Penn State Solar Decathlon
2009 Team
Project Manual

NATURAL FUSION

PENNSTATE
1855

Contents

1.0 Summary of Changes ... 1
2.0 Rules Compliance Checklist ... 4
3.0 Construction Specifications ... 7
4.0 Structural Calculations ... 196
4.1 Project Overview ... 196
4.2 Load Summary ... 196
4.2.1 General ... 196
4.2.2 Construction Loads ... 196
4.2.3 Transportation Loads ... 197
4.2.4 Seismic Loads ... 197
4.2.5 Dead Loads ... 197
4.2.6 Live Loads ... 198
4.2.7 Wind Loads ... 198
4.2.8 Snow Loads ... 199
4.2.9 Load Combinations ... 199
4.3 Specifications ... 200
4.3.1 Deflection Criteria ... 200
4.3.2 Roof ... 200
4.3.3 Frames ... 200
4.3.4 Shear Walls ... 202
4.3.5 Floor Joists ... 202
4.3.6 Decking ... 203
4.3.7 Foundations ... 203
4.4 Structural Appendices ... 204
A. Load Calculations ... 204
A.1 Transportation Loads ... 204
A.2 Seismic Loads ... 212
A.3 Dead Loads ... 213
A.4 Wind Loads ... 214
A.5 Snow Load ... 230
B. Load Simulation ... 236
B.1 Computer Model Setup ... 236
B.1.1 Input Command Files ... 236
B.1.1.1 Model 1 - All Moments ... 236
B.1.1.2 Model 2 - Moment Releases ... 241
B.1.1.3 Model 3 - Resistance to Roll ... 246
B.1.2 Geometry ... 249
B.1.3 Load Cases ... 251
B.1.3.1 Dead + Snow ... 251
B.1.3.3 Dead + Wind (N-S) ... 251
B.1.3.5 Dead + Snow + Wind (N-S) ... 252
B.1.3.7 Dead + Wind (S-N) ... 252
B.1.3.9 Dead + Snow + Wind (S-N) ... 253
B.1.3.11 Transportation + Wind (N-S) ... 254

B.1.3.13 Transportation + Wind (S-N) ... 254
B.2 Member Force Output ... 255
C. Main Wind Force Resistance System ... 261
C.1 Transverse Resistance to Roll ... 261
C.2 Frames ... 262
C.2.1 Wood Members ... 262
C.2.1.1 Forces ... 262
C.2.1.2 Reference Design Values ... 263
C.2.1.3 Factors ... 268
C.2.1.4 Stress Evaluation Check ... 272
C.2.2 Connections ... 284
C.3 Shear Walls ... 285
C.3.1 South Shear Wall ... 285
C.3.2 North Shear Wall ... 287
D. Roof Calculations ... 288
E. Decks and Ramps ... 292
E.1 Decking Selection ... 292
E.1.1 Egress Check ... 297
E.2 Joist Selection ... 299
E.2.1 Egress Check ... 306
E.3 Girder Selection ... 310
E.3.1 Egress Check ... 313
F. Foundations ... 315
F.1 Jack Loads ... 315
F.2 Pad Sizing ... 315
F.3 Deck Post Sizing ... 316
5.0 Water Budget ... 317
6.0 Unlisted Electrical Components ... 319
7.0 Retail PV Price Quote(s) ... 320
8.0 Reconfigurable Features ... 322
9.0 Interconnection Application Form ... 323
10.0 Energy Analysis Results and Discussion ... 324
10.1 Green Roof Integrated Photovoltaics ... 324
10.1.1 Green Roofs ... 324
10.1.2 Future Studies using CFD ... 325
10.1.3 PV performance ... 325
10.2 Solar Water Heaters ... 326
10.3 Overall Shape ... 328
10.4 Windows ... 329
10.5 Thermal Mass ... 330
10.5.1 Floor Water Bladders ... 330
10.5.2 Phase Change Material ... 330
10.6 Appliances ... 331
10.6.1 Selected Appliance Data ... 331
10.6.2 Load Profiles ... 332

10.7 HVAC 334
10.8 Summary 334
11.0 Architecture Design Narrative 335
12.0 Market Viability Justification 336
12.1 Executive Summary 336
12.2 Introduction 337
12.2.1 About the Area 337
12.2.2 Recent Economic Conditions 339
12.2.3 New Home Growth 340
12.2.4 Sustainability Initiatives of Philadelphia 341
12.2.5 Local Electric Utility 341
12.2.6 Pennsylvania Identity 342
12.2.7 About the People (DINKs) 343
12.2.8 Do DINK's Want Sustainable Homes? 344
12.2.9 Why the Natural Fusion home is appealing to them 344
12.3 Livability 345
12.3.1 Simple, yet Sophisticated Style 345
12.3.2 Public Space: The Great Room 347
12.3.3 Private Space: The Bedroom and Bathroom 348
12.3.4 High-Tech, yet Manageable Systems 349
12.4 Marketability 349
12.4.1 Summary of Systems – Simple, Cost Effective, and Efficient 349
12.4.2 Current, and Lasting, Value 359
12.5 Conclusion 360
12.6 Works Cited 361
13.0 Engineering Design Narrative 362
13.1 Mechanical and Plumbing 362
13.2 Electrical and Photovoltaic 363
13.3 Structural 363
14.0 Lighting Design Narrative 364

1.0 Summary of Changes

The Penn State 2009 Solar Decathlon Construction Documents have undergone significant changes.

Every Construction Drawing has been significantly changed since the last submission in December. Major aspects of design changes, per the Construction Drawings, are listed and briefly described in each of the following areas:

LANDSCAPING:

- Decking – The decking has been reconfigured to better incorporate a tour route, which has extended with a sense garden on the east side of the house. A connection from the east to the north has been added to develop a functional circulation.
- Green Walls – They have changed from a hydroponic wall system; the new life-well is a compilation of slats and planters that will grow to be a uniform wall that users can customize with plants or storage.
- Wall to railing – The removal of the western partition wall to a railing has been done to reduce the square footage.
- Wetland – The wetlands have been removed to comply with rules and guidelines.
- Sense Garden – The sense garden has grown to become a more private setting, and includes a sitting area, sustainable entertainment, and scented paths.
- Grow (GR_2O) – This area was relocated to conclude the tour so that individuals would have time explore the home options.

STRUCTURE:

- Framing – This has changed from standard 2 x 12 structure to a 9.5 open web joist going north to south.
- Truss – This has changed from built up 2x framing to timber framing.

HOUSE

- The south sliding glass doors have been removed and become folding glass doors.
- The cabinetry has been reconfigured to work better with the interior spaces.
- More outside elements such as the rain screen and plants have been incorporated to better fuse the inside with the outside.

ARCHITECTURE:

- Floor layout – After the bathroom was reconfigured and switched around as well as the bedroom was slightly rearranged so that the north wall is completely storage. Other changes are minimal.
- Nexus location change – Relocated to fit between two trusses.
- French doors – A set of French doors were added to the bedroom.
- South door system – The south door system has been modified from a track system with large door panes separated into a folding glass wall system.
- Nexus door - The door system was separated into two layers of doors one for the door and green wall and another for the rain screen, making the door more practical.
- Lifewell arrangement – To become a more centralized, we relocated the Lifewell below the truss as well as simplifying the construction and maintenance.
- Awning – The awning changed from a glass over hang to a tracking photovoltaic awning.
- Skylights – After relocating the Lifewell under the truss the skylight was broken up into 5 smaller openings for structural reasons as well as lighting design.
- Phase change – Was added into the walls and ceilings to reduce temperature fluctuation and absorb heat when not necessary and released when needed.
- Earth plaster – typical drywall – Change from earth plaster to drywall and zero VOC paint
- Advancement in detail drawings - After working with PBS (modular builder) we detailed the drawings to better comply with structure or code.

PLUMBING:

- Water tanks, in lieu of long capped pipe runs below the deck, two water bladders located in structure supporting boxes lined with moisture barrier will be located below the deck.
- Hot water schematic, heat pump no longer interacts with the solar collection loop.

MECHANICAL:

- Change from up-draft range hood to downdraft – hood now vents below the flooring.
- Mini Split System – changed to two outside fans and two interior units.
- Bladder layout changed – locations verified where electrical and plumbing routing is not below the floor obstructed bladder system.
- Change from evacuated tubes on south roof to flat-plate collectors on south façade.

ELECTRICAL:

- Photovoltaic array was rotated.
- Smoke detectors location was redone according to code.
- Lighting design was reworked.
- Awning was added to enhance the solar efficiency of the home to track the solar path throughout the day on the southern façade.

OTHER DISCIPLINES:

- Tour route changed to comply with safety and allow for constant circulation throughout the home.
- Uniform modification.

OPERATIONS:

- Changed from a roll off to a drive in and jack up.

The Project Manual has undergone changes in each of the following sections:

1.0 Summary of Changes
Added a brief summary of changes

2.0 Rules Compliance Checklist
Added this section and its content

3.0 Construction Specifications
Added complete set of specifications per MasterFormat2004

4.0 Structural Calculations
Updated calculations for the current design and obtained a professional structural engineer's stamp for approval

5.0 Water Budget
Updated the water budget and added details, including a hot water use estimate

6.0 Unlisted Electrical Components
Added one component, the only component in the section

7.0 Retail PV Price Quote(s)
Obtained quote(s)

8.0 Reconfigurable Features
Added and modified the reconfigurable features descriptions per the current design

9.0 Interconnection Application
Updated the content of the form per the current design; included views of the four requested drawing sheets that are contained in the Construction Drawings set

10.0 Energy Analysis Results and Discussion
Increased the depth of detail of the discussion of the analyses and portrayed the quantitative results that have been obtained

11.0 Architecture Design Narrative
Updated to match the current design

12.0 Market Viability Justification
Fully redone to better match what has been requested

13.0 Engineering Design Narrative
Updated to match the current design

14.0 Lighting Design Narrative
Updated to match the current design

2.0 Rules Compliance Checklist

Rule #	Rule Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
4-2	Construction Equipment	Drawing(s) showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	O-701,702,703	
4-2	Construction Equipment	Specs for heavy machinery	Specification 41 62 19	
4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	E-401	
4-4	Impact on the Turf	Drawing(s) showing the location, contact area, and soil bearing pressure of every component resting directly on the turf	S-101, S-102, S-103, L-101, L-506	
4-5	Generators	Specifications for generators	Specification 26 32 13	
4-6	Spill Containment	Drawing(s) showing the locations of all equipment, tanks, and pipes that will contain fluids at any point during the event	P-102, M-105, M-301, M-501, A-104	
4-6	Spill Containment	Specifications for all equipment, tanks, and pipes that will contain fluids at any point during the event	Specifications 22 11 16 22 11 19, 22 11 23, 22 12 19, 22 33 00, 22 40 00, 23 56 00	
4-7	Lot Conditions	Calculations showing that structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	S-102, 103	
4-7	Lot Conditions	Drawing(s) showing shimming methods and materials to be used if 18 in. (45.7 cm) of vertical elevation change exists on the lot	S-102, 103	
5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	L-101, 201, 202	
5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	N/A	
6-1	Structural Design Approval	List of, or marking on, all sheets in the complete electronic Construction Documents that have been or will be stamped by the structural engineer in the hard-copy, stamped structural submission; the stamped submission shall consist entirely of sheets or pages that also appear in the complete electronic construction document set	S-101,102,103,104, 105, 201, 501	

Rule #	Rule Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
6-2	Maximum Architectural Footprint	Drawing(s) showing all information needed by the Rules Officials to measure the architectural footprint electronically	A-105	
6-2	Maximum Architectural Footprint	Drawing(s) showing all movable components that may increase the footprint if operated during contest week	N/A	
6-2	Maximum Architectural Footprint	Shading calculations and/or diagrams for components that DO NOT shade the building above its finished floor height between 9 a.m. and 5 p.m. EDT on October 1 (shading calculations and/or diagrams are not necessary for components that are either shorter than finished floor height or obviously do not shade the building)	A-901	
6-3	Minimum Conditioned Space	Drawing(s) showing space conditioning means in primary living spaces	M-102, 104	
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	X-101	
7-1	Placement	Drawing(s) showing the location of all vegetation and, if applicable, the movement of vegetation designed as part of an integrated mobile system	L-102, L-103, L-105, L-501, L-507, L – 601 to L-605	
7-2	Watering Restrictions	Drawings showing the layout and operation of greywater irrigation systems	N/A	
8-1	PV Technology Limitations	Specifications for photovoltaic components	Specification 26 31 00	
8-1	PV Technology Limitations	Retail price quote for photovoltaic components	Project Manual Section 7.0 pg. 320	
8-3	Thermal Energy Storage	Drawing(s) showing the location of thermal energy storage components	M-105, M-501 A-305, A-306	
8-3	Thermal Energy Storage	Specifications for thermal energy storage components	Specification 23 71 00	
8-3	Thermal Energy Storage	Shading calculations and/or diagrams for thermal energy storage components (if necessary)	N/A	
8-4	Batteries	Drawing(s) showing the location(s) and quantity of stand-alone, PV-powered devices	E-106	

Rule #	Rule Description	Content Requirement(s)	Drawing Sheet(s)	Coordinates
8-4	Batteries	Specifications for all stand-alone, PV-powered devices	Specification 26 50 00	
8-5	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	N/A	
8-5	Desiccant Systems	Specifications for desiccant system components	N/A	
8-6	Village Grid	Completed Interconnection Application form.	Project Manual Section 9.0 pg. 323	
8-6	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	A-106, E-100, E-200 E-201, E-400	
8-6	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	Specifications 26 31 00, 48 19 16 26 27 13, 33 79 00	
8-6	Village Grid	One-line electrical diagram	E-601	
8-6	Village Grid	Calculation of service/feeder net computed load per NEC 220	E-701	
8-6	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box	X-101	
8-6	Village Grid	Elevation(s) showing the terminal box, meter housing, main utility disconnect, and other service equipment	E-201	
9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems	A-104	
9-6	Thermal Mass	Drawing(s) showing the locations of water-based thermal mass systems	M-105, M-501	
9-6	Thermal Mass	Specifications for components of water-based thermal mass systems	Specification 22 12 19	
10-2	Event Sponsor Recognition	Drawing(s) showing the dimensions, materials, artwork, and content of all communications materials, including signage	ALL X's	
10-3	Team Sponsor Recognition	Drawing(s) showing the dimensions, materials, artwork, and content of all communications materials, including signage	ALL X's	
11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route	X-101	
11-4	Public Exhibit	Drawing(s) showing the dimensions, materials, artwork, and content of the handout	X-511	
11-4	Public Exhibit	Drawing(s) showing the artwork and content of the team uniform	X-504	

3.0 Construction Specifications

CONTENTS

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP
Division 00 - Not Used

SPECIFICATIONS GROUP
GENERAL REQUIREMENTS SUBGROUP
Division 01 - General Requirements
01 10 00 - SUMMARY
01 40 00 - QUALITY REQUIREMENTS
01 42 00 - REFERENCES
01 50 00 - TEMPORARY FACILITIES AND CONTROLS
01 60 00 - PRODUCT REQUIREMENTS
01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS
01 74 19 - CONSTRUCTION WASTE MANAGEMENT
01 81 13 - SUSTAINABLE DESIGN REQUIREMENTS

FACILITY CONSTRUCTION SUBGROUP
Division 02 - Not Used

Division 03 - Concrete
03 41 00 - PRECAST STRUCTURAL CONCRETE

Division 04 - Not Used

Division 05 - Metals
05 50 00 - METAL FABRICATIONS
05 52 00 - METAL RAILINGS

Division 06 - Wood, Plastics and Composites
06 10 00 - ROUGH CARPENTRY
06 15 00 - WOOD DECKING
06 16 00 - SHEATHING
06 20 00 - FINISH CARPENTRY
06 64 00 - PLASTIC PANELING

Division 07 - Thermal and Moisture Protection
07 21 00 - THERMAL INSULATION
07 21 29 - SPRAYED INSULATION
07 33 00 - NATURAL ROOF COVERINGS
07 46 00 - SIDING
07 53 00 - ELASTOMERIC MEMBRANE ROOFING
07 57 13 - SPRAYED POLYURETHANE FOAM (SPF) ROOFING
07 71 00 - ROOF SPECIALTIES

Division 08 - Openings
08 11 13 - HOLLOW METAL DOORS AND FRAMES
08 11 16 - ALUMINUM DOORS AND FRAMES
08 14 00 - WOOD DOORS
08 35 13 - FOLDING DOORS
08 51 13 - ALUMINUM WINDOWS
08 62 00 - UNIT SKYLIGHTS
08 71 00 - DOOR HARDWARE

Division 09 - Finishes
09 29 00 - GYPSUM BOARD
09 63 40 - STONE FLOORING
09 64 00 - WOOD FLOORING
09 74 13 - WOOD WALL COVERINGS
09 91 00 - PAINTING

Division 10 - Specialties
10 14 00 - SIGNAGE
10 18 00 - INFORMATIONAL KIOSKS
10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES
10 44 16 - FIRE EXTINGUISHERS
10 73 13 - AWNINGS

Division 11 - Equipment
11 01 30 - OPERATION AND MAINTENANCE OF RESIDENTIAL EQUIPMENT
11 31 00 - RESIDENTIAL APPLIANCES

Division 12 - Furnishings
12 21 13 - HORIZONTAL LOUVER BLINDS
12 35 30 - RESIDENTIAL CASEWORK
12 36 40 - STONE COUNTERTOPS
12 42 00 - TABLE ACCESSORIES
12 44 00 - BATH FURNISHINGS
12 45 00 - BEDROOM FURNISHINGS
12 58 00 - RESIDENTIAL FURNITURE
12 92 00 - INTERIOR PLANTERS

Divisions 13 to 19 - Not Used

FACILITY SERVICES SUBGROUP
Divisions 20 to 21 - Not Used

Division 22 - Plumbing
22 05 00 - COMMON WORK RESULTS FOR PLUMBING
22 11 16 - DOMESTIC WATER PIPING
22 11 19 - DOMESTIC WATER PIPING SPECIALTIES
22 11 23 - DOMESTIC WATER PUMPS
22 12 19 - FACILITY POTABLE WATER STORAGE TANKS
22 13 16 - SANITARY WASTE AND VENT PIPING
22 13 19 - SANITARY WASTE PIPING SPECIALTIES
22 33 00 - ELECTRIC DOMESTIC WATER HEATERS
22 40 00 - PLUMBING FIXTURES

Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC)
23 05 00 - COMMON WORK RESULTS FOR HVAC
23 21 13 - HYDRONIC PIPING
23 21 23 - HYDRONIC PUMPS
23 23 00 - REFRIGERANT PIPING
23 31 00 - HVAC DUCTS AND CASINGS
23 34 23 - HVAC POWER VENTILATORS
23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES
23 56 00 - SOLAR ENERGY HEATING EQUIPMENT
23 71 00 - THERMAL STORAGE
23 72 00 - AIR TO AIR ENERGY RECOVERY EQUIPMENT
23 81 26 - SPLIT SYSTEM AIR-CONDITIONERS
23 82 33 - CONVECTORS

Divisions 24 to 25 - Not Used

Division 26 - Electrical
26 24 16 - PANELBOARDS
26 27 13 - ELECTRICITY METERING
26 27 26 - WIRING DEVICES
26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS
26 31 00 - PHOTOVOLTAIC COLLECTORS
26 32 13 - GENERATORS
26 50 00 - LIGHTING

Division 27 - Communications
27 10 13 - RESIDENTIAL STRUCTURED CABLING

Division 28 - Electronic Safety and Security
28 31 00 - FIRE DETECTION AND ALARM

Division 29 - Not Used

SITE AND INFRASTRUCTURE SUBGROUP
Division 30 to 31 - Not Used

Division 32 - Exterior Improvements
32 14 00 - UNIT PAVING
32 93 00 - PLANTS
Division 33 - Utilities
33 79 00 - SITE GROUNDING

Divisions 34 to 39 - Not Used

PROCESS EQUIPMENT SUBGROUP
Division 40 - Not Used

Division 41 - Material Processing and Handling Equipment
41 62 19 - FORKLIFT TRUCKS

Divisions 42 to 47 - Not Used

Division 48 - Electrical Power
48 19 16 - ELECTRICAL POWER EQUIPMENT

Division 49 - Not Used

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 PROJECT INFORMATION

A. Project: Penn State Solar Decathlon 2009: Natural Fusion.

1. Pre-Assembly Location: Porter Road, State College, PA 16801

2. NREL Competition Location: National Mall, Washington, DC 20002.

B. Design-Builder-Owner: Natural Fusion Team, The Pennsylvania State University

C. The Work consists of the designing, building, and operation of a solar powered home as part of the Department of Energy's Solar Decathlon Competition.

D. Work by Owner:

E. Owner-Furnished Items: The following products will be furnished by Owner and shall be installed by Contractor as part of the Work:

1.2 WORK RESTRICTIONS

A. Contractor's Use of Premises: During construction, Contractor will have limited use of site indicated. Contractor's use of premises is limited only by NREL's right to perform work or employ other contractors on portions of Project and as follows:

1. Perform construction utilizing three shifts 24 hours a day starting September 30th 2009, 11:01PM and ending October 8th 2009, 5:00pm unless otherwise agreed to in advance by NREL. Clean up work areas and return to usable condition at the end of each work shift.
2. Limits: Limit site disturbance, including no earthwork and clearing of vegetation. Contractor shall utilize event-deck and leak containment to protect the National Mall in accordance with NREL regulation.
3. Driveways, Walkways, and Entrances: Contractor shall have use of one traffic lane of the gravel on the north side of the site in accordance with NREL organizers' regulations.

B. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor-air intakes.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Testing and inspecting services shall be performed by independent testing agencies.

B. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements, comply with the most stringent requirement. Refer uncertainties to Architect for a decision.

C. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum. The actual installation may exceed the minimum within reasonable limits. Indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision.

D. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
6. Names of individuals making tests and inspections.
7. Description of the Work and test and inspection method.
8. Complete test or inspection data, test and inspection results, an interpretation of test results, and comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
9. Name and signature of laboratory inspector.
10. Recommendations on retesting and reinspecting.

E. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, notices, receipts for fee payments, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

F. Testing Agency Qualifications: An independent agency with the experience and capability to conduct testing and inspecting indicated; and where required by authorities having jurisdiction, that is acceptable to authorities.

G. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

H. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Promptly notify Architect and Contractor of irregularities or deficiencies in the Work observed during performance of its services.
2. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
3. Do not perform any duties of Contractor.

I. Associated Services: Cooperate with testing agencies and provide reasonable auxiliary services as requested. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Security and protection for samples and for testing and inspecting equipment.

J. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

K. Special Tests and Inspections: NREL, a qualified special inspector, will conduct special tests and inspections required by competition regulations, having jurisdiction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 GENRAL REQUIREMENTS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. Abbreviations and Acronyms: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

PRIVATE tbl1

AA	Aluminum Association, Inc. (The)
AAADM	American Association of Automatic Door Manufacturers
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ABAA	Air Barrier Association of America
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AEIC	Association of Edison Illuminating Companies, Inc. (The)
AF&PA	American Forest & Paper Association
AGA	American Gas Association
AGC	Associated General Contractors of America (The)
AHA	American Hardboard Association (Now part of CPA)
AHAM	Association of Home Appliance Manufacturers
AI	Asphalt Institute

AIA	American Institute of Architects (The)
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALCA	Associated Landscape Contractors of America (Now PLANET - Professional Landcare Network)
ALSC	American Lumber Standard Committee, Incorporated
AMCA	Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
AOSA	Association of Official Seed Analysts, Inc.
APA	Architectural Precast Association
APA	APA - The Engineered Wood Association
APA EWS	APA - The Engineered Wood Association; Engineered Wood Systems (See APA - The Engineered Wood Association)
API	American Petroleum Institute
ARI	Air-Conditioning & Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASCE	American Society of Civil Engineers
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	ASME International (American Society of Mechanical Engineers International)
ASSE	American Society of Sanitary Engineering
ASTM	ASTM International (American Society for Testing and Materials International)
AWCI	Association of the Wall and Ceiling Industry
AWCMA	American Window Covering Manufacturers Association

	(Now WCMA)
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association (Formerly: American Wood Preservers' Association)
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association (The)
BICSI	BICSI, Inc.
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International)
BISSC	Baking Industry Sanitation Standards Committee
BWF	Badminton World Federation (Formerly: IBF - International Badminton Federation)
CCC	Carpet Cushion Council
CDA	Copper Development Association
CEA	Canadian Electricity Association
CEA	Consumer Electronics Association
CFFA	Chemical Fabrics & Film Association, Inc.
CGA	Compressed Gas Association
CIMA	Cellulose Insulation Manufacturers Association
CISCA	Ceilings & Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CRRC	Cool Roof Rating Council
CPA	Composite Panel Association
CPPA	Corrugated Polyethylene Pipe Association

CRI	Carpet and Rug Institute (The)
CRSI	Concrete Reinforcing Steel Institute
CSA	Canadian Standards Association
CSA	CSA International (Formerly: IAS - International Approval Services)
CSI	Cast Stone Institute
CSI	Construction Specifications Institute (The)
CSSB	Cedar Shake & Shingle Bureau
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute)
DHI	Door and Hardware Institute
EIA	Electronic Industries Alliance
EIMA	EIFS Industry Members Association
EJCDC	Engineers Joint Contract Documents Committee
EJMA	Expansion Joint Manufacturers Association, Inc.
ESD	ESD Association (Electrostatic Discharge Association)
ETL SEMCO	Intertek ETL SEMCO (Formerly: ITS - Intertek Testing Service NA)
FIBA	Federation Internationale de Basketball (The International Basketball Federation)
FIVB	Federation Internationale de Volleyball (The International Volleyball Federation)
FM Approvals	FM Approvals LLC
FM Global	FM Global (Formerly: FMG - FM Global)
FMRC	Factory Mutual Research (Now FM Global)
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.
FSA	Fluid Sealing Association

FSC	Forest Stewardship Council
GA	Gypsum Association
GANA	Glass Association of North America
GRI	(Part of GSI)
GS	Green Seal
GSI	Geosynthetic Institute
HI	Hydraulic Institute
HI	Hydronics Institute
HMMA	Hollow Metal Manufacturers Association (Part of NAAMM)
HPVA	Hardwood Plywood & Veneer Association
HPW	H. P. White Laboratory, Inc.
IAS	International Approval Services (Now CSA International)
IBF	International Badminton Federation (Now BWF)
ICEA	Insulated Cable Engineers Association, Inc.
ICRI	International Concrete Repair Institute, Inc.
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
IESNA	Illuminating Engineering Society of North America
IEST	Institute of Environmental Sciences and Technology
IGCC	Insulating Glass Certification Council
IGMA	Insulating Glass Manufacturers Alliance
ILI	Indiana Limestone Institute of America, Inc.
ISO	International Organization for Standardization Available from ANSI

ISSFA	International Solid Surface Fabricators Association
ITS	Intertek Testing Service NA (Now ETL SEMCO)
ITU	International Telecommunication Union
KCMA	Kitchen Cabinet Manufacturers Association
LMA	Laminating Materials Association (Now part of CPA)
LPI	Lightning Protection Institute
MBMA	Metal Building Manufacturers Association
MFMA	Maple Flooring Manufacturers Association, Inc.
MFMA	Metal Framing Manufacturers Association, Inc.
MH	Material Handling (Now MHIA)
MHIA	Material Handling Industry of America
MIA	Marble Institute of America
MPI	Master Painters Institute
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International (National Association of Corrosion Engineers International)
NADCA	National Air Duct Cleaners Association
NAGWS	National Association for Girls and Women in Sport
NAIMA	North American Insulation Manufacturers Association
NBGQA	National Building Granite Quarries Association, Inc.
NCAA	National Collegiate Athletic Association (The)
NCMA	National Concrete Masonry Association
NCPI	National Clay Pipe Institute
NCTA	National Cable & Telecommunications Association

NEBB	National Environmental Balancing Bureau
NECA	National Electrical Contractors Association
NeLMA	Northeastern Lumber Manufacturers' Association
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
NFHS	National Federation of State High School Associations
NFPA	NFPA (National Fire Protection Association)
NFRC	National Fenestration Rating Council
NGA	National Glass Association
NHLA	National Hardwood Lumber Association
NLGA	National Lumber Grades Authority
NOFMA	NOFMA: The Wood Flooring Manufacturers Association (Formerly: National Oak Flooring Manufacturers Association)
NOMMA	National Ornamental & Miscellaneous Metals Association
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	NSF International (National Sanitation Foundation International)
NSSGA	National Stone, Sand & Gravel Association
NTMA	National Terrazzo & Mosaic Association, Inc. (The)
NTRMA	National Tile Roofing Manufacturers Association (Now TRI)
NWWDA	National Wood Window and Door Association (Now WDMA)
OPL	Omega Point Laboratories, Inc. (Now ITS)
PCI	Precast/Prestressed Concrete Institute

PDCA	Painting & Decorating Contractors of America
PDI	Plumbing & Drainage Institute
PGI	PVC Geomembrane Institute
PLANET	Professional Landcare Network (Formerly: ACLA - Associated Landscape Contractors of America)
PTI	Post-Tensioning Institute
RCSC	Research Council on Structural Connections
RFCI	Resilient Floor Covering Institute
RIS	Redwood Inspection Service
SAE	SAE International
SDI	Steel Deck Institute
SDI	Steel Door Institute
SEFA	Scientific Equipment and Furniture Association
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)
SGCC	Safety Glazing Certification Council
SIA	Security Industry Association
SIGMA	Sealed Insulating Glass Manufacturers Association (Now IGMA)
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SMPTE	Society of Motion Picture and Television Engineers
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division)
SPIB	Southern Pine Inspection Bureau (The)
SPRI	Single Ply Roofing Industry

SSINA	Specialty Steel Industry of North America
SSPC	SSPC: The Society for Protective Coatings
STI	Steel Tank Institute
SWI	Steel Window Institute
SWRI	Sealant, Waterproofing, & Restoration Institute
TCA	Tile Council of America, Inc. (Now TCNA)
TCNA	Tile Council of North America, Inc.
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
TMS	The Masonry Society
TPI	Truss Plate Institute, Inc.
TPI	Turfgrass Producers International
TRI	Tile Roofing Institute
UL	Underwriters Laboratories Inc.
UNI	Uni-Bell PVC Pipe Association
USAV	USA Volleyball
USGBC	U.S. Green Building Council
USITT	United States Institute for Theatre Technology, Inc.
WASTEC	Waste Equipment Technology Association
WCLIB	West Coast Lumber Inspection Bureau
WCMA	Window Covering Manufacturers Association
WCSC	Window Covering Safety Council (Formerly: WCMA - Window Covering Manufacturers Association)
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association)
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California)
WIC	Woodwork Institute of California

	(Now WI)
WMMPA	Wood Moulding & Millwork Producers Association
WSRCA	Western States Roofing Contractors Association
WWPA	Western Wood Products Association

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Use Charges: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated.

B. Pre-Assembly Location
   1. Electric Power: Available from Owner's mobile solar energy generating system, Power Lion, without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
   2. Water: Available from the Owner's existing facility.

C. National Mall Competition Location
   1. Electric Power: Available from Owner's mobile solar energy generating system, Power Lion, without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

D. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70E.

E. Accessible Temporary Egress: Comply with applicable provisions in ICC/ANSI A117.1.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pre-Assembly Location
   1. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts and top and bottom rails.

B. National Mall Competition Location
   1. Event-Deck: NREL Supplied ground protection

2.2 TEMPORARY FACILITIES

A. Provide tool trailer, storage and fabrication sheds, and other support facilities as necessary for construction operations. Store combustible materials apart from building.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.1 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities.

C. Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

3.2 SUPPORT FACILITIES INSTALLATION

A. Install project identification and other signs in locations approved by Owner to inform the public and persons seeking entrance to Project.

B. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction.

1. All materials will be sorted by material type: Metals, Plastics, Paper, Waste and sent to the appropriate recycling or disposal facility.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

B. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

C. Furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.

D. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

E. Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather tight enclosure for building exterior.

F. Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.

G. Install and maintain temporary fire-protection facilities. Comply with NFPA 241.

3.4 MOISTURE AND MOLD CONTROL

A. Before installation of weather barriers, protect materials from water damage and keep porous and organic materials from coming into prolonged contact with concrete.

B. After installation of weather barriers but before full enclosure and conditioning of building, protect as follows:

1. Do not load or install drywall or porous materials into partially enclosed building.
2. Discard water-damaged and wet material and material that begins to grow mold.
3. Allow installed wet materials adequate time to dry before being enclosed.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion.

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

B. Comparable Product Requests:

1. Submit request for consideration of each comparable product. Do not submit unapproved products on Shop Drawings or other submittals.
2. Identify product to be replaced and show compliance with requirements for comparable product requests. Include a detailed comparison of significant qualities of proposed substitution with those of the Work specified.
3. Architect will review the proposed product and notify Contractor of its acceptance or rejection.

C. Compatibility of Options: If Contractor is given option of selecting between two or more products, select product compatible with products previously selected.

D. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Deliver products to Project site in manufacturer's original sealed container or packaging, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
3. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
4. Store materials in a manner that will not endanger Project structure.
5. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.

E. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. Provide products that comply with the Contract Documents, are undamaged, and are new at the time of installation.

1. Provide products complete with accessories, trim, finish, and other devices and components needed for a complete installation and the intended use and effect.
2. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

B. Product Selection Procedures:

1. Where Specifications name a single manufacturer and product, provide the named product that complies with requirements.
2. Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
3. Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
4. Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements for "comparable product requests" for consideration of an unnamed product.
5. Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
6. Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements for "comparable product requests" for consideration of an unnamed manufacturer's product.
7. Where Specifications name a single product, or refer to a product indicated on Drawings, as the "basis-of-design," provide the named product. Comply with provisions for "comparable product requests" for consideration of an unnamed product by another manufacturer.

C. Where Specifications require "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

D. Unless otherwise indicated, Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017000 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 CLOSEOUT SUBMITTALS

A. Record Drawings: Maintain a set of prints of the Contract Drawings as record Drawings. Mark to show actual installation where installation varies from that shown originally.

1. Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

B. Operation and Maintenance Data: Submit one copy of manual. Organize data into three-ring binders with identification on front and spine of each binder, and envelopes for folded drawings. Include the following:

1. Manufacturer's operation and maintenance documentation.
2. Maintenance and service schedules.
3. Maintenance service contracts.
4. Emergency instructions.
5. Spare parts list.
6. Wiring diagrams.
7. Copies of warranties.

1.2 CLOSEOUT PROCEDURES

A. Substantial Completion: Before requesting Substantial Completion inspection, complete the following:

1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
2. Advise Owner of pending insurance changeover requirements.
3. Submit specific warranties, maintenance service agreements, and similar documents.
4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Submit record Drawings**,** operation and maintenance manuals, and similar final record information.
6. Deliver tools, spare parts, extra materials, and similar items.
7. Make final changeover of permanent locks and deliver keys to Owner.
8. Complete startup testing of systems.
9. Remove temporary facilities and controls.
10. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
11. Complete final cleaning requirements, including touchup painting.
12. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will proceed with inspection or advise Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will advise Contractor of items that must be completed or corrected before certificate will be issued.

C. Request inspection for Final Completion, once the following are complete:

1. Submit a copy of Substantial Completion inspection list stating that each item has been completed or otherwise resolved for acceptance.
2. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

D. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

E. Submit a written request for final inspection for acceptance. On receipt of request, Architect will proceed with inspection or advise Contractor of unfulfilled requirements. Architect will prepare final Certificate for Payment after inspection or will advise Contractor of items that must be completed or corrected before certificate will be issued.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Verify compatibility with and suitability of substrates.
2. Examine roughing-in for mechanical and electrical systems.
3. Examine walls, floors, and roofs for suitable conditions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Take field measurements as required to fit the Work properly. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication.

D. Verify space requirements and dimensions of items shown diagrammatically on Drawings.

3.2 CONSTRUCTION LAYOUT AND FIELD ENGINEERING

A. Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks.

3.3 INSTALLATION

A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated. Make vertical work plumb and make horizontal work level.

1. Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections to form hairline joints.
2. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
3. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.

B. Comply with manufacturer's written instructions and recommendations.

C. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

D. Use products, cleaners, and installation materials that are not considered hazardous.

E. Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place. Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed.

3.4 CUTTING AND PATCHING

A. Provide temporary support of work to be cut. Do not cut structural members without prior written approval of Structural Engineer.

B. Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

C. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

1. Restore exposed finishes of patched areas and extend finish restoration into adjoining construction in a manner that will minimize evidence of patching and refinishing.
2. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

3.5 CLEANING

A. Clean Project site and work areas daily, including common areas. Dispose of materials lawfully.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
3. Remove debris from concealed spaces before enclosing the space.

B. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion:

1. Remove labels that are not permanent.
2. Clean transparent materials, including mirrors. Remove excess glazing compounds. Replace chipped or broken glass.
3. Clean exposed finishes to a dust-free condition, free of stains, films, and foreign substances. Sweep concrete floors broom clean.
4. Vacuum carpeted surfaces and wax resilient flooring.
5. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication. Clean plumbing fixtures. Clean light fixtures, lamps, globes, and reflectors.
6. Clean Project site, yard, and grounds, in areas disturbed by construction activities. Sweep paved areas; remove stains, spills, and foreign deposits. Rake grounds to a smooth, even-textured surface.

3.6 DEMONSTRATION AND TRAINING

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system. Include a detailed review of the following:

1. Include instruction for basis of system design and operational requirements, review of documentation, emergency procedures, operations, adjustments, troubleshooting, maintenance, and repairs.

END OF SECTION 017000

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Performance Requirements: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total nonhazardous solid waste generated by the Work.

1.2 SUBMITTALS

A. Waste Management Plan: Submit plan within 90 days of date established for commencement of the Work.

B. Waste Reduction Progress Reports: Submit concurrent with each Application for Payment. Include total quantity of waste, total quantity of waste salvaged and recycled, and percentage of total waste salvaged and recycled.

C. Records of Donations and Sales: Receipts for salvageable waste donated or sold to individuals and organizations. . Indicate whether organization is tax exempt.

D. Recycling and Processing Facility Records: Manifests, weight tickets, receipts, and invoices.

E. Landfill and Incinerator Disposal Records: Manifests, weight tickets, receipts, and invoices.

F. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Administrative Requirements." Review methods and procedures related to waste management.

G. Waste Management Plan: Develop a waste management plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

1. Salvaged Materials for Reuse: Identify materials that will be salvaged and reused.
2. Salvaged Materials for Sale: Identify materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: Identify materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.

C. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

3.2 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work: Clean salvaged items and install salvaged items to comply with installation requirements for new materials and equipment.

B. Salvaged Items for Sale: Permitted on Project site.

C. Salvaged Items for Owner's Use: Clean salvaged items and store in a secure area until delivery to Owner.

D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs.

F. Plumbing Fixtures: Separate by type and size.

G. Lighting Fixtures: Separate lamps by type and protect from breakage.

3.3 RECYCLING WASTE

A. General: Recycle paper and beverage containers used by on-site workers.

B. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.

4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

C. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

D. Metals: Separate metals by type.

E. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

F. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

G. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

H. Conduit: Reduce conduit to straight lengths and store by type and size.

3.4 DISPOSAL OF WASTE

A. Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

B. Do not burn waste materials.

END OF SECTION 017419

SECTION 018113 - SUSTAINABLE DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Definitions:

1. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.
2. Recycled Content: The recycled content shall be determined by weight.

   a. "Post-consumer" material is defined as waste material generated by end users of the product, which can no longer be used for its intended purpose.
   b. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as scrap generated in a process that is reclaimed in the same process that generated it.

B. Submittals:

1. List of proposed materials with recycled content. Indicate post-consumer recycled content and pre-consumer recycled content for each product. Submit within 60 days of date established for commencement of the Work.
2. List of proposed regional materials. Submit within 60 days of date established for commencement of the Work.
3. List of proposed certified wood products. Submit within 60 days of date established for commencement of the Work.
4. Product Data.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Recycled Content of Materials: Provide building materials with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 10 percent of cost of materials used for Project.

1. Do not include mechanical and electrical components in the calculation.

B. Regional Materials: Provide 34.5percent of building materials (by cost) that are regional materials.

C. Certified Wood: Provide a minimum of 50 percent (by cost) of wood-based materials that are produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:

    a. Rough carpentry.
    b. Miscellaneous carpentry.
    c. Heavy timber construction.
    d. Wood decking.
    e. Metal-plate-connected wood trusses.
    f. Structural glued-laminated timber.
    g. Finish carpentry.
    h. Architectural woodwork.
    i. Wood paneling.
    j. Wood veneer wall covering.
    k. Wood flooring.
    l. Wood lockers.
    m. Wood cabinets.

2.2 LOW-EMITTING MATERIALS

A. Use adhesives and sealants that comply with the following limits for VOC content:

1. Wood Glues: 30 g/L.
2. Metal-to-Metal Adhesives: 30 g/L.
3. Adhesives for Porous Materials (Except Wood): 50 g/L.
4. Subfloor Adhesives: 50 g/L.
5. Plastic Foam Adhesives: 50 g/L.
6. Carpet Adhesives: 50 g/L.
7. Carpet Pad Adhesives: 50 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesive: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesive: 100 g/L.
18. Structural Wood Member Adhesive: 140 g/L.
19. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, PTFE, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
20. Top and Trim Adhesive: 250 g/L.
21. Plastic Cement Welding Compounds: 350 g/L.
22. ABS Welding Compounds: 400 g/L.
23. CPVC Welding Compounds: 490 g/L.
24. PVC Welding Compounds: 510 g/L.
25. Adhesive Primer for Plastic: 650 g/L.
26. Sheet-Applied Rubber Lining Adhesive: 850 g/L.

27. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
28. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
29. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
30. Other Adhesives: 250 g/L.
31. Architectural Sealants: 250 g/L.
32. Nonmembrane Roof Sealants: 300 g/L.
33. Single-Ply Roof Membrane Sealants: 450 g/L.
34. Other Sealants: 420 g/L.
35. Sealant Primers for Nonporous Substrates: 250 g/L.
36. Sealant Primers for Porous Substrates: 775 g/L.
37. Modified Bituminous Sealant Primers: 500 g/L.
38. Other Sealant Primers: 750 g/L.

B. Use **interior** paints and coatings that comply with the following limits for VOC content:

1. Flat Paints and Coatings: 0 g/L.
2. Nonflat Paints, Coatings: 0 g/L.
3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 450 g/L.
4. Clear Wood Finishes, Varnishes: 410 g/L.
5. Clear Wood Finishes, Lacquers: 410 g/L.
6. Floor Coatings: 410 g/L.
7. Shellacs, Clear: 730 g/L.
8. Shellacs, Pigmented: 550 g/L.
9. Stains: 0 g/L.
10. Primers, Sealers, and Undercoaters: 200g/L.
11. Dry-Fog Coatings: 400 g/L.
12. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
13. Pretreatment Wash Primers: 420 g/L.

