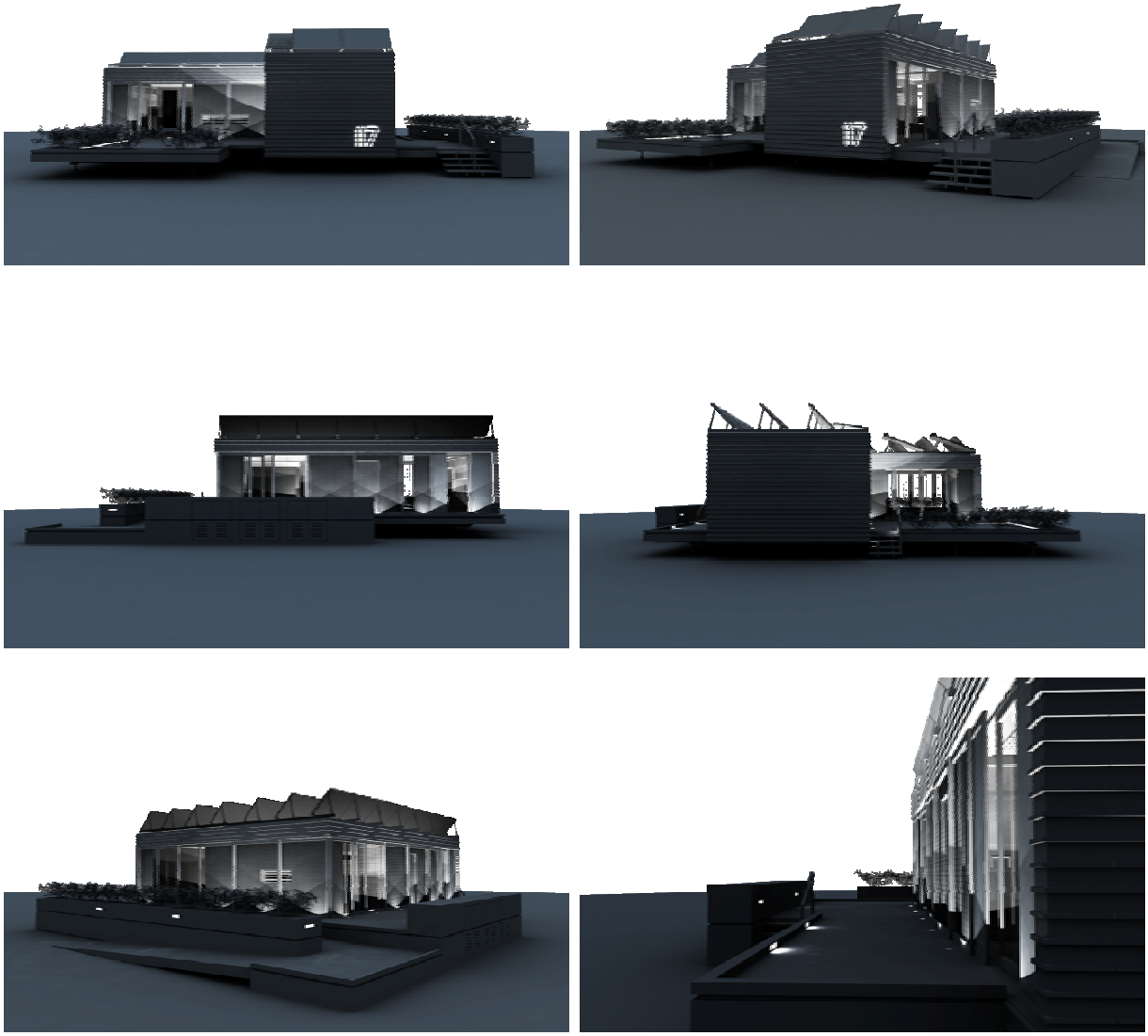
The idea of creating an environment pleasant enough to reach the individuals expectations is achieved with these fluorescent fixtures by adjusting the intensity produced in the different areas.

Also included in the design are three halogen fixtures in the bedroom/hallway area that supply the amount of task light needed, for example, to read in bed. Other task lighting areas such as the kitchen, counter and the workstation area satisfy the needs to execute a specific task or obligation by using low wattage fluorescent tubes varying in size and energy consumption, giving each area the amount of illumination required without exceeding the amount needed.

Hidden in the walls and furniture, the scenic lighting gives a more private and personal touch in the design of each space, alternating it to a distinctive ambient.

Another elegant feature is the starry sky effect; emitted by 30 1W LED lights which are installed in the multi-purpose space, complimented with a nice beach hammock give the notion of lying under the stars. The design's hidden psychological intent is to provoke interest in the observer for celestial phenomena such as the stars or simply to bring about the satisfaction of observing the beauty of a

true starry night, creating a sense of conscience towards proper lighting use, and therefore reducing and avoiding further luminous pollution such as sky glow and over-illumination.



…Till Dawn

Considering the amount of sunlight received and the fact that it's entirely free, our design was based on the concept of a completely open house in order to provide as much natural illumination as possible regardless of its orientation. The house's geographical position influenced the decision to open the house to the exterior, not only because of the amount of natural light available but to rescue the possibility of natural ventilation as well. By taking advantage of all the natural illumination and ventilation we also gave the liberty to manipulate how much light gets in or out with the flexibility of juxtaposing or combining two different elements: glass and the KoolShade screens - an innovative metallic screen designed to block direct Sun rays. Not only is natural light more than abundant in our design, we also have given the occupant the option to adjust the amount of light to his or her like needs.

TEAM UNIFORM

Our team will have various uniform shirts that will be used at different times throughout the project. Some will be informal for construction, and assembly purposes. Others will be formal for special events and activities. A 100% cotton short and long sleeve T-shirt will be used during construction at the University. Both will have the Solar Decathlon logo and the University of Puerto Rico logo on one sleeve and the uniform sponsor logo on the other sleeve. These will be either white of light charcoal color. Team Uniforms will follow the SD 2009 Rules and Regulations.

For special events, activities and the competition week, we will be using a long sleeve buttoned shirt. This shirt will be embroidered on front with the Solar Decathlon logo on one side, our team logo on the other side, and the sponsor's logos on the back.

And to make our Caribbean theme stand out during the Dinner Party contest, we will be using a light colored *guayabera*, commonly known as a Cuban shirt. This will be complemented with a *Panama* hat.