C. Do not use composite wood or agrifiber products or adhesives that contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 REFRIGERANT REMOVAL

A. Remove CFC-based refrigerants from existing HVAC&R equipment indicated to remain and replace with refrigerants that are not CFC based. Replace or adjust existing equipment to accommodate new refrigerant.

3.2 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

A. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."

1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Division 01 Section "Temporary Facilities and

Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.

2. Replace all air filters immediately prior to occupancy.

B. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, ventilate it at a minimum rate of 0.30 cfm per sq. ft. of outside air. During each day of the occupied flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. Maintain these conditions until a total of 14000 cu. ft./sq. ft. of outside air has been delivered to the space.

END OF SECTION 018113

SECTION 034100 - PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data, Shop Drawings and structural analysis data signed and sealed by a qualified professional engineer.

B. Fabricator Qualifications: Fabricator participates in PCI's Plant Certification Program and is designated a PCI-certified plant, Product Group C.

C. Comply with ACI 318; PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete"; PCI MNL 116, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products"; AWS D1.1/D.1.1M; and AWS D1.4.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide precast structural concrete units capable of withstanding design loadings and size requirement indicated.
   1. 4’x 4’ x 4” Concrete Pads
   2. 5500lb point load centered on the pad
   3. Q_a=1500psf
   4. 1” Webbing: Installed in the side of footing for lift point
      a. 1000 lb capacity

B. Provide units with fire resistance indicated, calculated according to ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies"; or PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete."

2.2 MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Steel Wire: ASTM A 82, plain, cold drawn.

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

D. Portland Cement: ASTM C 150, Type I or Type III.

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

F. Metakaolin Admixture: ASTM C 618, Class N.

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

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

I. Normal-Weight Aggregates: ASTM C 33, with coarse aggregates complying with Class 4S.

J. Air-Entraining Admixture: ASTM C 260.

K. Chemical Admixtures: ASTM C 494/C 494M, high-range water reducing. Do not use admixtures containing chlorides.

2.3 ACCESSORIES AND FINISHES

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563; and flat, unhardened steel washers, ASTM F 844.

C. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M or ASTM A 153/A 153M.

D. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply lead- and chromate-free, rust-inhibitive primer according to SSPC-PA 1.

E. Grout: ASTM C 150, Type I, portland cement, and clean, natural sand.

2.4 CONCRETE MIX

A. Proportion normal-weight concrete mixes to provide the following properties:

1. Compressive Strength: 4000 psi at 28 days.
2. Water-Cementitious Materials Ratio: 0.40 maximum.
3. Air Content: 5.5 to 7.5 percent for concrete exposed to freezing and thawing, 2.5 to 4.5 percent elsewhere.
4. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
5. Limit use of fly ash to 25 percent replacement of portland cement by weight and granulated blast-furnace slag to 40 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.

B. Concrete Mixing: Comply with ASTM C 94.

C. Finishes: Standard for formed surfaces.

D. Replace precast concrete units deficient in strength, manufacturing tolerances, and finishes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install bearing pads level, true, and on uniform bearing surfaces.

B. Protect precast units and bearing pads from damage during welding.

C. Install precast units level, plumb, square, and true, within the recommended erection tolerances of PCI MNL 135, "Tolerance Manual for Precast and Prestressed Concrete Construction."

D. Shore and brace precast concrete units to maintain location, stability, and alignment until permanent connections are installed.

E. Grout open spaces at keyways, connections, and joints after precast concrete units have been placed and secured.

F. Clean exposed surfaces of precast concrete units after erection.

END OF SECTION 034100

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

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

PART 2 - PRODUCTS

2.1 METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Galvanized Metal: ASTM A 123.

2.2 FABRICATION

A. General: Shear and punch metals cleanly and accurately. Remove burrs and ease exposed edges. Form bent-metal corners to smallest radius possible without impairing work.

B. Welding: Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2.3 STEEL AND IRON FINISHES

A. Hot-dip galvanize steel fabrications at exterior locations.

B. Prepare uncoated ferrous metal surfaces with Rust-Oleum Professional Oil Based Enamel Topcoat in matte black finish.
   1. Rust-Oleum Professional Oil Based Enamel Topcoat:
      http://www.rustoleum.com/CBGProduct.asp?pid=130

C. 1”x3”x1/8” L for support of trench heater grille along south glazing. Finish with Rust-Oleum Black Matte finish.

D. Grilles for trench heaters. Polished Stainless Steel Finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack.

B. Fit exposed connections accurately together to form hairline joints.

END OF SECTION 055000

SECTION 055200 - METAL RAILINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data

PART 2 - PRODUCTS

2.1 RAILING SYSTEMS

A. Available Manufacturers:

1. UltraTech
   a. http://www.ultra-tec.com/Content/Complete_Railing_Systems.html

B. Provide railings capable of withstanding a uniform load of 50 lbf/ ft. and a concentrated load of 200 lbf applied to handrails and top rails of guards in any direction. Uniform and concentrated loads need not be assumed to act concurrently.

C. Provide railing infill capable of withstanding a concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft. Infill load and other railing loads need not be assumed to act concurrently.

2.2 METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.3 OTHER MATERIALS

A. Wood Rails: Hardwood rails of species and profile indicated; with manufacturer's standard transparent finish, and secured to recessed metal subrail.

2.4 FABRICATION

A. Assemble railing systems in shop to the greatest extent possible. Use connections that maintain structural value of joined pieces.

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

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

2.5 FINISHES

A. Steel Railings: Cleaned and shop primed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fit exposed connections accurately together to form tight, hairline joints.

B. Set railings accurately in location, alignment, and elevation and free of rack.

C. Anchor posts in concrete by forming or core-drilling holes 5 inches deep and 3/4 inch greater than OD of post. Fill annular space between post and concrete with nonshrink, nonmetallic grout.

END OF SECTION 055200

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: ICC-ES evaluation reports for **wood-preservative treated wood** and **engineered wood products**.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

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

B. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

2.2 TREATED MATERIALS

A. Preservative-Treated Materials: AWPA C24, for all exterior lumber.

1. Use treatment containing no arsenic or chromium.
2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

B. Provide preservative-treated materials for **all exterior rough carpentry unless otherwise indicated.**

2.3 LUMBER

A. Dimension Lumber:

1. Maximum Moisture Content: **19 percent**.
2. All interior framing: **No. 2**.
3. Panel Source International
   a. http://www.panelsource.net/products/FSC%2BCertified%2BLumber

B. Heavy Timbers: **Eastern white pine.**
1. Envinity: http://www.envinity.com/

2.4 ENGINEERED WOOD PRODUCTS

A. Engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be demonstrated by comprehensive testing.

B. Laminated-Veneer Lumber: Manufactured with exterior-type adhesive complying with ASTM D 2559. Allowable design values determined according to ASTM D 5456.

C. Open Joists: Manufactured Open Joist from Universal Forest Products complying with 2006 IRC.
   1. http://www.ufpi.com/product/oj/tech/index.htm

2.5 MISCELLANEOUS PRODUCTS

A. Fasteners: Size and type as indicated. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners **with hot-dip zinc coating complying with ASTM A 153/A 153M** or **of Type 304 stainless steel**.

   1. Power-Driven Fasteners: CABO NER-272.
   2. Bolts: Steel bolts complying with ASTM A 307, Grade A ; with ASTM A 563 hex nuts and flat washers where bolt head or hex nut is in direct contact with wood.
   3. Use fasteners as specified from Simpson Strongtie Catalog when applicable.

B. Connectors as used for deck framing:
   http://www.strongtie.com/ftp/catalogs/c-2009/C-2009.pdf

   1. Joist Hangers: LUS28
      a. 1 9/16 x 6 5/8 x 1 3/4; Fasteners: 6-10d, Header; 4-10d, Joist; Code Ref.: I7, L3, F6.
   2. Angles: A23
      a. 2 x 2 ¾; Fasteners: 4-10d x 1 ½, Base; 4-10d x 1 ½, Post; Code Ref.: I14, L21, F13.
   3. Post Caps: BC46
      a. 3 9/16 x 4 7/8 x 3 ½; Fasteners: 12-16d, Beam Flange; 6-16d, Post Flange; Code Ref.: I12, L20, F11.
   4. Post Caps: LCE4
      a. 5 3/8; Fasteners: 14-16d, Beam; 10-16d, Post; Code Ref.: IP1, 160.
   5. Angles: ML24Z
      a. Fasteners: 6-SDS ¼" x 1 ½"; Code Ref.: 170.
   6. Rigid Tie Connectors: RTA2Z
      a. 2x, 2x; Fasteners: 4-SD8 x 1.25, Post; 4-SD8 x 1.25, Joist; Code Ref.: 170.
      b. For Mechanical Room Door.

C. Foundation Jacks:
   J/JP Floor Beam Levelers: http://www.strongtie.com/ftp/catalogs/c-2009/C-2009.pdf
      1) Code Ref.: IL14, L4.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Securely attach rough carpentry to substrates, complying with the following:

1. CABO NER-272 for power-driven fasteners.
2. **Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachment", in ICC's International Residential Code for One- and Two-Family Dwellings**.

END OF SECTION 061000

SECTION 061500 – WOOD DECKING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data

PART 2 - PRODUCTS

2.1 WOOD DECKING

A. 3/4" Black Locust: Galley of Woods: planed four sides @ various lengths

2.2 FASTENERS

A. Screws:

1. Material: No. 304 stainless steel, No. 316 stainless steel
2. Length: 2 1/2 inches

2.3 PROTECTING FINISH

A. No finishing required

PART 3 - EXECUTION

3.1 INSTALLATION

A. Select decking boards of longest possible lengths. Discard boards that are warped, twisted, bowed, crooked or otherwise defective.

B. Install decking square, plumb, and level, evenly fitted and securely fastened.

C. Space decking planks 1/4 inch apart to allow for adequate drainage and expansion.

D. Fasten deck with screws long enough to penetrate 1 inch into support members. Provide 1-1/2 inches penetration for structural components.

1. All holes are to be predrilled

E. Follow installation instructions specified.

F. Installation must comply with local building codes and regulations.

END OF SECTION 061500

SECTION 061500 – WOOD DECKING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data

PART 2 - PRODUCTS

2.1 WOOD DECKING

A. 3/4" Black Locust: Galley of Woods: planed four sides @ various lengths

2.2 FASTENERS

A. Screws:

1. Material: No. 304 stainless steel, No. 316 stainless steel
2. Length: 2 1/2 inches

2.3 PROTECTING FINISH

A. No finishing required

PART 3 - EXECUTION

3.1 INSTALLATION

A. Select decking boards of longest possible lengths. Discard boards that are warped, twisted, bowed, crooked or otherwise defective.

B. Install decking square, plumb, and level, evenly fitted and securely fastened.

C. Space decking planks 1/4 inch apart to allow for adequate drainage and expansion.

D. Fasten deck with screws long enough to penetrate 1 inch into support members. Provide 1-1/2 inches penetration for structural components.

1. All holes are to be predrilled

E. Follow installation instructions specified.

F. Installation must comply with local building codes and regulations.

END OF SECTION 061500

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

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

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS, GENERAL

A. Plywood: DOC PS 1.

B. Oriented Strand Board: DOC PS 2.
1. http://huberwood.com/main.aspx?pagename=advantechsheathing

2.2 TREATED PLYWOOD

A. Preservative-Treated Plywood: AWPA C9.

1. Use treatment containing no arsenic or chromium.
2. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

B. Provide preservative-treated plywood for all exterior plywood.

2.3 WALL SHEATHING

A. Oriented-Strand-Board Wall Sheathing: formaldehyde-free 5/8-inch sheathing.

B. Gypsum Wall Sheathing:

1. Paper-Surfaced Gypsum Wall Sheathing: ASTM C 79/C 79M or ASTM C 1396/C 1396M, gypsum sheathing; with water-resistant-treated core.

C. Insulating Foam Wall Sheathing:
1. Foil-Faced, Polyisocyanurate-Foam Wall Sheathing: ASTM C 1289.

D. Fiber cement board: complying with ASTM C 1186, Type A, not less than 7/16-inch- thick.

2.4 ROOF SHEATHING

A. Oriented-Strand-Board Roof Sheathing: formaldehyde-free 5/8-inch sheathing.

2.5 SUBFLOORING AND UNDERLAYMENT

A. Subflooring:
1. Oriented-Strand-Board Subflooring: Structural I sheathing, 5/8-inch.

2.6 MISCELLANEOUS PRODUCTS

A. Fasteners: Size and type indicated.

1. For roof and wall sheathing, provide fasteners.
2. Power-Driven Fasteners: CABO NER-272.

B. Sheathing Joint-and-Penetration Treatment Materials:

1. Sealant for Fiber Cement Sheathing: Joint sealant recommended by sheathing manufacturer for application indicated.
2. Sheathing Tape for Fiber Cement Sheathing: Self-adhering, glass-fiber tape recommended by sheathing and tape manufacturers for application indicated.

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely attach to substrates, complying with the following:

1. CABO NER-272 for power-driven fasteners.
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

B. Fastening Methods:

1. Subflooring, Wall and Roof Sheathing:

a. Glue and nail to wood framing.

C. Fiber Cement Sheathing Joint-and-Penetration Treatment: Seal sheathing joints and penetrations according to sheathing manufacturer's written instructions.

END OF SECTION 061600

SECTION 062000 - FINISH CARPENTRY

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Information

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Lumber: DOC PS 20 and grading rules of inspection agencies certified by American Lumber Standards Committee Board of Review.

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

2.2 INTERIOR STANDING AND RUNNING TRIM

A. Interior Hardwood Lumber Trim: Clear, kiln-dried, red oak.

2.3 SHELVING AND CLOTHES RODS

A. Shelving: 3/4-inch finish boards as specified for interior lumber.

B. Shelf Brackets with Rod Support: Häfele America Co. product.
1. http://www.hafele.com/us/products/kitchen-cabinet-hardware-closet-hardware-accessories-range-hoods.asp

2.4 MISCELLANEOUS MATERIALS

A. Fasteners for Exterior Finish Carpentry: Stainless-steel, hot-dip galvanized steel, or aluminum.

B. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer.

1. Use waterproof resorcinol glue for exterior applications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install finish carpentry level, plumb, true, and aligned with adjacent materials. Scribe and cut to fit adjoining work. Refinish and seal cuts.

B. Install standing and running trim with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Stagger joints in adjacent and related trim. Cope at returns and miter at corners.

END OF SECTION 062000

SECTION 066400 - PLASTIC PANELING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and material samples.

PART 2 - PRODUCTS

2.1 PLASTIC SHEET PANELING

A. General: Engineered resin; 3form.

1. Nominal Thickness: Thicknesses of 1/8-inch, ½-inch, and 1-inch where indicated.
2. Finish: Chroma renew, matte finish; Linea Ivory finish; Varia pure color sprout finish; Chroma clear, matte finish.
   a. http://www.3-form.com/materials.php

B. Adhesive: As recommended by manufacturer.

C. Sealant: Single-component, mildew-resistant, silicone sealant recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lay out paneling before installing. Locate panel joints so that trimmed panels at corners are not less than 12 inches wide.

1. Locate trim accessories to allow clearance at panel edges according to manufacturer's written instructions.

B. Install panels in a full spread of adhesive.

C. Install trim accessories with adhesive and nails or staples. Do not fasten through panels.

D. Fill grooves in trim accessories with sealant before installing panels and bed inside corner trim in a bead of sealant.

E. Maintain uniform space between panels and wall fixtures. Fill space with sealant.

END OF SECTION 066400

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 INSULATION PRODUCTS

A. Foil-Faced Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1 or 2, faced on both sides with aluminum foil.
   1. Hunter Panels: H-Shield-F, Thickness to be 1" R-Value 6.7:
      a. http://www.hpanels.com/pages/pdfs/Lit_Prod_Color/H-Shield-F.pdf.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install insulation in areas and in thicknesses indicated or required to produce R-values indicated. Cut and fit tightly around obstructions and fill voids with insulation.

END OF SECTION 072100

SECTION 072129 – SPRAYED INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data (Bayer MaterialScience Specifications).

PART 2 - PRODUCTS

2.1 SPRAYED POLYURETHANE FOAM (SPF)

A. BayerSeal CC MaterialScience: a closed cell spray applied polyurethane foam:
   1. ASTM Method E84 (UL 723)
   2. http://www.bsna.com/index.php?option=com_content&view=article&id=60&Itemid=56

   3. Refer to Data Sheet from Bayer MaterialScience and Bayblock Roofing Specification Sheet from 07 53 00 Elastomeric Membrane Roofing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Application of sprayed polyurethane roofing to be completed by a professional specified by the manufacturer, Bayer MaterialScience.

END OF SECTION 072129

SECTION 073300 – NATURAL ROOF COVERINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Summary: The green roof is a modular system of independent and transportable trays. Each tray contains its own growing media and vegetation. The trays are mulched with a fine white gravel to maximize albedo for power production with Solyndra photovoltaics. Perforations on the trays allow water to drain when fully saturated from which point the water runs off the roof's waterproofed spray foam and exits by way of scupper. Once off the roof water is directed into a storage cistern and harvested for irrigation.

B. Submittals: Product Data and Shop Drawings.

PART 2 - PRODUCTS

2.1 TRAY SYSTEM

A. Available Products:

1. Carlisle Syntec; Carlisle Syntec Roof Gardens GreenGrid
   a. http://www.carlisle-syntec.com/documents/ResLib/4016-EPDM_Green_Grid_brochure_lo_res.pdf

B. 2'x2' trays at 4" depth, 82 trays total across roof.

2.2 GROWING MEDIA

A. Available Products:
1. Skyland USA; Rooflite Extensive MC
   a. http://www.rooflite.us/docimg/specs_rooflite_ext_mc.pdf

2.3 PLANTS

A. All plants are shade/drought tolerant sedums and succulents from Emory Knoll Farms. Species used: Sedum ternatum, Sedum lanceolatum, Sedum oreganum, Sedum album, Talinum calycinum, and Cymbalaria muralis.
1. http://www.greenroofplants.com/

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the trays to be done per manufacturer instructions with growing media and plants to be placed according to planting instructions for proper growth.

3.2 CARE AND MAINTENANCE

A. PLANTS
1. Plants are to be watered by hose weekly in periods of drought or as otherwise necessary. Fertilizer may be mixed into irrigation twice a year. Regular replanting is not necessary, all species are perennial. If weeding is necessary, vinegar or table salt may be used as an environmentally friendly weed killer.

END OF SECTION 073300

SECTION 074600 - SIDING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data, Samples.

PART 2 - PRODUCTS

2.1 SIDING

A. Wood Siding:

1. Available Products:

a. Termawood; heat treated poplar, or equivalent product.

2. Horizontal Pattern: 2 1/2-inch boards with 1/2-inch gap exterior wood rain screen.
3. Finish: Manufacturer heat treatment and standard finish.

2.2 ACCESSORIES

A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.

1. Provide accessories made from same material as adjacent siding unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wood siding and related accessories according to A-307

1. Install weather treated wood furring strips every 24in. o.c. with anchoring bolts.

2. Mount thermally heat treated wood siding with 1 ½” lag screws using a drill.

END OF SECTION 074600

SECTION 075300 – ELASTOMERIC MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data (Bayer MaterialScience Specifications Document).

PART 2 - PRODUCTS

2.1 ELASTOMERIC MEMBRANE ROOFING

A. Bayer MaterialScience: Bayblock acrylic elastomeric coating for protection of spray polyurethane form insulation.
   1. http://www.baysystemsspray.com/images/DATA_Bayblock_I_06_17_08.pdf
   2. See following Bayer MaterialScience Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Apply elastomeric membrane roofing as instructed by manufacturer (Bayer MaterialScience).

END OF SECTION 075300

SECTION 075713 – SPRAYED POLYURETHANE FOAM (SPF) ROOFING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data (Bayer MaterialScience Specifications).

PART 2 - PRODUCTS

2.1 SPRAYED POLYURETHANE FOAM (SPF)

A. BayerSeal CC MaterialScience: a closed cell spray applied polyurethane foam:
   1. ASTM Method E84 (UL 723)
   2. http://www.bsna.com/index.php?option=com_content&view=article&id=60&Itemid=56
   3. Refer to Data Sheet from Bayer MaterialScience and Bayblock Roofing Specification Sheet from 07 53 00 Elastomeric Membrane Roofing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Application of sprayed polyurethane roofing to be completed by a professional specified by the manufacturer, Bayer MaterialScience.

END OF SECTION 075713

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and Shop Drawings.

PART 2 - PRODUCTS

2.1 ROOF SPECIALTIES

A. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop with a horizontal flange and vertical leg, drain-through fascia, and concealed splice plates of same material, finish, and shape as gravel stop.

1. Zinc-Coated Steel: 0.028 inch thick.

B. Gutters and Downspouts:

1. Available Products:

a. Gutter Supply - Galvanized Aluminum 24 Gauge Sheet Metal.
1) http://www.guttersupply.com/m-steel-gutters.gstml

2. Gutters: Manufactured in uniform section lengths, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish expansion joints, and expansion-joint covers.

a. Gutter Style: Rectangular
b. Prepainted, Zinc-Coated Steel: 0.028 inch (0.71 mm) thick.
c. Gutter Supports: Gutter brackets with finish matching the gutters.

3. Downspouts: Plain rectangular with mitered elbows. Furnish wall brackets of same material and finish as downspouts, with anchors.
a. Prepainted, Zinc-Coated Steel: 0.028 inch thick.

4. Scuppers: drainage trays that convey water from the roof to the deck
a. Prepainted, Zinc-Coated Steel: 0.028 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement.

B. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless indicated.

C. Fastener Sizes: Use fasteners of sizes that will penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws

D. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches apart. Attach ends with rivets and [seal with sealant] [solder] to make watertight. Slope to downspouts.

E. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1/4 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.

END OF SECTION 077100

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and Shop Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cold-Rolled Steel Sheets: ASTM A 1008/A 1008M, suitable for exposed applications.

B. Frame Anchors: ASTM A 591/A 591M, 40Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, sheet steel complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

C. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

2.2 HOLLOW METAL DOORS AND FRAMES

A. Available Products:

1. Pella; Steel Entry Door, without glazing.
   a. http://web.pella.com/PRODUCTS/DOORS/FLUSHSOLIDSTEELENTRY/Pages/detailpage.asp

B. Doors: Complying with ANSI 250.8 for level and model and ANSI A250.4 for physical-endurance level indicated, 1-3/4 inches thick unless otherwise indicated.
   1. Exterior Doors: Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush), metallic-coated steel sheet faces.

      a. Thermal-Rated (Insulated) Doors: Where indicated, provide doors with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

   2. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as door face sheets.

C. Frames: ANSI A250.8; conceal fastenings unless otherwise indicated.
   1. Steel Sheet Thickness for Exterior Doors: 0.053 inch.

2. Fabricate exterior frames from metallic-coated steel sheet, with mitered or coped and continuously welded corners.
3. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.
4. Frame Anchors: Not less than 0.042 inch thick.

D. Door Silencers: Three on strike jambs of single-door frames and two on heads of double-door frames.

E. Prepare doors and frames to receive mortised and concealed hardware according to ANSI A250.6 and ANSI A115 Series standards.

F. Reinforce doors and frames to receive surface-applied hardware.

G. Prime Finish: Manufacturer's standard, factory-applied coat of lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install hollow metal frames to comply with ANSI/SDI A250.11.

1. Fire-Rated Frames: Install according to NFPA 80.

B. Install doors to provide clearances between doors and frames as indicated in ANSI/SDI A250.11.

END OF SECTION 081113

SECTION 081116 – ALUMINUM DOORS AND FRAMES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and Shop Drawings.

PART 2 - PRODUCTS

2.1 ALUMINUM DOORS AND FRAMES

A. Available Products:
1. Traco: Aluminum Entrance Doors:
a. http://www.traco.com/spz/indexframe.html
2. Traco Aluminum Terrace Doors:
a. http://www.traco.com/spz/indexframe.html
3. Or Equivalent manufacturer and product.

2.2 MATERIALS

A. Aluminum extrusions conforming to ASTM B 211, Alloy 6063-T5, free of scratches and blemishes on exposed surfaces.

2.3 FABRICATION

A. The required sizes for door frame units and the profile requirements are shown on the Drawings.

B. Fabricate frame connections in accordance with notes, schedules, and details, and as shown on accepted Shop Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install aluminum doors and frames to comply with manufacturer instructions.

B. Install doors to provide clearances between doors and frames as indicated in ANSI/SDI A250.11.

END OF SECTION 081116

SECTION 081400 – WOOD DOORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 WOOD DOORS

A. Available Products:

1. Custom-made interior wood doors.
   a. Sliding wood framed door with 3form; bathroom door.
   b. Sliding wood pocket door; bedroom door.
2. Hardware selected for door type from Häfele:
   a. http://www.hafele.com/us/products/97.asp

B. Provide finished wood doors.

1. Natural Oil Finish: Landark:
   a. http://www.landarknw.com/Images/2009%20Product%20Info%20for%20web%20with%20color%20charts.pdf

C. Roller Assemblies: Comply with AAMA 906.

D. Floor Track: Exterior type, low profile, ADA-ABA compliant.

E. Lock: Install a standard lock system recommended for specific door type.

F. Glazed unit with 3form; translucent engineered resin panel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set units level, plumb, and true to line, without warp or rack of frames and panels.

B. Clean frame surfaces and glass immediately after installing sliding wood-framed glass doors.

END OF SECTION 083219

SECTION 083513 - FOLDING DOORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data, Shop Drawings.

PART 2 - PRODUCTS

2.1 FOLDING DOORS

A. Folding Doors: Top supported, horizontal sliding, manually operated; with pantographic or X-type, accordion-folding frame and manufacturer's standard track and hardware.

1. Available Products:

a. Solar Innovations: Folding Glass Wall System.
1) http://www.solarinnovations.com/residential/fgw/

2. Carriers: Four-wheel carriers at lead post and two-wheel intermediate carriers.
3. Sweeps: Top and bottom sweep seals on one side with brush stop.
4. Lock: Manufacturer's standard cylinder lock, key-operated one side, privacy lock other side.

2.2 MATERIALS

A. Aluminum; thermally broken frames:
1. Matte, black finish.

B. IGU's manufactured by Cardinal Glass:
1. Cardinal 366; Neat exterior finish.
a. http://www.cardinalcorp.com/products_neat/neat.htm
2. All units fully tempered.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow installation instructions included with folding door system from manufacturer.

END OF SECTION 083513

SECTION 085113 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Provide AAMA- or WDMA-certified aluminum windows with an attached label.

PART 2 - PRODUCTS

2.1 ALUMINUM WINDOWS

A. Available Products:

1. Traco; with IGUs manufactured by PPG Industries.
   a. http://www.traco.com/commercial_6_pro_guide.html
   b. http://corporateportal.ppg.com/NA/Glass/ResidentialGlass/ResidentialBuildersRemodelers/ProductInformation/
2. Or Equivalent manufacturer and product.

B. Window Types: The following types, as indicated on Drawings:
1. Casement.
2. Fixed.

C. Performance Requirements: AAMA/WDMA/CSA 101/I.S.2/A440.

1. Performance Class: R.
2. Tempered where indicated; as per IRC R308.4.
3. Condensation-Resistance Factor: per AAMA 1503.
4. Thermal Transmittance: Whole-window U-factor not more than 0.35 Btu/sq. ft. x h x deg F at 15-mph wind velocity and winter temperatures per AAMA 1503 or ASTM E 1423.
5. Solar Heat-Gain Coefficient: Whole-window SHGC not more than 0.70, per NFRC 200.

D. Construction: Provide units with a concealed, thermal break.

E. Provide gear-type rotary operators with folding handles for casement windows.

F. Glaze units with clear, low-e coated, argon-filled, sealed insulating glass.

G. Finish: Baked-enamel finish, AA-C12C42R1x, complying with AAMA 2603; matte black.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Set sill members in bed of sealant to provide weather tight construction.

C. Adjust operating panels and hardware to provide a tight fit at contact points and weather stripping for smooth operation and weather tight closure. Lubricate hardware and moving parts.

D. Clean aluminum surfaces and glass immediately after installing windows. Remove nonpermanent labels from glass surfaces.

END OF SECTION 085113

SECTION 086200 - UNIT SKYLIGHTS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Provide AAMA-certified unit skylights with an attached label.

PART 2 - PRODUCTS

2.1 SKYLIGHTS

A. Available Products:

1. VTech Industries; Polycarbonate with Acrylic Dome Curb-Mounted Cap (CMC).
   a. http://www.vtechindustries.com/skylight_spec_sheets/polycarbonate_CMC_A_Dome.pdf

B. Type: Mounted on site-built curb.

2.2 MATERIALS

A. Surface-Burning Characteristics of Plastic Glazing: Labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing indicated below:

1. Self-Ignition Temperature: 650 deg F or more when tested per ASTM D 1929.
2. Smoke-Developed Index or Smoke Density: 75 or less when tested per ASTM D 2843.
3. Relative-Burning Characteristics: Class CC1 according to the IBC.

B. Acrylic Glazing: ASTM D 4802, Finish 1 (smooth or polished), Type UVF (UV absorbing).

1. Single-Glazing Profile: Dome.

   a. Single-Glazing Color: Colorless, transparent.

C. Polycarbonate Glazing: Extruded sheets, UV resistant, and burglar resistant per UL 972.

1. Double-Glazing Profile: open wall polycarbonate.

   a. Nanogel filled open wall polycarbonate glazing; taped edges: white, translucent.

2.3 FABRICATION

A. Site built curb: 2x framing; 22 ½ x 22 ½ -inches on center.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with recommendations in AAMA 1607 and with manufacturer's written instructions for installing unit skylights.

B. Follow installation instructions included with skylights.

END OF SECTION 086200

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Hardware schedule.

B. Deliver keys to Owner.

PART 2 - PRODUCTS

2.1 HARDWARE

A. Available Manufacturers:

1. Häfele
   a. http://www.hafele.com/us/products/97.asp

B. Hinges:

1. Stainless-steel hinges with stainless-steel pins for exterior.
2. Nonremovable hinge pins for exterior and public interior exposure.
3. Ball-bearing hinges for doors with closers and entry doors.
4. 2 hinges for 1-3/8-inch- thick wood doors.
5. 3 hinges for 1-3/4-inch- thick doors 90 inches or less in height; 4 hinges for doors more than 90 inches in height.

C. Locksets and Latchsets:

1. BHMA A156.2, Series 4000, Grade 1 for bored locks and latches.
2. BHMA A156.3, Grade 1 for exit devices.
3. BHMA A156.5, Grade 1 for auxiliary locks.
4. BHMA A156.12, Series 5000, Grade 1 for interconnected locks and latches.
5. BHMA A156.13, Series 1000, Grade 1 for mortise locks and latches.
6. Lever handles on locksets and latchsets.
7. Provide trim on exit devices matching locksets.

D. Key locks to Owner's new master-key system.

1. Cylinders with five-pin tumblers.
2. Provide construction keying.

E. Provide wall stops or floor stops for doors without closers.

F. Provide hardware finishes as follows:

1. Hinges: Matching finish of lockset/latchset.
2. Locksets, Latchsets, and Exit Devices: Satin chrome plated.
3. Other Hardware: Matching finish of lockset/latchset.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 HARDWARE SCHEDULE

A. Entry doors:

1. Hinges.
2. Interconnected entry lock (F96); handle set trim (F102).
3. Threshold and weather stripping.

B. Interior doors:

1. Hinges.
2. Metal flush handles; finish as indicated.
3. Privacy, bedroom and bath locks (F76).
4. Pocket sliding door set including pocket framing, overhead track, hangers, flush pulls, and edge pull.

C. Folding door system:

1. See 08 35 15 Folding Doors.

2. Tri-fold door set including overhead track, hangers, pivots, hinges, and knobs.

D. Mechanical room doors:

1. Hinges.
2. Bored entry lock (F81).

END OF SECTION 087100

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing and inspecting agency.

2.2 PANEL PRODUCTS

A. Available Products:
1. USG Corporation, Sheetrock Gypsum Panels:
a. Regular type:
http://www.usg.com/navigate.do?resource=/USG_Marketing_Content/usg.com/web_files/products/Interior_Panels_and_Finishes_Category.htm

b. Type X (where indicated):
http://www.usg.com/navigate.do?resource=/USG_Marketing_Content/usg.com/web_files/products/prod_details/SHEETROCK_Brand_Firecode_C_Core_Gypsum_Panels.htm

B. Provide in maximum lengths available to minimize end-to-end butt joints.

C. Interior Gypsum Board: ASTM C 36/C 36M or ASTM C 1396/C 1396M, in thicknesses ½-inch or 5/8-inch where indicated, with manufacturer's standard edges. Regular type; Type X where indicated.

D. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M or ASTM C 1396/C 1396M, in thickness indicated. Regular type.

2.3 ACCESSORIES

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

1. Provide cornerbead at outside corners unless otherwise indicated.
2. Provide LC-bead (J-bead) at exposed panel edges.
3. Provide control joints where indicated.

B. Aluminum Accessories: Extruded-aluminum accessories not coated.

C. Joint-Treatment Materials: ASTM C 475/C 475M.

1. Joint Tape: Fiberglass mesh tape unless otherwise recommended by panel manufacturer.
2. Joint Compounds: Setting-type compounds.
3. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gypsum board to comply with ASTM C 840.

1. Isolate gypsum board assemblies from abutting structural and masonry work. Provide edge trim and acoustical sealant.
2. Single-Layer Fastening Methods: Fasten gypsum panels to supports with screws.
3. Multilayer Fastening Methods: Fasten base layers and face layer separately to supports with screws or nails.

B. Fire-Resistance-Rated Assemblies: Comply with requirements of listed assemblies.

C. Finishing Gypsum Board: ASTM C 840.

1. At concealed areas, unless a higher level of finish is required for fire-resistance-rated assemblies, provide Level 1 finish: Embed tape at joints.
2. At substrates for tile, provide Level 2 finish: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges.
3. Unless otherwise indicated, provide Level 4 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges.
4. Where indicated, provide Level 5 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges. Apply skim coat to entire surface.

D. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin or patterned application.

END OF SECTION 092900

SECTION 096340 - STONE FLOORING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:
   1. Stone Samples at least 12 inches square.

B. Do not set stone when air or material temperature is below 50 deg F.

PART 2 - PRODUCTS

2.1 STONE

A. Slate: Dark grey chalkboard slate.

   1. Classification: II Interior.
   2. Dark grey in color.
   3. Penn State University, reclaimed material.
   4. Finish: unfinished.

2.2 MORTAR AND GROUT

A. Mortar for Stone Paving and Flooring: ASTM C 270, Proportion Specification, Type N for interior use.

   1. Thinset Mortar: selected based on slate color and mortar type for slate tile.

B. Grout: Standard unsanded grout; color to be matched to slate.

   1. Use unsanded grout for joints 1/8 inch and narrower.

2.3 ACCESSORIES

A. Floor Sealer: Colorless, slip- and stain-resistant sealer not affecting color or physical properties of stone surfaces.

2.4 STONE FABRICATION

A. Fabricate stone in sizes and shapes to comply with requirements indicated.
   1. Pattern: Rectilinear pattern of 6-by-48-inch units, laid in brickwork pattern.

B. Cut stone to produce uniform joints 1/8 inch wide or less.

C. Pattern Arrangement: Fabricate and arrange stone units as indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do necessary field cutting as stone is set. Cut lines straight and true and finish field-cut edges to match shop-cut edges.

B. Field-cut stone as necessary to fit at obstructions. Produce neat joints of size specified or indicated.

3.2 INSTALLING STONE

A. Spread, tamp, and screed setting bed to uniform thickness at elevations required for accurate setting of stone. Mix and place only as much mortar setting bed as can be covered with stone before initial set.

B. Place stone before initial set of cement occurs. Immediately before placing stone on setting bed, apply 1/16-inch- thick, bond coat to back of each stone.

C. Tamp and beat stone to obtain full contact with setting bed. Set each unit in a single operation before initial set of mortar; do not return to areas already set and readjust stone.

D. Rake out joints to depth required to receive grout as units are set.

E. Point joints after setting. Tool joints flat, uniform, and smooth, without visible voids.

F. Grout stone joints to comply with ANSI A108.10. Tool joints uniformly and smoothly with plastic tool.

3.3 CLEANING

A. Clean stone flooring as work progresses. Remove mortar fins and smears before tooling joints.

B. Clean stone flooring after setting and grouting are complete and apply sealer to cleaned stone flooring.

END OF SECTION 096340

SECTION 096400 - WOOD FLOORING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and material Samples.

B. Hardwood Flooring: Comply with NOFMA grading rules for species, grade, and cut.

PART 2 - PRODUCTS

2.1 FIELD-FINISHED WOOD FLOORING

A. Solid-Wood Strip and Plank Flooring: Kiln dried and as follows:

1. Species and Grade: Aged Woods: Antique Distressed Oak; combination reclaimed red and white oak planks.
   a. http://www.agedwoods.com/html/flooring.html
2. Cut: Reclaimed, refinished barn wood.
3. Thickness: 3/4 inch.
4. Face Width: Varies from 3”-6”.
5. Lengths: Random-length strips.

2.2 FINISHING MATERIALS

A. Urethane Finish System: Complete natural oil finish system of compatible components that is recommended by finish manufacturer for application indicated.

1. Floor Sealer: Landark Natural Oil Finish; formulated for multicoat application on wood flooring.
   a. http://www.landarknw.com/buffing%20wax.html

2.3 ACCESSORY MATERIALS

A. Wood Flooring Adhesive: Mastic recommended by flooring and adhesive manufacturers for application indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with flooring manufacturer's written installation instructions, but not less than applicable recommendations in NWFA's "Installation Guidelines: Wood Flooring."

B. Provide expansion space at walls and other obstructions and terminations of flooring of not less than 1/2 inch.

C. Solid-Wood, Plank Flooring: Adhere flooring to substrate.

1. Plank Flooring: Adhere flooring planks using floor manufacturer recommended adhesive.

3.2 SANDING AND FINISHING

A. Machine-sand flooring to remove offsets, ridges, cups, and sanding-machine marks that would be noticeable after finishing. Vacuum and tack with a clean cloth immediately before applying finish.

B. Apply floor-finish materials in number of coats recommended by finish manufacturer for application indicated.

END OF SECTION 096400

SECTION 097413 – WOOD WALL COVERINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and Samples.

PART 2 - PRODUCTS

2.1 WOOD WALL COVERING

A. Available Products: Wood Siding:
   1. Termawood; heat treated poplar.
      a. Horizontal Pattern: 2 1/2-inch boards with 1/2-inch gap interior wood wall covering.
      b. Finish: Manufacturer heat treatment and standard finish.

   2. Or Equivalent product similar to exterior rain screen.

B. Finish: If not heat treated, then apply natural oil finish for interior use from Landark finishes available according to manufacturer instructions.
   1. http://www.landarknw.com/interior%20finish.html

2.2 ACCESSORIES

A. Provide necessary mounting accessories to attach screen to wall in method used for exterior rain screen siding; refer to 07 46 00 Siding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prepare surfaces and attach finished wood pieces in method used for exterior rain screen siding in areas of the home indicated in drawings.

END OF SECTION 097413

SECTION 099100 - PAINTING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals:

1. Product Data.
2. Samples.

PART 2 - PRODUCTS

2.1 PAINT

A. Available Products:

1. PPG Pure Performance:
   a. http://www.pittsburghpaints.com/pure_performance.htm

2. Rust-Oleum Professional Oil Based Enamel Topcoat, Flat Black 7776402:
   a. http://www.rustoleum.com/CBGResourceCenter.asp?sn=ms2&msdstyp=PROCBG&msdsprc=130

3. Landark Natural Oil Finishes:
   a. http://www.landarknw.com/Images/2009%20Product%20Info%20for%20web%20with%20color%20charts.pdf

4. PPG primer:
   a. http://www.pittsburghpaints.com/pure_performance.htm

B. MPI Standards: Provide materials that comply with MPI standards indicated and listed in its "MPI Approved Products List."

C. Material Compatibility: Provide materials that are compatible with one another and with substrates.

1. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

D. Use interior paints and coatings that comply with the following limits for VOC content:

1. Flat Paints: Pure Performance; Zero VOC.
2. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 450 g/L.
3. Clear Wood Finishes, Finishing Oil: 405.45 g/L
4. Floor Coatings: refer to Stone and Wood Flooring Specifications 09 63 40 and 09 64 00.
5. Primers, Sealers, and Undercoaters: PPG Primer; Zero VOC.

E. Colors: As selected.

PART 3 - EXECUTION

3.1 PREPARATION

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

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

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

3.2 APPLICATION

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

B. Paint exposed surfaces unless otherwise indicated.

1. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.
2. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint the back side of access panels.
4. Do not paint prefinished items, items with an integral finish, operating parts, and labels unless otherwise indicated.

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

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

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, or other surface imperfections. Cut in sharp lines and color breaks.

1. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

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

3.3 INTERIOR PAINT APPLICATION SCHEDULE

A. Steel:

1. Flat, two coats of Quick-Dry Enamel.

B. Dressed Lumber: Including cabinetry, flooring and heavy timber framing

1. Natural, finishing oils: Two coats; applied according to manufacturers instructions.

C. Gypsum Board:

1. Flat or Eggshell Latex: Two coats over primer/sealer: MPI INT 9.2A.

END OF SECTION 099100

SECTION 101400 - SIGNAGE

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

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

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

C. 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.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, Type 304.

B. Plastic Laminate: Engineered Resin, 3form:
1. http://www.3-form.com/materials.php; Interior at 1/8-inch thickness; Exterior at ¼-inch thickness.

2.2 SIGNS

A. Plaques: Engineered resin; 3form free from pits, scale, sand holes, and other defects.

B. Dimensional Characters: Etched characters.

1. Finish and Color: As indicated.
2. Illuminated Characters: Manufacturer's standard LED lighting including transformers, insulators, and other components.

C. Interior Panel Signs: Engineered resin; 3form free from pits, scale, sand holes, and other defects with square-cut edges and square corners.

1. Finishes and Colors: As indicated.
2. Etched characters.
3. Provide signs for the following:
   a. Welcome
   b. Enter
   c. Open/Closed
   d. Detail Signs (As required)

e. Gr2O
f. Exit
g. Natural Fusion

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Wall-Mounted Signs:
1. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes.

END OF SECTION 101400

SECTION 101800 – INFORMATIONAL KIOSKS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

C. 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.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, Type 304.

B. Plastic Laminate: Engineered Resin, 3form:
1. http://www.3-form.com/materials.php; ½-inch thickness.

C. Dimensional Lumber: 4 x 4 posts.

2.2 SIGNS

A. Plaques: Engineered resin; 3form free from pits, scale, sand holes, and other defects.

B. Dimensional Characters: Etched characters.

1. Finish and Color: As indicated.

C. Monitors: 4 HP TouchSmart tx2z series monitors:
1. http://www.shopping.hp.com/webapp/shopping/computer_can_series.do?storeName=computer_store&category=notebooks&a1=Category&v1=Ultra-Portable&series_name=tx2z_series

PART 3 - EXECUTION

3.1 INSTALLATION

A. Power supply to be routed underneath event deck.

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

C. Touch screens will display reconfigurable options for the Natural Fusion home; GR2O prototype homes.

END OF SECTION 101800

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, No. 4 finish (satin), 0.0312-inch minimum nominal thickness unless otherwise indicated.

B. Aluminum: ASTM B 221, Alloy 6063-T6 or 6463-T6.

C. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

D. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.2 TOILET AND BATH ACCESSORIES

A. Toilet Tissue Dispenser:
1. Type: Single-roll dispenser.
2. Mounting: Surface mounted with concealed anchorage.
3. Material: Satin-finish aluminum bracket with plastic spindle.
4. Capacity: Designed for 4-1/2- or 5-inch- diameter-core tissue rolls.

B. Waste Receptacle:
1. Type: Undercounter.

C. Mirror Unit:
1. Frame: Stainless-steel channel; lighting system part of mirror unit.

D. Towel Bar:
1. Description: 3/4-inch- round tube with circular end brackets.
2. Mounting: Flanges with concealed fasteners.
3. Length: 18 inches .
4. Material and Finish: Polished aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

END OF SECTION 102800

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS AND BRACKETS

A. Portable Fire Extinguishers: NFPA 10, listed and labeled for the type, rating, and classification of extinguisher.

1. Products:
   a. Kiddie PRO 340 Fire Extinguisher: Multipurpose Dry-Chemical Type: UL-rated 3-A:40-B:C, 5-lb nominal capacity, in enameled-aluminum container.
      1) http://www.kidde.com/utcfs/ws-384/Assets/Pro%20340%20Fire%20Extinguisher%20(For%20Moderate%20Hazard%20Protection).pdf

   b. Kiddie Electrical Fire Extinguisher: Multipurpose Dry-Chemical Type: UL-rate 1-A:10-B:C, 2.5 lb nominal capacity, in enameled-aluminum container. 1)http://www.kidde.com/utcfs/ws-384/Assets/Electrical%20Fire%20Extinguisher%20(Secondary%20Protection).pdf

B. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for fire extinguishers indicated, with plated or baked-enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install mounting brackets in locations indicated at heights acceptable to authorities having jurisdiction.

B. Install fire extinguishers in mounting brackets and cabinets where indicated.

END OF SECTION 104416

SECTION 107313 - AWNINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

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

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

PART 2 - PRODUCTS

2.1 AWNINGS

A. Products:

1. Construction Specialties Group: C/S Sun Controls. Customized operable shading device with integrated photovoltaic modules:
   a. http://www.c-sgroup.com/files/tech-center/sun_controls/cad/pdf/100-3S-9.pdf

B. Performance Requirements: Provide awnings capable of withstanding design loads indicated. Operable daytime solar tracking system.

2.2 AWNING FRAMES

A. Aluminum Frames: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

1. Aluminum Plate and Sheet: ASTM B 209
2. Aluminum Extrusions: ASTM B 221
3. Aluminum Finish: powder coat.

B. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Corrosion-resistant, weather-resistant, nonstaining materials. Where exposed to view, provide finish and color as selected.

2.3 PHOTOVOLTAICS

A. Products:
1. Solar Power Industries: Customized multicrystalline silicon photovoltaic modules.
   a. http://www.solarpowerindustries.com/docs/english/156mm2BusSolarCellSG.pdf

B. Performance Requirements: Bus voltage of less than 60VDC

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

C. Install photovoltaic modules to awning louvers.

END OF SECTION 107313

SECTION 110130 - OPERATION AND MAINTENANCE OF RESIDENTIAL EQUIPMENT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Safety Standards: OSHA 1926.104.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Fall Protection Equipment: Anchorage Point
   1. MANUFACTURER: MSA: The Safety Company – D-Plate Anchorage Connector
      a. http://www.msanet.com/catalog/product707.html

B. Fall Protection Equipment: Fall Arrest System
   1. MANUFACTURER: MSA: The Safety Company – Self-Retracting Lanyards
      a. http://www.msanet.com/catalog/product503311.html
   2. OR EQUIVALENT

C. Fall Protection Equipment: Full Body Harness
   1. MANUFACTURER: MSA: The Safety Company – Full Body Harness
      a. http://www.msanet.com/catalog/product1202.html
   2. OR EQUIVALENT

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Anchorage points shall be installed per the manufacturer's written instructions with 1/8" metal back plate at the locations indicated on the structural roof plan.

3.2 EQUIPMENT USE

A. General: Use of the arrest system and harness per manufacturer instructions.

END OF SECTION 110130

SECTION 113100 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Regulatory Requirements: Comply with provisions of the following product certifications:

1. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. UL and NEMA: Provide electrical components required as part of residential appliances that are listed and labeled by UL and that comply with applicable NEMA standards.
3. ANSI: Provide gas-burning appliances that comply with ANSI Z21 Series standards.
4. NAECA: Provide residential appliances that comply with NAECA standards.

C. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

D. Energy Ratings: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.

PART 2 - PRODUCTS

2.1 RESIDENTIAL APPLIANCES

A. Electric Cook top: Electrolux EW30CC55GS; 30-inch, built-in induction hybrid cook top with four burner elements.
   a. http://www.electroluxappliances.com/Files/Documents/Specifications/EW30CC55G_sp_EN.pdf

B. Electric Wall Oven: GE Advantium SCB1001; Built-in, single, electric, self-cleaning wall oven with broiler unit in stainless steel.
   a. http://products.geappliances.com/MarketingObjectRetrieval/Dispatcher?RequestType=PDF&Name=240444_psb1001n_c2.pdf

C. Exhaust Hood: Broan 273003; 30-inch, retractable-downdraft exhaust hood with variable speed fan.
   a. http://www.broan.com/ImageLibrary/broan/pdf/Specifications/99041819.pdf

2. Fan Control: flush-mounted switch, with separate light switch.
3. Weatherproof floor cap with back draft damper and rodent-proof screening.

D. Refrigerator/Freezer: Liebherr CS1601; Freestanding, frost-free, two-door refrigerator with bottom-mounted freezer, ABS thermoplastic-copolymer interior cabinet liners.
   a. http://www.liebherr-appliances.com/products/freestanding/30_refrigerator.html

   2. Fresh Food Compartment Volume: 11.3 cu. Ft.
   3. Freezer Compartment Volume: 4.2 cu. Ft.
   4. Shelf Area: 4 adjustable glass shelves, 24 sq. ft.

E. Dishwasher: Bosch SHE98M05UC; Built-in, under counter, automatic dishwasher, sized to replace 24-inch base cabinet, 9 wash cycles with hot-air and heat-off drying cycles, stainless-steel tub and door liner, nylon-coated sliding dish racks.
   a. http://www.boschappliances.com/products/specs_dimensions_popup.aspx?product_id=693

F. Electric Clothes Washer/Dryer Combo: LG WM3431HS; Freestanding, front-loading, automatic clothes washer and dryer with 2.44 cu. Ft. capacity stainless-steel tub; 9 wash cycles including regular, delicate, and permanent press, and 5 dry times; 1/3-hp motor.
   a. http://www.lge.com/us/appliances/pdf/WM3431HW_HSss_v1.pdf

2.2 RESIDENTIAL ELECTRONIC ENTERTAINMENT UNITS

A. Laptop Computer: Apple 17" Macbook Pro; 17-inch (viewable) high-resolution LED-backlit glossy widescreen: 1920 x 1200 pixels

   a. http://store.apple.com/us/browse/home/shop_mac/family/macbook_pro?mco=MTM0ODA

B. Surround Sound Systems: Philips HTS3544; Complete home theater system including 5.1-channel Class D digital amplifier with built in surround sound decoders, progressive-scan DVD/CD/MP3/divx player, AM/FM tuner, 4 satellite speakers, 1-center-channel speaker and subwoofer.

   a. http://www.p4c.philips.com/files/h/hts3544_37/hts3544_37_pss_aen.pdf

C. LED Television: Samsung UN40B6000 40" 1080P LED HDTV; The Samsung LED TV is a clearer more dynamic television that uses up to 40

   a. http://www.samsung.com/us/system/consumer/product/2009/04/17/un40b6000vfxza/UN40B6000-FINAL-041609-R6.pdf

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

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

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

END OF SECTION 113100

SECTION 122113 - HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and Samples.

PART 2 - PRODUCTS

2.1 HORIZONTAL BLINDS.

A. Available Products:

1. Hunter Douglas, Duette Architella honeycomb shades.
   a. http://www.hunterdouglas.com/php/images/cache/orig/8133__architella_product_sheet.pdf

B. Honeycomb size: ¾ inch.

C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled; fully enclosing operating mechanisms on three sides and ends.

D. Tilt Operation: Powered with remote control operation.

E. Mounting: As indicated.

F. Colors, Textures, Patterns: As selected from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install blinds level, plumb, and located not closer than 1 inch to interior face of glass.

1. Flush Mounted: Install blinds with edges flush with finish face of opening when blinds are completely lifted.

B. Adjust horizontal louver blinds to operate smoothly and easily throughout entire operational range.

END OF SECTION 122113

SECTION 123530 - RESIDENTIAL CASEWORK

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and Shop Drawings.

B. Verify dimensions by field measurements.

PART 2 - PRODUCTS

2.1 CASEWORK

A. Comply with KCMA A161.1.

B. Forest Certification: Provide cabinets produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "Principles and Criteria for Forest Stewardship."

C. Cabinets:

1. Available Products:
   a. Spectra Wood: Cabinetry manufacturer; custom cabinets:
      1) http://www.spectrawood.com/
   b. Häfele America Co.: Hardware manufacturer:
      1) http://www.hafele.com/us/services/4398.asp

2. Face Style: Flush overlay and Flush inset.
3. Cabinet Style Frameless.
4. Door and Drawer Fronts: Veneer-faced walnut plywood.
5. Face Frame Finish: Wood
6. Exposed Cabinet End Finish: Wood.
7. Exposed Wood: Veneer-faced walnut plywood. Hardwood plywood with Grade A faces per HPVA HP-1, selected for compatible color and grain.
8. Semi-exposed Materials: Hardwood plywood with Grade C faces per HPVA HP-1, stained to match faces.
9. Door and Drawer Pulls: Back-mounted decorative pulls
10. Hinges: Concealed European-style self-closing hinges.
11. Drawer Guides: Epoxy-coated-metal, self-closing drawer guides with nylon-tired, ball-bearing rollers.

D. Solid-Surface-Material Countertops and Splashes: IceStone countertop.

1. Available Products:

   a. IceStone Durable Surfaces; refer to 12 36 40 Stone Countertops.

E. Under-counter mounted sink: Stainless steel sink; refer to 22 40 00 Plumbing Fixtures.

F. Countertop Configuration:

1. Front Style: Straight, slightly eased at top.
2. Cove Type: Post-formed laminate supported at junction of top by wood-cove molding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cabinets with no variations in flushness of adjoining surfaces by using concealed shims. Where casework abuts other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match casework face.

B. Install cabinets without distortion so doors and drawers fit openings properly and are aligned.

C. Install level and plumb to a tolerance of 1/8 inch in 12 feet.

D. Fasten each cabinet to adjacent unit and to structural members of wall construction. Fasten wall cabinets through back, near top and bottom, at ends and not less than 24 inches o.c.

1. Use No. 10 wafer-head screws sized for 1¼ -inch penetration into wood framing, blocking, or hanging strips.

E. Fasten stone countertops by following manufacturer's installation and guide. Glue joints in countertops and use concealed mechanical clamps.

1. Provide cutouts for sinks and lavatories, including holes for faucets and accessories.
2. Seal edges of cutouts by saturating with varnish.

END OF SECTION 123530

SECTION 123640 - STONE COUNTERTOPS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and Shop Drawings.

B. Verify dimensions of stone countertops by field measurements and indicate on Shop Drawings.

PART 2 - PRODUCTS

2.1 STONE

A. IceStone:

1. IceStone Durable Surfaces: 100% recycled glass in a cement matrix, Freezing Mist color.
2. IceStone Durable Surfaces: http://www.icestone.biz/index.php?option=com_content&task=view&id=12&Itemid=270
3. Finish: Polished.

2.2 SETTING MATERIALS

A. Water-Cleanable Epoxy Adhesive: ANSI A118.3.

1. Available Products:
   a. Countertop manufacturer recommended adhesive.

B. Water-Cleanable Epoxy Grout: ANSI A118.3.

1. Available Products:

   a. Countertop manufacturer recommended grout.

C. Sealant: Clear silicone sealant.

1. Available Products:

   a. Manufacturer recommended: Aquamix Penetrating Sealer

   b. Or, manufacturer recommended: Bulletproof by StoneTech Pro.

2.3 COUNTERTOP FABRICATION

A. Comply with recommendations in MIA's "Dimensional Stone - Design Manual IV."

1. Thickness: 1-1/4 inches.
2. Edge Detail: Straight, slightly eased at top .

B. Splashes: 3/4-inch nominal thickness backsplashes.

1. Height: 4 inches.
2. Top-Edge Detail: Straight, slightly eased at corner.

C. Fabricate molded edges with machines having abrasive shaping wheels made to reverse contour of edge profile. Form corners of molded edges as indicated with outside corners slightly eased.

D. Seams: Fabricate countertops without seams.

E. Cutouts and Holes:

1. Undercounter Fixtures: Make cutouts for undercounter fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

a. Edge Detail: Vertical, slightly eased at top and bottom surfaces and projecting 3/16 inch into fixture opening.

2. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
3. Fittings: Drill countertops in shop for plumbing fittings.

PART 3 - EXECUTION

3.1 INSTALLING COUNTERTOPS

A. Install countertops by adhering to supports with water-cleanable epoxy adhesive.

B. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts while cutting.

C. Install backsplash and end splashes by adhering to wall with water-cleanable epoxy adhesive. Leave 1/16-inch gap between countertop and splash for filling with sealant. Use temporary shims to ensure uniform spacing.

D. Grout seams to comply with ANSI A108.10. Tool grout uniformly and smoothly with plastic tool.

E. Apply sealant to seams and to gap between countertops and splashes.

3.2 CLEANING

A. Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.

B. Clean stone countertops not less than six days after completion of sealant installation, using clean water and soft rags. Do not use materials or methods that could damage stone.

C. Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions.

END OF SECTION 123640

SECTION 124200 – TABLE ACCESSORIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Information.

PART 2 - PRODUCTS

2.1 TABLE ACCESSORIES

A. Ceramics:
   a. Simple table set of dinner plates, side plates, bowls, and cups for 16:
      1) http://www.target.com/Square-Dinnerware-16-pc-Set-White/dp/B000WYEP5U/sr=1-11/qid=1243863910/ref=sr_1_11/184-2618197-5277305?ie=UTF8&frombrowse=0&rh=k%3Asquare%20dinnerware%20set&page=1
      2) Or Equivalent number of pieces and simple style.

B. Flatware:
   a. http://www.oneida.com/index.cfm/fuseaction/product.detail/_/Stasis/productID/4e479b87-0728-455e-88ab-ced722e3724a/categoryID/68d0271b-6300-4227-ad66-5a6c6b87e483/
   b. Or Equivalent number of pieces and style.

C. Hollowware:
   a. Fagor Rapid Express 5 Piece Pressure Cooker Set:
      1) http://www.costco.com/Browse/Product.aspx?Prodid=11338022
   b. Other serving tools and cookware to be selected matching previously specified pieces.

D. Glassware:
   a. Ethan Glasses; Crate&Barrel:
      1) http://www.crateandbarrel.com/family.aspx?c=150&f=31866
      2) Or Equivalent glassware to match style of other kitchenware.

E. Other Kitchen Accessories:
   a. All other kitchen accessories should be selected to match style of other pieces.

END OF SECTION 124200

SECTION 124400 – BATH FURNISHINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 BATH FURNISHINGS

A. Bath Linens:
   a. Bath Towels: 100% cotton, 2 ply terry velour towels at 1.09 lbs each and 30”x 60”
      1) Distributed by: Consumer Contact Company: 777 S. Wadsworth Blvd, Suite 1-103, Lakewood, CO 80226, Phone: 303-973-4779.

END OF SECTION 124400

SECTION 124500 – BEDROOM FURNISHINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Information.

PART 2 - PRODUCTS

2.1 BEDROOM FURNISHINGS

A. Mattress: An organic mattress selected for custom double bed frame for bedroom.

B. Bed linens:
   a. http://www.restorationhardware.com/rh/catalog/product/product.jsp?productId=prod1340030&navCount=14
   b. Or Equivalent color and set count for full bed.

C. Pillows: Organic pillows for bed.
   a. http://www.ecobedroom.com/shop/pillows/cotton.html
   b. Or Equivalent organic pillow and number of pillows for cases.

END OF SECTION 124500

SECTION 125800 – RESIDENTIAL FURNITURE

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Information

PART 2 - PRODUCTS

2.1 RESIDENTIAL FURNITURE

A. Couches:
   a. Environment Furniture: from the Upholstery Collection:
      1) Stay Sofa & Chaise
      2) Studio Sofa & Chaise
      3) Or Equivalent sofa and chaise or configurable sofa that works into the size and design of the living space.
         a) http://www.environmentfurniture.com/upholstery.html#

B. Dining Table and Chairs:
   a. Table: Custom built dining table designed to be stored over the island unit and moved or split to accommodate up to eight people, to be moved to a new dining location, to allow for prep space, or to allow for use of the stove top.
   b. Chairs: Stackable kitchen island stools with and/or without backs to provide everyday seating and easy storage for extras but allow for enough seating for up to 8 people.

C. Coffee and End Tables:
   a. Custom built tables designed for either side as well as in front of the couch. Made from sustainably harvested and/or reclaimed wood products.

D. Entertainment Center:
   a. Custom built entertainment unit designed to house all necessary home entertainment equipment as well as provide storage space. Custom designed end desk space that allows for usable work space when needed but retracts to simplify and clean up the overall look of the space.

E. Bed:
   a. Environment Furniture: from the Beds Collection; with under bed storage space
      1) http://www.environmentfurniture.com/beds.html#
   b. Or equivalent custom built bed unit to incorporate shelving as well as under bed storage space; built using sustainably harvested or reclaimed wood.

F. Armoire:
   a. Custom built-in armoire in bedroom with hanging space and shelving space for clothes and other needed storage. Custom door panels across unit to simplify and

clean up the overall look of the bedroom; wood frame with 3form center panel. Unit made of wood.

1) 3form, engineered resin: http://www.3-form.com/materials.php

G. Nightstands:

a. Custom built shelving feature with lighting and a chalkboard slate headboard built to match bed and provide ample bedside storage.

H. Other Residential Furniture:

a. Other furniture, custom built or otherwise, to be built or selected to meet necessary design criteria and functional purposes for the space in which it is located.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Built-in Furniture: Custom built-in units to be installed to measurements specified on drawings.

B. Freestanding Furniture: All other furniture, custom-built or otherwise, to be built to drawing specifications or placed in appropriate location as specified by drawings.

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

END OF SECTION 125800

SECTION 129200 – INTERIOR PLANTERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data

B. High quality, Vinca major, to cover an area of 170 square feet.

C. Planting Restrictions: Plant during one of the following periods:

1. Evergreen Planting: late spring

2. Perennial Planting: dates vary on species of herb

D. Maintain plants until established, but not less than three months.

PART 2 - PRODUCTS

2.1 PLANTING MATERIALS

A. Plants: Established and well rooted in pots or similar containers.

2.2 SOIL AND AMENDMENTS

A. Leaf Compost: Well-composted, stable, and weed-free organic matter; pH range of 5.5 to 8.

B. Organic Slow-Release Fertilizer: Granular fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium; 5 percent nitrogen; 10 percent phosphorous; 5 percent potassium; by weight.

2.3 MISCELLANEOUS

1. Edgings: Painted steel

a. Gutter Supply - Galvanized Aluminum 24 Gauge Sheet Metal.

1) http://www.guttersupply.com/m-steel-gutters.gstml

PART 3 - EXECUTION

3.1 PREPARATION

A. Plants 4 inches apart. Dig holes large enough to allow root spread. Plant stock working soil around roots and leave a slight saucer around plants to hold water. Water after planting. Do not cover plant crowns with wet soil.

B. Edgings: Install edgings and anchor with nails driven below front elevation of edging and attach to steel brackets to be hung on horizontal slating.

C. Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

END OF SECTION 129200

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Mechanical Sleeve Seals: Modular rubber sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

B. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. PVC Pipe: ASTM D 1785, Schedule 40.

2.2 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2.3 MOTORS

A. Motor Characteristics:

1. Motors 3/4 HP and Larger: Three phase.
2. Motors Smaller Than 3/4 HP: Single phase.
3. Frequency Rating: 60 Hz.
4. Voltage Rating: NEMA standard voltage for circuit voltage to which motor is connected.
5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
6. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
7. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
8. Enclosure: Unless otherwise indicated, open drip-proof.
9. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

2.4 PRESSURE GAGES AND TEST PLUGS

A. Pressure Gages: Direct-mounting, indicating-dial type complying with ASME B40.100. Dry metal case, minimum 2-1/2-inch diameter with red pointer on white face, and plastic window. Minimum accuracy 3 percent of middle half of range. Range two times operating pressure.

B. Test Plug: Corrosion-resistant brass or stainless-steel body with two self-sealing rubber core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping. Minimum pressure and temperature rating 500 psig at 200 deg F.

PART 3 - EXECUTION

3.1 MOTOR INSTALLATION

A. Anchor motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions.

3.2 GENERAL PIPING INSTALLATIONS

A. Install piping free of sags and bends.

B. Install fittings for changes in direction and branch connections.

C. Install sleeves for pipes passing through gypsum board partitions.

D. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.

E. Comply with requirements in Division 07 Section "Penetration Firestopping" for sealing pipe penetrations in fire-rated construction.

F. Install unions at final connection to each piece of equipment.

G. Install dielectric unions and flanges to connect piping materials of dissimilar metals in gas piping.

H. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.

3.3 GENERAL EQUIPMENT INSTALLATIONS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 220500

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

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

B. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Hard Copper Tubing: ASTM B 88, Types L and M, water tube, drawn temper with wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

1. Copper Unions: Cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
2. Joining Materials: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder.

B. Soft Copper Tubing: ASTM B 88, Types K and L, water tube, annealed temper with copper pressure fittings, cast-copper-alloy or wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

1. Joining Materials: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder.

C. Galvanized-Steel Piping: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe, with ASME B16.4, Class 125, galvanized, standard pattern gray-iron, threaded fittings.

D. CPVC Piping: ASTM F 441/F 441M, Schedule 40 pipe with ASTM F 438, CPVC Schedule 40 socket-type fittings.

E. PEX Tube and Fittings: ASTM F 877, SDR 9 PEX tubing and ASTM F 1807, metal insert-type fittings with copper or stainless-steel crimp rings.

1. Manifold: ASTM F 877 plastic or corrosion-resistant-metal assembly, with a plastic or corrosion-resistant-metal valve for each outlet.

F. PVC Pipe: ASTM D 1785, Schedule 40.

1. PVC Fittings: ASTM D 2466, Schedule 40, socket type.

G. Special-Duty Valves:

1. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
2. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.
3. PVC Union Ball Valves: MSS SP-122, with full-port ball, socket detachable end connectors, and pressure rating not less than 150 psig at 73 deg F.
4. PVC Non-Union Ball Valves: MSS SP-122, with full- or reduced-port ball, socket or threaded ends, and pressure rating not less than 150 psig at 73 deg F.
5. PVC Check Valves: Swing or ball-check design and pressure rating not less than 150 psig at 73 deg F.

H. Transition Fittings: Manufactured piping coupling or specified piping system fitting. Same size as pipes to be joined and pressure rating at least equal to pipes to be joined.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping installation requirements.

B. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for wall penetration systems.

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

D. Install domestic water piping without pitch for horizontal piping and plumb for vertical piping.

E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

F. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

1. Soldered Joints: Comply with procedures in ASTM B 828 unless otherwise indicated.

G. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pipe hanger and support devices.

H. Support vertical piping at each floor.

I. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

3.2 INSPECTING AND CLEANING

A. Inspect and test piping systems as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

B. Clean and disinfect potable and non-potable domestic water piping by filling system with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

3.3 PIPING SCHEDULE

A. Aboveground Distribution Piping: PEX piping.

3.4 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Install gate valves close to main on each branch and riser serving two or more plumbing fixtures or equipment connections and where indicated.

C. Install gate or ball valves on inlet to each plumbing equipment item, on each supply to each plumbing fixture not having stops on supplies, and elsewhere as indicated.

D. PVC ball, butterfly, and check valves may be used in matching piping materials.

E. Install drain valve at base of each riser, at low points of horizontal runs, and where required to drain water distribution piping system.

F. Install swing check valve on discharge side of each pump and elsewhere as indicated.

G. Install ball valves in each hot-water circulating loop and discharge side of each pump.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Pipe-Applied, Atmospheric Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.

B. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013.

C. Water Regulators: ASSE 1003.

D. Balancing Valves: MSS SP-110 for two-piece, copper-alloy ball valves, with memory stop.

E. Clothes Washer Outlet Boxes: Plastic box and face plate with combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.

F. Hose Bibbs: Bronze body in rough-bronze chrome-plated finish, with removable composition disc, threaded or soldered inlet, garden-hose threaded outlet, and wheel handle.

G. Stop-and-Waste Drain Valves: MSS SP-110 for ball valves or MSS SP-80 for gate valves.

H. Strainers: Y-pattern, bronze body, 125-psig minimum steam working pressure.

I. Water Filters: Cartridge type, including housing, fittings, filter cartridges, and cartridge end caps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers at each water-supply connection to mechanical equipment.

B. Install hose bibbs with integral or field-installed vacuum breaker.

END OF SECTION 221119

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data. Include certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PUMPS

A. In-Line, Sealless Centrifugal Pumps: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps. Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal; rated for 125-psig minimum working pressure and minimum continuous water temperature of 225 deg F.

1. Available Products:

a. TACO: 1600 Series.
1) http://www.taco-hvac.com/uploads/FileLibrary/301-001.pdf

2. Casing: Bronze, with threaded or companion-flange connections.
3. Impeller: Plastic.

2.2 MOTORS

A. NEMA MG 1, "Standard for Motors and Generators." Include NEMA listing and labeling.

B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.3 CONTROLS

A. Constant Pressure: Electric; adjustable for control of water circulation.
1. Settings: maintain pressure in the system at 40 psi.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support pumps and piping so weight of piping is not supported by pump volute.

D. Install electrical connections for power, controls, and devices.

E. Suspend in-line pumps independent from piping. Use continuous-thread hanger rods and vibration isolation hangers. Fabricate brackets or supports as required for pumps.

F. Install vertical in-line pumps on concrete bases.

G. Connect piping with valves that are at least the same size as piping connecting to pumps.

H. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

I. Install shutoff valve and strainer on suction side of pumps.

J. Install nonslam check valve and throttling valve on discharge side of pumps.

K. Install thermostats in hot-water return piping.

L. Install pressure gages on suction and discharge of each pump. Install at integral pressure gage tappings where provided.

END OF SECTION 221123

SECTION 221219 – FACILITY POTABLE WATER STORAGE TANKS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Product Data.

B. Complies with ANSI STANDARD 61 DRINKING WATER SYSTEM COMPONENTS

PART 2 - PRODUCTS

2.1 PILLOW TANKS

A. Product Data:
   1. Fol-Da-Tank PW1340 Potable water storage tank.
      a. http://www.tank-depot.com/product.aspx?id=866

B. Material: Polyester

   1. Joining Materials: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder.

C. Connections:
   1. Fill: 4 inches steel fitting.
   2. Discharge: 1-1/2 inches steel fitting

D. Sizing
   1. Dimensions: 168” x 84” x24”
   2. Dry weight: 64 lbs
   3. Max Capacity: 1340 gal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pillow tanks shall be installed on top of 2x4 boards on their sides covered with OSB to keep the tank off of the National Mall.

B. The tank enclosure will be built so as to not impact the structural layout of the deck support system on the north side of the house.

END OF SECTION 221219

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Minimum Pressure Requirement for Soil, Waste, and Vent: 10-foot head of water.

B. Comply with NSF 14, "Plastic Piping Components and Related Materials," for plastic piping components.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Copper Drainage Tube and Fittings: ASTM B 306, Type DWV drawn temper with wrought - copper, Type DWV drainage fittings.

B. Hub-and-Spigot Cast-Iron Soil Pipe and Fittings: ASTM A 74, Service class; ASTM C 564 rubber gaskets.

C. Hubless Cast-Iron Soil Pipe and Fittings: ASTM A 888 or CISPI 301, with ASTM C 1277 shielded couplings.

D. PVC Plastic, DWV Pipe and Fittings: ASTM D 2665, Schedule 40, plain ends with PVC socket-type, DWV pipe fittings.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping installation requirements.

B. Install 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."

C. Install wall penetration system at each pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for wall penetration systems.

1. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

D. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

E. 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.

F. 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.

G. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

H. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

J. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

K. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure unless otherwise indicated.

L. Comply with requirements in Division 22 Section "Common Work Results for Plumbing" for pipe hanger and support devices.

3.2 PIPE SCHEDULE

A. Aboveground Applications: PVC plastic, DWV pipe and fittings with solvent-cemented joints.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. PVC Backwater Valves: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

B. Cleanouts, CO-1:

1. Application: Floor cleanout.
2. Body or Ferrule: Plastic.
3. Outlet Connection: Inside calk.
4. Closure: Plastic plug.
5. Adjustable Housing Material: Plastic.
6. Frame and Cover Material and Finish: Stainless steel.
7. Frame and Cover Shape: Round.
8. Top-Loading Classification: Light Duty.

C. Plastic Floor Drains, FD-1:

1. Standard: ASME A112.6.3.
2. Material: PVC.
3. Seepage Flange: Not required.
4. Clamping Device: Not required.
5. Outlet: Bottom.
6. Sediment Bucket: Not required.
7. Top or Strainer Material: Plastic.
8. Top of Body and Strainer Finish: Stainless steel.
9. Top Shape: Round.
10. Trap Material: Plastic drainage piping.
11. Trap Pattern: Standard P-trap.

D. Roof Flashing Assemblies: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

E. Air-Gap Fittings: ASME A112.1.2, chrome-plated brass cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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.

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

C. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor unless otherwise indicated.

1. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
2. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

D. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

E. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

F. Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction. Install control panel adjacent to unit, unless otherwise indicated.

G. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain grease removal devices.

END OF SECTION 221319

SECTION 223300 - ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable-water-tank linings.

C. Comply with performance efficiencies prescribed in ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings."

D. Warranties: Submit a written warranty executed by manufacturer agreeing to repair or replace water heaters that fail in materials or workmanship within five years from date of Substantial Completion. Failures include, but are not limited to, tanks and elements.

PART 2 - PRODUCTS

2.1 WATER HEATERS, GENERAL

A. Insulation: Suitable for operating temperature and required insulating value. Include insulation material that surrounds entire tank except connections and controls.

B. Anode Rods: Factory installed, magnesium.

C. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.

D. Drain Valve: Factory or field installed.

2.2 ELECTRIC WATER HEATERS

A. Products:

1. Stiebel Eltron; Tempura 20 Plus.
   a. http://www.stiebel-eltron-usa.com/techdata_tempranew.html

B. Thermostat-Control, Instantaneous Electric Water Heaters: UL 499, 0.5-gal. capacity; with 150-psig working-pressure rating; 120 volts, 750 watts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install temperature and pressure relief valves and extend to closest floor drain.

B. Install vacuum relief valves in cold-water-inlet piping.

C. Install shutoff valves and unions at hot- and cold-water piping connections.

D. Make piping connections with dielectric fittings where dissimilar piping materials are joined.

E. Electrically ground units according to authorities having jurisdiction.

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data for each type of plumbing fixture, including trim, fittings, accessories, appliances, appurtenances, equipment, and supports.

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

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

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

PART 2 - PRODUCTS

2.1 WATER CLOSET: WC-1

A. Vitreous-China Water Closet: Elongated, siphon-jet type, floor-mounted, floor outlet with close-coupled, gravity-type tank.

1. Basis-of-Design Product: Product indicated on Drawings: American Standard FloWise Dual Flush 2480.216.
   a. http://www.americanstandard-us.com/products/productDetail.aspx?id=2055

2. Design Consumption: Dual Flush; 1.6 gal./flush (Full Flush), .8 gal./flush (Partial Flush).

B. Toilet Seat: Elongated, solid plastic closed front with cover with bumpers and hardware, Residential class.

1. Basis-of-Design Product: Product indicated on Drawings: American Standard FloWise Dual Flush 2480.216.

C. Fixture Support: Combination carrier designed for accessible mounting height. Include additional faceplate and coupling for water closet at wide pipe space. Compact-type carrier for back-to-back water-closet installation is prohibited.

2.2 LAVATORY: LAV-1

A. Wood Lavatory: Vessel, 16-inch diameter.

B. Faucets: ASME A112.18.1; solid-brass underbody.

1. Basis-of-Design Product: Product indicated on Drawings: Kohler; K-12183.
   a. http://www.us.kohler.com/onlinecatalog/detail.jsp?prod_num=12183

2. Type: Center set with central inlets and with pop-up waste.
3. Finish: Polished chrome-plate.
4. Handle(s): Single-lever toggle.
5. Maximum Flow Rate: 1.5 gpm.

C. Drain: Pop up with NPS 1-1/4 (DN 32) tailpiece, included with faucet.

D. Trap: Chrome-plated with slip-joint inlet and wall flange.

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

2.3 SHOWER: SH-1

A. Plastic Shower Enclosure: ANSI Z124.2 and ANSI Z124.2a; 3form: 60” x 34”.

1. Basis-of-Design Product: Product indicated on Drawings: 3form. Chroma White matte 1”; refer to 06 64 00 Plastic Paneling.

B. Shower Base Receptor: Vikrell with threshold matching enclosure and slip-resistant surface, 60” x 34”. Include integral corrosion-resistant-metal drain with removable strainer and NPS 2 (DN 50) bottom outlet.

1. Basis-of-Design Product: Product indicated on Drawings: Sterling (A Kohler Company): Single Threshold Shower Receptor 72131100.
   a. http://www.sterlingplumbing.com/onlinecatalog/bathsandshowers/showerbases/detail.strl?productNumber=72141110&resultId=-1496942747-0

2. Type: Standard, residential.

C. Shower Handle: Delta Faucet
1. Basis-of-Design Product: Product indicated on Drawings: Delta Faucet T124086: http://www.deltafaucet.com/bath/details/T14086.html

D. Mixing-Valve Faucet and Miscellaneous Fittings: Single-lever, thermostatic and pressure-balance antiscald-type faucet; maximum 1.75-gpm flow rate.

1. Basis-of-Design Product: Product indicated on Drawings; Kohler, K-997.
   a. http://www.us.kohler.com/onlinecatalog/detail.jsp?item=13323902&section=2&category=8&subcategory=50

2. Include ball, gate, or globe valves on supplies if check stops are not included with faucet.
3. Body Material: Solid brass.
4. Finish: Polished chrome-plate.
5. Shower Arm, Flow-Control Fitting: 1.75 gpm.

E. Drain: NPS 2 (DN 50), nickel-bronze-strainer, floor drain.

2.4 SINK: S-1

A. Stainless-Steel Sink: Undercounter type, 0.050 inch thick, 2 compartments 31 7/8" x 20 5/8".

1. Basis-of-Design Product: Product indicated on Drawings: Double bowl Stainless Steel Undermount Kitchen Sink or comparable product by one of the following:

a. Kohler Undertone large/medium undercounter kitchen sink: K-3150.
1) http://www.surplusdecor.com/Double_Bowl_Undermount_Kitchen_Sink_p/bf935r.htm

B. Faucet: Solid-brass underbody. Maximum 2.5-gpm flow rate.

1. Basis-of-Design Product: Product indicated on Drawings: Delta Grail Kitchen Pull-Down Faucet, #985.
a. http://www.deltafaucet.com/kitchen/details/985.html

2. Type: Center set with central inlets, with spray.
3. Finish: Polished chrome-plate.
4. Handle(s): Single-lever toggle.
5. Spout: Swing gooseneck with aerator.

C. Drain(s): 1-1/2-inch (38-mm) removable, stainless-steel strainer bucket with NPS 1-1/2 (DN 40) tubular stainless-steel tailpiece; stainless steel kitchen sink strainer.

D. Mounting: Counter-mounted.

E. Rim Guard: Chrome plated, brass.

F. Trap Standard: NPS 3 (DN 80), enameled, with cleanout, and floor flange.

G. Drain: NPS 3 (DN 80) with grid strainer.

PART 3 - EXECUTION

3.1 INSTALLATIONS

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

B. Install fixtures with flanges and gasket seals.

C. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

D. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

E. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.

F. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.

G. Fasten wall-mounted fittings to reinforcement built into walls.

H. Fasten counter-mounting plumbing fixtures to casework.

I. Secure supplies to supports or substrate within pipe space behind fixture.

J. Set shower receptors and mop basins in leveling bed of cement grout.

K. Install individual supply inlets, supply stops, supply risers, and tubular brass traps with cleanouts at fixture.

L. Install water-supply stop valves in accessible locations.

M. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes unless otherwise indicated.

N. Install disposers in sink outlets. Install switch where indicated, or in wall adjacent to sink if location is not indicated.

O. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.

P. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

Q. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

R. Install piping connections between plumbing fixtures and piping systems and plumbing equipment. Install insulation on supplies and drains of fixtures for people with disabilities.

S. Ground equipment.

END OF SECTION 224000

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Mechanical Sleeve Seals: Modular rubber sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

B. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. PVC Pipe: ASTM D 1785, Schedule 40.

2.2 MOTORS

A. Motor Characteristics:
1. Motors: Single phase.
2. Frequency Rating: 60 Hz.
3. Voltage Rating: NEMA standard voltage for circuit voltage to which motor is connected.
4. Service Factor: 1.15 for open drip-proof motors; 1.0 for totally enclosed motors.
5. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
6. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
7. Enclosure: Unless otherwise indicated, open drip-proof.
8. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

2.3 HANGERS AND SUPPORTS

A. Hanger and Pipe Attachments: Factory fabricated with galvanized coatings; nonmetallic coated for hangers in direct contact with copper tubing.

B. Powder-Actuated Fasteners: Threaded-steel stud, with pull-out and shear capacities appropriate for supported loads and building materials where used.

2.4 PRESSURE GAGES AND TEST PLUGS

A. Pressure Gages: Direct-mounting, indicating-dial type complying with ASME B40.100. Dry metal case, minimum 2-1/2-inch diameter with red pointer on white face, and plastic window. Minimum accuracy 3 percent of middle half of range. Range two times operating pressure.

B. Test Plug: Corrosion-resistant brass or stainless-steel body with two self-sealing rubber core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping. Minimum pressure and temperature rating of 500 psig at 200 deg F.

PART 3 - EXECUTION

3.1 MOTOR INSTALLATION

A. Anchor motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions.

3.2 GENERAL PIPING INSTALLATIONS

A. Install piping free of sags and bends.

B. Install fittings for changes in direction and branch connections.

C. Install sleeves for pipes passing through **gypsum board partitions**.

D. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.

E. Comply with requirements in Division 07 Section "Penetration Firestopping" for sealing pipe penetrations in fire-rated construction.

F. Install unions at final connection to each piece of equipment.

G. Install dielectric unions and flanges to connect piping materials of dissimilar metals in gas piping.

H. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.

3.3 GENERAL EQUIPMENT INSTALLATIONS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.4 HANGERS AND SUPPORTS

A. Comply with MSS SP-69 and MSS SP-89. Install building attachments within concrete or to structural steel.

B. Install hangers and supports to allow controlled thermal and seismic movement of piping systems.

C. Install powder-actuated fasteners and mechanical-expansion anchors in concrete after concrete is cured. Do not use in lightweight concrete or in slabs less than 4 inches thick.

D. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
3. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
4. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
5. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

3.5 VIBRATION ISOLATION AND SEISMIC CONTROL DEVICE INSTALLATION

A. Adjust vibration isolators to allow free movement of equipment limited by restraints.

B. Install resilient bolt isolation washers and bushings on equipment anchor bolts.

C. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

END OF SECTION 230500

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Summary: Heating and cooling water piping and condensate drain piping.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Hard Copper Tubing: ASTM B 88, Type L with ASME B16.22 wrought-copper solder fittings and ASTM B 32, 95-5 tin antimony solder.

B. Soft Copper Tubing: ASTM B 88, Type K with ASME B16.22 wrought-copper solder fittings.

C. CPVC Pipe: ASTM F 441/F 441M, Schedule 40, plain ends with ASTM F 438, socket-type solvent welding fittings.

D. PVC Pipe: ASTM D 1785, Schedule 40, plain ends with ASTM F 438, socket-type solvent welding fittings.

E. PEX Pipe: ASTM F876, ½” and ¾” sizes.

F. PEX Fittings: ASTM F877 plastic or copper fittings.

G. Unions: ASME B16.39, malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

H. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure, 250 deg F maximum operating temperature.

I. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, ends.

2.2 SPECIAL-DUTY VALVES

A. Calibrated Plug Valves: 125-psig water working pressure, 250 deg F maximum operating temperature; bronze body with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening.

B. Pressure-Reducing Valves: Diaphragm-operated, cast-iron or brass-body valve, with low-inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem.

C. Safety Relief Valves: Brass or bronze body with brass and rubber, wetted, internal working parts; to suit system pressure and heat capacity; according to ASME Boiler and Pressure Vessel Code: Section IV.

2.3 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements in Division 23 Section "Common Work Results for HVAC" for basic piping installation requirements.

B. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 23 Section "Common Work Results for HVAC" for wall penetration systems.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping free of sags and bends and install fittings for changes in direction and branch connections.

E. Use the fewest number of joints belowground and within floor slabs.

F. Install piping at a uniform slope of 0.2 percent upward in the direction of flow.

G. Make reductions in pipe sizes using eccentric reducer fitting installed with level side up.

H. Install branch connections to mains using tee fittings in main with takeoff out the bottom of the main, except for up-feed risers, which shall have swing joint and takeoff out the top of the main line.

I. Install unions in pipes adjacent to each valve, at final connections with each piece of equipment, and elsewhere as indicated.

J. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps) and other vibration-producing equipment.

K. Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before soldering or brazing.

3.2 VALVE INSTALLATIONS

A. Shutoff Duty: Use gate or ball valves.

B. Throttling Duty: Use globe or ball valves.

C. Install shutoff-duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

D. Install throttling-duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

E. Install calibrated plug valves on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing.

F. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and cap.

G. Install check valves on each pump discharge and elsewhere as required to control flow direction.

H. Install safety relief valves on hot-water generators and elsewhere as required by authorities having jurisdiction. Pipe discharge to floor drain without valves.

I. Install manual air vents at high points in the system, at heat-transfer coils, and elsewhere as required for system air venting.

J. Run piping from boiler air vent connection or air separator to compression tank with 1/4 inch per foot upward slope towards tank. Connect boiler outlet piping.

K. Install valves with stem up. Allow clearance above stem for check mechanism removal.

3.3 SPECIALTIES INSTALLATIONS

A. Install chemical feeders in each hydronic system in upright position with top of funnel not more than 48 inches above floor. Install feeder across pump or in bypass line, off main using ball valves on each side of feeder, and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.

B. Install diaphragm-type compression tanks on floor. Vent and purge air from hydronic system; charge tank with proper air charge to suit system design requirements.

C. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated.

3.4 TESTING, ADJUSTING, AND BALANCING

A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens.

B. Hydrostatically test completed piping at a pressure one and one-half times operating pressure. Isolate equipment before testing piping. Repair leaks and retest piping until there are no leaks.

C. Balance water flow within distribution system, including submains, branches, and terminals, to indicated quantities.

END OF SECTION 232113

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data. Include certified pump-performance curves, furnished specialties, motor horsepower and electrical characteristics.

B. Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 HYDRONIC PUMPS

A. Close-Coupled, In-Line Centrifugal Pumps: Factory-assembled and -tested, overhung impeller, designed for installation with pump and motor shafts mounted horizontally or vertically. Rated for 125-psig minimum working pressure and minimum continuous water temperature of 225 deg F.

1. Products:

a. TACO; 003-BC4-IFC

2. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded union end connections.
3. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
4. Pump Shaft: Steel, with copper-alloy shaft sleeve.
5. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

2.2 MOTORS

A. NEMA MG 1, "Standard for Motors and Generators." Include NEMA listing and labeling.

B. Less than 1/2 HP: Built-in thermal-overload protection.

C. 1/2 to 3 HP: Permanently lubricated ball bearings.

D. 5 HP and Larger: Grease-lubricated ball bearings.

E. Motor shall be non-overloading within full range of pump performance.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps with access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

B. Support pumps and piping so weight of piping is not supported by pump volute.

C. Install electrical connections for power, controls, and devices.

D. Suspend in-line pumps independent from piping. Use continuous-thread hanger rods and vibration isolation hangers. Fabricate brackets or supports as required for pumps.

E. Install vertical in-line pumps on concrete bases.

F. Connect piping with valves that are at least the same size as piping connecting to pumps.

G. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

H. Install shutoff valve and strainer on suction side of pumps.

I. Install nonslam check valve and throttling valve on discharge side of pumps.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Comply with ASME B31.5, "Refrigerant Piping," and with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

PART 2 - PRODUCTS

2.1 TUBES AND FITTINGS

A. Copper Tube: ASTM B 88, Types K and L and ASTM B 280, Type ACR.

B. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

2.2 REFRIGERANT PIPING SPECIALTIES

A. Refrigerant: ASHRAE 34, R-410A.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements in Division 23 Section "Common Work Results for HVAC" for basic piping installation requirements.

B. Install wall penetration system at each pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Division 23 Section "Common Work Results for HVAC" for wall penetration systems.

C. Install refrigerant piping and charge with refrigerant according to ASHRAE 15.

D. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

E. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

B. Hot-Gas and Liquid Lines: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

END OF SECTION 232300

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Shop Drawings detailing duct layout and including locations and types of duct accessories, duct sizes, transitions, radius and vaned elbows, special supports details, and inlets and outlet types and locations.

B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

C. Comply with NFPA 96 for ducts connected to commercial kitchen hoods.

D. Comply with UL 181 for ducts and closures.

PART 2 - PRODUCTS

2.1 DUCTS

A. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip galvanized coating.

B. Stainless Steel: ASTM A 480/A 480M, Type 304, with a No. 2D finish for concealed ducts and No. 4 finish for exposed ducts.

C. Fibrous-Glass Duct Board: Comply with UL 181, Class 1, 1-inch- thick, fibrous glass with fire-resistant, reinforced foil-scrim-kraft barrier, and having the air-side surface treated to prevent erosion.

D. Joint and Seam Tape, and Sealant: Comply with UL 181A.

E. Rectangular Metal Duct Fabrication: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ACCESSORIES

A. Volume Dampers and Control Dampers: Single-blade and multiple opposed-blade dampers, standard leakage rating, and suitable for horizontal or vertical applications; factory fabricated and complete with required hardware and accessories.

B. Fire Dampers: Rated and labeled according to UL 555 by an NRTL; factory fabricated and complete with required hardware and accessories.

C. Ceiling Fire Dampers: Labeled according to UL 555C by an NRTL and complying with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire

Resistance Directory." Provide factory-fabricated units complete with required hardware and accessories.

D. Smoke Dampers: Labeled according to UL 555S by an NRTL. Combination fire and smoke dampers shall also be rated and labeled according to UL 555. Provide factory-fabricated units complete with required hardware and accessories.

E. Flexible Connectors: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

F. Flexible Ducts: Spiral-wound steel spring with flameproof vinyl sheathing complying with UL 181, Class 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

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

1. Outdoor, Supply-Air Ducts: Seal Class A.
2. Outdoor, Exhaust Ducts: Seal Class C.
3. Outdoor, Return-Air Ducts: Seal Class C.
4. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
6. Unconditioned Space, Exhaust Ducts: Seal Class C.
7. Unconditioned Space, Return-Air Ducts: Seal Class B.
8. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
10. Conditioned Space, Exhaust Ducts: Seal Class B.
11. Conditioned Space, Return-Air Ducts: Seal Class C.

C. Conceal ducts from view in finished and occupied spaces.

D. Avoid passing through electrical equipment spaces and enclosures.

E. Support ducts to comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Hangers and Supports."

F. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

G. Install volume and control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.

H. Clean new duct system(s) before testing, adjusting, and balancing.

3.2 TESTING, ADJUSTING, AND BALANCING

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

END OF SECTION 233100

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Products shall be licensed to use the AMCA-Certified Ratings Seal.

C. Power ventilators shall comply with UL 705.

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

PART 2 - PRODUCTS

2.1 CEILING-MOUNTING OR IN-LINE CENTRIFUGAL VENTILATORS

A. Basis-of-Design Product:

1. Broan Model QTXE050
   a. http://www.broan.com/ImageLibrary/broan/pdf/Specifications/99044085.pdf

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Motion Sensor: Motion detector with adjustable shutoff timer.
4. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
5. Filter: Washable aluminum to fit between fan and grille.
6. Isolation: Rubber-in-shear vibration isolators.

G. Capacities and Characteristics:

1. Airflow: 80 cfm.
2. Static Pressure: 0.1 inches wg.
3. Volts: 120.
4. Phase: Single.
5. Hertz: 60.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ceiling-Mounted Units: Suspend units from structure using steel wire or metal straps.

B. Ground power ventilators.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 OUTLETS AND INLETS

A. Diffusers:

1. Products:

a. Titus; LL-1 - One-Way Pattern, Fixed Louvers.

b. http://www.titus-hvac.com/ecatalog/model.aspx?prodid=465&catid=186

2. Material: Aluminum.
3. Finish: Baked enamel color selected by architect.
4. Mounting: Surface.

B. Wall and Ceiling Grilles:

1. Products:

a. Titus; 56FS Aluminum Return Grille.

b. http://www.titus-hvac.com/ecatalog/model.aspx?prodid=91&catid=42

2. Material: Steel.
3. Finish: Baked enamel, color selected by Architect.
4. Mounting: Concealed.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel unless otherwise indicated. Where

architectural features or other items conflict with installation, notify Architect for a determination of final location.

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

END OF SECTION 233713

SECTION 235600 – SOLAR ENERGY HEATING EQUIPMENT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Comply with requirements of applicable NSF, AWWA, or FDA and EPA regulatory standards for tasteless and odorless, potable-water-tank linings.

C. Comply with performance efficiencies prescribed in ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings."

D. Warranties: Submit a written warranty executed by manufacturer agreeing to repair or replace equipment that fails in materials within 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WATER HEATERS, GENERAL

A. Insulation: Suitable for operating temperature and required insulating value. Include insulation material that surrounds entire tank except connections and controls.

B. Anode Rods: Factory installed, magnesium.

C. Combination Temperature and Pressure Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input and pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into tank.

D. Drain Valve: Factory or field installed.

2.2 INDIRECT-FIRED DOMESTIC HOT WATER TANK

A. Products:

1. RHEEM RS80-42BP, 80 gallon storage capacity
   a. http://waterheating.rheem.com/content/resources/documents/specsheets/RHSolaraideHE.pdf

B. Household, Storage, Indirect-Fired Water Heaters: ANSI Z21.10.1, **80-gal.** capacity; steel with 150-psig working-pressure rating.

2.3 SUNNOVATIONS PUMP UNIT

A. Products:

1. Sunnovations Residential Single-Story Pump Unit
   a. http://sunnovations.com/index.html

B. Pump-less system component: Maximum operating pressure 14.7 psi, beyond which system vents to atmosphere, flexible copper connections, 3 ft radiator arm for over-heat rejection.

2.4 SOLAR THERMAL COLLECTORS

A. Products:

1. SolarHot Platinum Series S-SC-126P40: 1.1 gal. capacity, Max operating pressure 80 psi.
   a. http://www.solarhotusa.com/pdf/Platinumspecsheet%20.pdf

B. Solar Flat Plate Thermal Collector: Black Anodized Aluminum Frame Finish, Absorber is SunSelect Tinox on copper fins.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install temperature and pressure relief valves and extend to closest floor drain.

B. Sunnovations Unit must be located at the highest point in the solar loop.

C. Entire solar loop must be tested to 100psi to insure that connections are made correctly.

D. Install vacuum relief valves in cold-water-inlet piping.

E. Install shutoff valves and unions at hot- and cold-water piping connections.

F. Make piping connections with dielectric fittings where dissimilar piping materials are joined.

END OF SECTION 235600

SECTION 237100 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Product data.

PART 2 - PRODUCTS

2.1 TPU Bladder System.

A. Bladder Material: Bayer Material Science Desmopan® Thermoplastic Polyurethane.
   1. http://www.bayermaterialscience.com/internet/global_portal_cms.nsf/id/Deerfield_en

B. TPU is fastened using Radio Frequency Weld.

C. Connections between bladders are snap-lock plastic connections.

2.2 Bio PCM

A. Phase Change Material.
   1. http://phasechangeenergy.com/brochure.pdf

B. Organic Phase Change Material encased in plastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install behind gypsum board in front of insulation.

B. Insure that pockets of Phase Change Material are not ruptured in the installation process.

END OF SECTION 232300

SECTION 237200 – AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Comply with:
1. ARI 1060-2005: Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Heat Equipment
2. 52.1-92: Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
3. 52.2-07: Method of Testing General Ventilation Air- Cleaning Devices for Removal Efficiency by Particle Size
4. 84-91: Method of Testing Air-to-Air Heat Exchangers D. American Society for Testing and materials (ASTM)
5. D635-06: Standard Test Method for Rate of Burning and/ or Extent and Time of Burning of Plastics in a Horizontal Position
6. E84-07: Standard Test Method for Surface Burning Characteristics of Building Materials

PART 2 - PRODUCTS

2.1 AIR-TO-AIR PLATE HEAT EXCHANGER

A. Products:

1. EnergyWall**; 135 cfm residential unit.**
   a. http://www.energywall.com/products.html

B. Plates: Ceramicly bonded Lithium chloride to paper plates, spacing as recommended by the manufacturer.

C. Casing and End Strips: Casing of 1.6 mm (16 gage) galvanized steel, except casings for corrosive air streams shall be stainless steel. End strips of the same material as exchanger plates. Ends of unit exchanger plates shall be sealed with high temperature silicon sealant prior to installation of end strip for corrosive air streams provide welded end strips to avoid cross contaminations.

D. Casings shall have integral duct connections and shall have lifting holes or lugs.

E. Drain Pan: Same material as unit casing. Drain-pan surface shall be covered with molded ABS, and shall have drain connections on exhaust and supply side. Comply with requirements in ASHRAE 62.1-2004.

F. Extended-Surface, Disposable Panel Filters: Comply with NFPA 90A.

1. Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
2. Filter Type: Factory-fabricated, dry, extended-surface type.
3. Media Thickness: 1 inch
4. Initial Resistance: 0.2 inches wg.
5. Recommended Final Resistance: 0.7 inches wg.
6. Arrestance (According to ASHRAE 52.1): 90.
7. MERV (ASHRAE 52.2): 7.
8. Filter Media: Fibrous material formed into deep-V-shaped pleats held by self-supporting wire grid.
9. Media-Grid Frame: closed-cell cellular phenolic housing (R-8.2 per in.).
10. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow the equipment manufacturer's instructions for handling and installation, and setting up of ductwork for makeup and exhaust air steamers for maximum efficiency.

B. Seal ductwork tightly to avoid air leakage.

C. Install units with adequate spacing and access for cleaning and maintenance of heat recovery coils as well as filters.

END OF SECTION 237200

SECTION 238126 – SPLIT SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Comply with ASHRAE 15.

C. EER: Equal to or greater than that prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Comply with NFPA 70.

E. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace refrigeration components that fail in materials or workmanship within 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED UNITS

A. Description: Self-contained, factory-assembled, -tested, and -wired unit.

B. Products:

1. Fujitsu; ASU9RLS indoor unit and AOU9RLS outdoor unit.
   a. http://www.fujitsugeneral.com/wallmounted9-12RLS_specs.htm

C. Cabinet: Structural-steel frame and galvanized-steel panels with baked-enamel finish with access doors or panels. Minimum 1/2-inch thick, acoustic duct liner on cabinet interior and control panel. Stainless-steel drain pan.

D. Discharge Plenum: Cabinet extension with directional louvers.

E. Evaporator Fan: Galvanized steel; double-width, double-inlet, forward-curved centrifugal fan; statically and dynamically balanced. Direct drive with fan and motor resiliently mounted. Cast-iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Adjustable pitch selected so required rpm are obtained when set at midposition. Motor, multispeed, PSC type, or single speed, ODP polyphase.

F. Evaporator and Condenser Coil: Seamless copper tubes expanded into aluminum fins; leak tested to 425 psig.

G. Remote Air-Cooled Condenser: Factory assembled and tested; consisting of condenser coil, fans and motors, and operating controls. Direct-drive propeller-type fans with permanently

lubricated motors and built-in thermal-overload protection. Low-ambient control cycle fans and modulates condenser-fan damper assembly to permit operation down to 0 deg F.

1. Annealed-copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; insulated suction line; appropriate fittings at ends, and service valves for both suction and liquid lines.

H. Compressor: Hermetic reciprocating, 3600 rpm maximum; resiliently mounted with positive lubrication and internal motor protection.

I. Refrigerant Circuits: Separate circuit for each compressor. Minimum two circuits for units larger than five nominal tons. Equalized expansion valve with replaceable thermostatic element, refrigerant filter-dryer, high- and low-pressure safety switches, thermal overload protection, anti-recycle timer, brass service and charging valves installed in hot-gas and liquid lines, and charged with R-410A refrigerant.

J. Water Coil: Copper tube, with mechanically bonded aluminum fins; two-position control valve; and leak tested to 300 psig underwater.

K. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and fuses in terminal box for overcurrent protection.

L. Control Package: Factory wired and tested, including control-circuit transformer.

1. Thermostat: Remote, programmable for occupied/unoccupied periods and temperatures to cycle compressor or heating coil. Provide field wiring for condenser fan operation with compressor.
2. Supply fan runs on fan control switch.

2.2 CAPACITIES AND CHARACTERISTICS

A. Cooling:

1. Total Cooling Capacity: 9,000 Btu/h
2. Ambient-Air Temperature: 72 deg F
3. EER: 17.31

B. Heating:
1. Heating Capacity: 12,000

C. Single-Point Electrical Connection:

1. Volts: 240.
2. Phase: Single.
3. Hertz: 60.
4. Full-Load Amperes: 3.7A
5. Minimum Circuit Ampacity: 10A
6. Maximum Overcurrent Protection: 15A

PART 3 - EXECUTION

3.1 INSTALLATION

A. Isolation: Mount cabinet and remote air-cooled condenser on restrained for minimum 1-inch.

B. Install piping adjacent to unit to allow service and maintenance.

C. Install refrigerant piping between self-contained air-conditioning unit and remote condenser.

D. Install condensate piping to indirect drain.

END OF SECTION 238126

SECTION 238233 - CONVECTORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data, including color charts for cabinet finishes.

B. Test and rate according to the Hydronics Institute.

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

PART 2 - PRODUCTS

2.1 HOT-WATER CONVECTORS

A. Basis-of-Design Product:

1. Vulcan Linovector 1" C-3¼" × 3¼" - 33/.020"
   a. http://www.vulcanrad.com/litlibrary/Data-Linevector-Bare-Elements.pdf

B. Convector Elements: Seamless copper tubing and aluminum fins; steel side plates and supports.

C. Enclosures: Steel with exposed corners rounded; removable front panels with tamperproof fasteners braced and reinforced for stiffness.

1. Insulation: 1/2-inch-thick, fibrous glass on inside at back of enclosure.
2. Enclosure Style: Enclosed trench with top register.

D. Capacity: 150 Btu/h. per linear foot, based on 65 deg F entering-air temperature, 100 deg F average water temperature.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install baseboard and convector units level and plumb.

B. Center units under windows.

C. Install baseboard units continuously around corners, using manufacturer's standard outside and inside corner fittings.

D. Join with splicer sets to provide continuous cabinet.

E. Install access fitting in cabinets for access to valves and other fittings.

F. Use manufacturer's filler pieces and end caps.

G. Connect to supply and return hydronic piping with shutoff valve and union or flange at each connection.

H. Connect units to wiring systems and to ground.

END OF SECTION 238233

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

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

C. Comply with NEMA PB 1.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Common Work Results for Electrical."

B. Enclosures: Flush- and surface-mounted cabinets; NEMA 250, Type 1

1. Front: Secured to box with concealed trim clamps.
2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

C. Incoming Mains Location: bottom.

D. Phase, Neutral, and Ground Buses: Tin-plated aluminum Include instructions in first paragraph below if special sizing or oversizing of lugs is required, if allowing optional use of aluminum for circuits sized for copper conductors, or when upsizing conductors for voltage drop.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Mains: Circuit breaker.
   1. Square D QO140M200C Load Center:
      a. http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO140M200C&countrycode=us

B. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

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

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating to meet available fault currents.

   1. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Common Work Results for Electrical."

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Arrange conductors into groups; bundle and wrap with wire ties.

E. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data and Shop Drawings.

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

C. Coordinate with utility companies for services and components they furnish.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Meters will be furnished by NREL.

B. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.

C. Meter Sockets: Comply with requirements of electrical power utility company.
1. Square D: URTRS213B METER SOCKET http://www.schneider-electric.us/products-services/product-detail/?event=productDetail&partNumber=URTRS213B&countryCode=us

D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

E. Modular Meter Center: Factory-coordinated assembly of a main service disconnect device, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below:

1. Comply with requirements of utility company for meter center.
2. Housing: NEMA 250, Type 3R enclosure.
3. Minimum Short-Circuit Rating: 22,000 A symmetrical at rated voltage.
4. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers: Provided by NREL
5. Tenant Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect circuit breakers in downstream tenant and to house loadcenters and panelboards that have 10,000-A interrupting capacity.

   a. Identification: Not yet determined
   b. Physical Protection: Tamper resistant, with hasp for padlock.

6. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install equipment for utility company metering. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to NECA 400 switchboard installation requirements.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

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

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 DEVICES

1. http://www.lutron.com/pdfspecs/novatb.pdf

B. Convenience Receptacles: NEMA WD 1, NEMA WD 6, Configuration 5-20R, and UL 498.

1. Products:

a. LUTRON: 125V NTR-15-WH:

C. Duplex GFCI Convenience Receptacles: 125 V, 15 A or 20 A, straight blade, feed through type. NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

1. Products:

a. LUTRON: 125V NTR-15-GFCI-WH and 125V NTR-20-GFCI-WH: Ground-fault interrupter receptacles shall be Lutron Nova Ta style with two-pole, three-wire ground and rated 15A or 20A at 125VAC. Configuration shall be of the duplex type with rectangular NEMA WD-6 design. Receptacles shall have a 5 milliampere ground-fault trip level with "test" and "reset" buttons.

D. Wall-Box Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

1. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections. Comply with UL 1472.
2. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
3. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

E. Telephone Outlet: Single RJ-45 jack for terminating 100-ohm, balanced, 4-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.

1. Products:

a. Lutron NT-PJ-WH: Telephone jacks shall be designed to mate with standard 4- or 6-conductor modular jacks, and be compatible with 2, 4 or 6 conductor lines. Telephone jacks shall meet FCC Part 68, paragraph F standards to ensure compatibility with U.S. telephone systems.

F. Cable Outlet: Single

1. Products:

a. LUTRON: NT-CJ-WH: Cable TV jacks shall be the coaxial type, designed for use with standard 75-Ohm cables

G. Wall Plates, Finished Areas: Smooth, high-impact thermoplastic, fastened with metal screws having heads matching plate color.

H. Floor Service Fittings:

1. Modular, flush-type, dual-service units suitable for wiring method used.
2. Compartments: Barrier separates power from voice and data communication cabling.
3. Service Plate: Rectangular with satin finish.
4. Power Receptacle: NEMA WD 6, Configuration 5-20R, white finish, unless otherwise indicated.

I. Finishes:

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Install devices and assemblies plumb, level, and square with building lines.

C. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

D. Install unshared neutral conductors on line and load side of dimmers.

E. Mount devices flush, with long dimension vertical, and grounding terminal of receptacles on top unless otherwise indicated. Group adjacent devices under single, multigang wall plates.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

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

PART 2 - PRODUCTS

2.1 FUSIBLE AND NONFUSIBLE SWITCHES

A. Fusible Switches, 600 A and Smaller: UL 98 and NEMA KS 1, Type HD, that accommodate specified fuses, and with lockable handle interlocked with cover in closed position.
   1. Square D: D221N Safety Switch:
      a. http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=D221N&countrycode=us
   2. Square D: H361RB Safety Switch:
      a. http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=H361RB&countrycode=us

B. Nonfusible Switches, 600 A and Smaller: UL 98 and NEMA KS 1, Type HD, with lockable handle interlocked with cover in closed position.
   1. Xantrex internal disconnect:
      a. http://www.xantrex.com/web/id/1890/docserve.aspx

2.2 MOLDED-CASE CIRCUIT BREAKERS

A. Description: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to meet available fault currents.

   1. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with field-adjustable instantaneous trip settings.
      a. Square D QO115 Miniature Circuit Breaker
         1) http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO115&countrycode=us
      b. Square D QO120 Miniature Circuit Breaker
         1) http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO120&countrycode=us
      c. Square D QO230 Miniature Circuit Breaker
         1) http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO230&countrycode=us
      d. Square D QO240 Miniature Circuit Breaker

1) http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO240&countrycode=us

e. Square D QO250 Miniature Circuit Breaker

1) http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO250&countrycode=us

2. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

a. Square D QO115GFI Miniature Circuit Breaker

1) http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO115GFI&countrycode=us

b. Square D QO120GFI Miniature Circuit Breaker

1) http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO120GFI&countrycode=us

3. AFCI Circuit Breakers: Single pole configuration with 75-A line-to-neutral arc detection trip sensitivity.

a. Square D QO115AFI Miniature Circuit Breaker

1) http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO115AFI&countrycode=us

b. Square D QO120AFI Miniature Circuit Breaker

1) http://www.schneider-electric.us/products-services/product-detail/?event=datasheet&partnumber=QO120AFI&countrycode=us

B. Features and Accessories:

1. Lugs: Suitable for number, size, trip ratings, and conductor material.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
3. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with ground-fault indicator; relay with adjustable pickup and time-delay settings, and push-to-test feature.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.3 ENCLOSURES

A. NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen 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. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Sections "Common work Results for Electrical."

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

END OF SECTION 262816

SECTION 263100 – PHOTOVOLTAIC COLLECTORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

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

PART 2 - PRODUCTS

2.1 PHOTOVOLTAICS

A. Available Product:

1. Solyndra SL-001-191: UL1703, IEC 61646: Voc 104.5v, Isc 2.75A
   Cell Type: Cylindrical CIGS
   a. http://www.zonnefabriek.nl/files/Solyndra%20Data%20Sheet.pdf
2. Solar Power Industries: Customized multicrystalline silicon photovoltaic modules.
   a. http://www.solarpowerindustries.com/docs/english/156mm2BusSolarCellSG.pdf

2.2 PV MOUNTS

A. Available Product:

1. Solyndra: Non-penetrating, powder-coated Al, up to 2.17 mounts per panel
2. For Solar Power Industries modules; reference 10 73 13 AWNINGS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install photovoltaic modules on flat roof by sliding on mounts legs and attaching strap to manufacturer's specifications.

B. Comply with mounting and anchoring requirements specified in Division 26 Sections "Common work Results for Electrical."

END OF SECTION 263100

SECTION 263213 - GENERATORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

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

C. Comply with NEMA PB 1.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR STAND ALONE PV SYSTEM

A. PHOTOVOLTAIC MODULES:
1. Siemens Solar SM55: 5 series x 6 parallel configuration

B. BATTERIES

C. CHARGE CONTROLLER
1. Xantrex FLEXmax60: Max power point tracking, 150VDC input

D. INVERTER
1. SMA America Sunny Island 5040U: UL 1741 / UL 1998, NEMA 1 encosure,

PART 3 - EXECUTION

3.1 INSTALLATION

A. Preconstructed trailer with stand alone PV system must be parked before operation.

B. Drive grounding rod into suitable surface.

C. Ensure all wiring devices are properly protected before engaging disconnects.

END OF SECTION 263213

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

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

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

C. Comply with IEEE C2, "National Electrical Safety Code."

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

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

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

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

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

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

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

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

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

2.2 BALLASTS

A. Ballasts for Linear Fluorescent Lamps:

1. Electronic: Comply with ANSI C82.11; programmed rapid start type.

a. Sound Rating: A, except B for T12/HO and T12/Slimline lamp ballasts.
b. BF: 1.0
c. Power Factor: .95 or higher.

2. Electromagnetic: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
3. For Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with indicated lamp types.
4. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures 0 deg F and higher.
5. Dimmer Controlled: Electronic type.

a. Dimming Range: 100 to 10 percent of rated lamp lumens.
b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

B. Ballasts for Compact Fluorescent Lamps: Electronic programmed rapid-start type, complying with ANSI C 82.11.

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. BF: 0.95 or higher unless otherwise indicated.
5. Power Factor: .95 or higher.

C. Ballasts for Metal-Halide Lamps:

1. Electromagnetic: Comply with ANSI C82.4 and UL 1029,

a. Constant-wattage autotransformer or regulating high-power-factor type.

2. Electronic:

a. Lamp end-of-life detection and shutdown circuit.
b. Total Harmonic Distortion Rating: Less than 15 percent.
c. Transient Voltage Protection: IEEE C62.41, Category A or better.

D. Ballasts for High-Pressure Sodium Lamps: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

2.3 EXIT SIGNS

A. Internally Lighted Signs: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.

1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
2. Lamps for AC Operation: LEDs, 70,000 hours minimum of rated lamp life.

2.4 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
4. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.5 LAMPS

A. Low-Mercury Fluorescent Lamps: Comply with the EPA's toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.

B. T5 Programmed Rapid-Start Fluorescent Lamps: Rated 21 W maximum, nominal length 36 inches, 2100 initial lumens (minimum), CRI 85 (minimum), color temperature of 3000 K, and average rated life of 20,000 hours unless otherwise indicated.

C. Compact Fluorescent Lamps: Four pin, CRI 80 (minimum), color temperature 3000 K average rated life of 10,000 hours at three hours' operation per start, and suitable for use with dimming ballasts unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 83, and color temperature 3000 K.

2.6 RETROFIT KITS FOR FLUORESCENT LIGHTING FIXTURES

A. Comply with UL 1598 listing requirements.

1. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces.
2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.

2.7 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

A. Fixture F1

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number F305-T221 manufactured by Elliptipar

a. http://www.elliptipar.com/ceiling/Clngpdf/C19.pdf

2. Voltage: 120V ac.
3. Mounting: Surface mounted in the architectural cove.
4. Nominal Dimensions: Length 70", width 7", and height 3".
5. Lamps: Two (2) lamp FP21/830/ECO by Osram Sylvania
6. Ballast for Fluorescent Lamps: Electronic dimming.
   a. Quantity of Ballasts per Fixture: 1.
   b. Lutron Eco-10™ E 3 T521 C 120 2
      http://www.lutron.com/CMS400/WorkArea/downloadasset.aspx?id=10035

B. Fixture F2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number 3G-SPL316-20w MR16-LEDCC-NG-120-OA- 3'5" and 3'4" manufactured by 3G Lighting.
   a. http://www.3glighting.com/public/Media/3G-SPL316.pdf

2. Voltage: 120V ac.
3. Mounting: Suspended pendant, 6'0" mounting height.
4. Nominal Dimensions: Length 23", width 15", and height 6"
5. Lamps: Three (3) 20MR16/IR/WFL60/C, lamps by Osram Sylvania
6. Lens: Frosted acrylic diffuser.
7. External Finish: Clear etched anodized finish.
8. Other Features: Aircraft cable suspension, adjustable cable lock.

C. Fixture F3:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number M-FOR-2SQ-3-PN manufactured by Edge Lighting.
   a. http://www.edgelighting.com/pdfs/edge_mo_form_2-head.pdf

2. Voltage: 120-V ac.
3. Mounting: Surface ceiling.
4. Nominal Dimensions: Length 6", width 3", and height 3".
5. Lamps: Two (2) 20MR16/IR/WFL60/C, lamps by Osram Sylvania
6. External Finish: Polished Nickel
7. Other Requirements:
   a. Sloped ceiling canopy
      1) http://www.edgelighting.com/pdfs/edge_mo_sloped_ceiling_power_feeds.pdf
   b. Remote magnetic transformer
      1) http://www.edgelighting.com/pdfs/monorail_instructions/904-T-150-12.pdf

D. Fixture F4:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number 700KHELLO-MR16 manufactured by Tech Lighting.
   a. http://www.techlighting.com/SpecSheets/hds_khello_spec.pdf

2. Voltage: 120V ac.
3. Mounting: Cable wall suspened
4. Nominal Dimensions: Length 3.5", width 3.5", and height 2.5".
5. Lamps: One (1) 20MR16/IR/FL35/C, lamp by Osram Sylvania
6. Lens: Hexcell louver cuts glare for lamp.
   a. http://www.techlighting.com/SpecSheets/acc_eggcrate_louver_spec.pdf
7. External Finish: Satin aluminum finish.
8. Other Requirements:
   a. #10 gauge insulated cable (24ft)
      1) http://www.techlighting.com/SpecSheets/kl_insulated_cable_spec.pdf
   b. Remote magnetic transformer
      1) http://lib.store.yahoo.net/lib/ylighting/tran_at150t_spec.pdf
   c. Center power feed
      1) http://www.techlighting.com/SpecSheets/kl_center_pwrfd_spec.pdf
   d. Slimline turnbuckles
      1) http://www.techlighting.com/SpecSheets/kl_slimline_trnbuckl_spec.pdf
   e. Slimline anchors
      1) http://www.techlighting.com/SpecSheets/kl_slimline_anchors_spec.pdf

E. Fixture F5:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number 0503 WA-HOTELSW-010-WH-GY from Lightology or comparable product:
   a. 0503 WA-HOTELSW-010-WH-GY from Lightology
      1) http://common.csnstores.com/common/marketing/blauet/hotelwall.pdf
   b. Alternate: ART-TOL-7-10-W by Artemide
      1) http://lib.store.yahoo.net/lib/ylighting/tolomeo_wall_shade-mfgspec.pdf

2. Voltage: 120V ac.
3. Mounting: Surface wall.
4. Nominal Dimensions: Length 19.5", width 9.5", and height 6.75".
5. Lamps: One (1) CF13EL/MINI/830, lamp by Osram Sylvania
6. Ballast for Fluorescent Lamps: Integral.
7. External Finish: Satin Nickel.

F. Fixture F6:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number ALS-ELUM-16-115 manufactured by Nexxus Lighting.
   a. http://www.nexxuslighting.com/commercial/products/Specs/elumcovergb.pdf

2. Voltage: 120-V ac.
3. Mounting: Surface wall (wood column)
4. Nominal Dimensions: Length 16" and width .65".
5. Lamps: RGB LED.
6. Lens: 115 degree LED optic.
7. Other Requirements:
   a. eLum RGB Controller
      1) http://www.nexxuslighting.com/commercial/products/Specs/elumrgbcontroller.pdf

b. 120VAC/24DC Transformer for RGB Controller
c. SAVI Key Pad DMX Controller
1) http://www.nexxuslighting.com/commercial/products/Specs/keypad.pdf
d. Mounting clip
e. Closed end cap
f. 30' Power Cable.

G. Fixture F7:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number 0315010A manufactured by Artemide or comparable product:
a. Artemide 0315010A
1) http://ylighting.lucepedia.com/specsheet.pl?action=start&vwitem=art-tol-7-10-w
b. Alternate: Artemide R730100
1) http://lib.store.yahoo.net/lib/ylighting/rzk-jupe.pdf

2. Voltage: 120-V ac.
3. Mounting: Table lamp.
4. Nominal Dimensions: Diameter 9.5" and height 23".
5. Lamps: Dimmable CFL Marathon 14646-4, lamp by Philips
6. Ballast for Fluorescent Lamps: Integral.
7. External Finish: Aluminum grey

H. Fixture F8:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, 30”x30” Silhouette mirror light manufactured by Electric Mirror. or comparable product by one of the following:
a. 30”x30” Silhouette mirror light by Electric Mirror
1) http://www.electricmirror.com/pages/polished_efinity.php
b. Alternate: TWINSLIM-20-F1 by Edge Lighting
1) http://www.lightology.com/productspecs/0713ML-TWINSLM.pdf

2. Voltage: 120-V ac.
3. Mounting: Surface wall.
4. Nominal Dimensions: Length 30", width 30", and depth 2.5”.
5. Lamps: Four (4) FP24/830/HO/ECO, lamps by Osram Sylvania.
6. Ballast for Fluorescent Lamps: Electronic programmed

I. Fixture F9:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number GLB-BLX-SOR-ADA manufactured by B.Lux or comparable product:
a. GLB-BLX-SOR-ADA by B.Lux
1) http://ylighting.lucepedia.com/specsheet.pl?action=start&vwitem=glb-blx-sorada

b. Alternate: ITR-ROCKETTE58 by I Tre.

1) http://ylighting.lucepedia.com/specsheet.pl?action=start&vwitem=itr-rockette-58

c. Alternate: FMEC-2-1T5HO-1C-WM-L830-TS by Focal Point.
1) http://www.focalpointlights.com/downloads/cuts/FMEC.pdf

2. Voltage: 120-V ac.
3. Mounting: Surface Wall.
4. Nominal Dimensions: Length 17", width 7", and depth 4".
5. Lamps: One (1) CF13DS/827/RP/ECO, lamp by Osram Sylvania.
6. Ballast for Fluorescent Lamps: Electronic programmed.
7. External Finish: Brushed nickel structure and pleated fabric cascades.

J. Fixture F10:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number 33519 by ERCO or comparable product:
a. 33519 by ERCO
1) http://www.erco.com/en_index.htm?http://www.erco.com/~klickmeister/km_ls_download/km_ls_artno_download_v2.pl?aktion=downloadtyp_zeigen&tu=1&lang=2065&artikelnummer=33519000&sprachkuerzel=en

b. Alternate: 2493P by BEGA
1) http://www.bega-us.com/downloads/2493P_sub.pdf

2. Voltage: 120-V ac.
3. Mounting: Surface wall, mounting height: 5'-6".
4. Nominal Dimensions: Length 5.9", width 4.9", and depth 3.5".
5. Lamps: One (1) MC20TF/U/GU6.5/830, lamp by Osram Sylvania
6. Quantity of Ballasts per Fixture: 1
7. Lens: Spread lens as safety glass.
8. External Finish: Double powder-coated.

K. Fixture F11:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number 2288LED manufactured by BEGA, or comparable product:
a. 2288LED by BEGA
1) http://bega-us.com/groupdetail.aspx?groupid=9b&familyid=13

b. Alternate: 33733 by ERCO
1) http://www.erco.com/en_index.htm?http://www.erco.com/~klickmeister/km_ls_download/km_ls_artno_download_v2.pl?aktion=downloadtyp_zeigen&tu=1&lang=2065&artikelnummer=33733023&sprachkuerzel=en

2. Voltage: 120-V ac.
3. Mounting: Recessed wall, mounting height: 1'-6".
4. Nominal Dimensions: Length 9.5", width 2.5", and depth 4.25".
5. Lamps: Two (2) 3500K LED modules (integral).
6. Lens: Clear tempered glass with translucent white ceramic coating.

7. External Finish: Black
8. Other Features: U.L. listed for wet locations and for installation within 3 feet of the ground, Integral 120V electronic LED driver.

L. Fixture F12:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number 523-000004-00 manufactured by Philips Color Kinetics.
   a. http://www.colorkinetics.com/support/datasheets/eW_Cove_Powercore_Ordering_SpecSheet.pdf

2. Voltage: 120-V ac.
3. Mounting: Cove surface.
4. Nominal Dimensions: Length 12" and diameter 1.4".
5. Lamps: 2800K LED
6. Lens: Clear polycarbonate.
7. Other Features: Integral LED power supply.

M. Fixture F13:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number LED-STEP03-3-001/HO-ND120V-BSS-X-STD manufactured by Winona Lighting.
   a. http://www.winonalighting.com/client/G5button/9/lineID/4

2. Voltage: 120-V ac.
3. Mounting: Wall recessed, mounting height: 1’-3”.
4. Nominal Dimensions: Length 5.5", Width 5.5”, and depth 2.1".
5. External Finish: Brushed stainless steel.
6. Lamps: 3000K LED
7. Other Features: Integral LED power supply.

N. Fixture F14:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number 170C manufactured by Meteor.
   a. http://www.meteor-lighting.com/files/gray_paver_spec.pdf

2. Mounting: Floor recessed.
3. Nominal Dimensions: Length 6.05", Width 6.05”, and depth 2.1".
4. Lamps: White LED
5. Lens: Clear Bayer super light-permeable PC.
6. Other Features: Integral crystalline solar panel 2V 380 mA.

O. Fixture F15:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawing, Product number 180C manufactured by Meteor.

a. http://www.meteor-lighting.com/images/stories/Spec%20sheet%20for%20SH180%20and%20SH200.pdf

2. Voltage: 120-V ac.
3. Mounting: Wall recessed, mounting height: vary.
4. Nominal Dimensions: Length 7.9", Width 3.9", and depth 2".
5. Lamps: White LED
6. Lens: Clear Bayer super light-permeable PC.
7. Other Features: Integral crystalline solar panel 2.5V 220 mA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set units level, plumb, and square with ceiling and walls, and secure.

B. Support for Recessed and Semirecessed Grid-Type Fluorescent Fixtures:

1. Install ceiling support system wires at a minimum of four wires for each fixture, located not more than 6 inches from fixture corners.
2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Fixtures: Install with dampers closed.

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

F. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's written instructions.

END OF SECTION 265000

SECTION 271013 - RESIDENTIAL STRUCTURED CABLING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data, Shop Drawings, system schematic, floor plans with cabling point labeling, and cabling color scheme.

B. Performance Requirements: Coordinate the features of materials and equipment so they form an integrated system complying with TIA/EIA-570-A. Match components and interconnections for optimum performance.

C. Comply with NFPA 70, "National Electrical Code."

D. Comply with TIA/EIA-570-A.

PART 2 - PRODUCTS

2.1 DISTRIBUTION DEVICE

A. Telephone: For 1 line from the exchange access provider; with cross-connect device to enable the selection and pairing of incoming lines with outlet lines.

1. Place outlet cabling in a star topology.
2. Cross Connect: Modular, IDC-type, cross-connect device with modules designed for punch-down caps or tools.
3. Provide space for installation and connection of an ADSL gateway distribution device furnished by access provider.

B. Television: Distribution device shall have space for CATV lines, and distribute in-home generated video and radio-frequency sources.

1. Place outlet cabling in a star topology.
2. Provide space for installation of signal amplification and conditioning.
3. Distribute in-home generated video sources to same outlet as cable television service.
4. Accommodate the installation and connection of a cable gateway distribution device furnished by access provider.

2.2 CABLE

A. Series-6 Coaxial Cable: 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.

2. Cable Connecting Hardware: Type BNC, 75 ohms.

2.3 RACEWAYS

A. Nonmetallic Flexible Raceway and Fittings: UL 2024. One-piece, plastic, dual-voltage, two-gang box and bracket, with molded-in nailing flanges.

2.4 WIRING DEVICES

A. Modular; each outlet configuration field fabricated from factory-made components. Listed and labeled as complying with TIA/EIA-568-B.2, TIA/EIA-B.3, and UL 1863.

B. Mount connectors on single or multigang faceplate.

1. Faceplates: High-impact plastic; colors as selected by Architect. Colors shall be white

2.5 GROUNDING AND BONDING

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

PART 3 - EXECUTION

3.1 DEMARCATION POINTS

A. Contact access providers to locate demarcation points according to applicable regulations. Demarcation points shall be installed for the following:

1. Telephone yet to be determined
2. Television yet to be determined

3.2 INSTALLATION

A. Comply with BICSI RNCM.

B. Install firestopping according to TIA/EIA-569-A.

C. Ground equipment complying with ANSI-J STD-607-A.

D. Cable Installation:

1. Install exposed cable parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
2. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.
3. Secure and support cable at intervals not exceeding 30 inches and not more than 6 inches from boxes, outlets, and terminals.

E. Wiring within Distribution Device:

1. Group cable-connecting hardware into separate logical fields.
2. Train conductors to terminal points with no excess.
3. Use lacing bars to restrain cable, to prevent straining connections, and to prevent bending cable to smaller radii than minimums recommended by manufacturer.

F. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Within Connector Fields in Distribution Devices: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

END OF SECTION 271013

SECTION 283100 - FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. System Description: Noncoded, conventional, hardwired, 120-V ac loop system.

1. Initiating Device Circuits: NFPA 72, Class B, Style B.

B. Submittals: Product Data and system operating description.

C. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals, make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations.

D. Comply with NFPA 72.

E. UL listed and labeled.

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

PART 2 - PRODUCTS

2.1 ALARM-INITIATING DEVICES

A. Kiddie 12060: Smoke Detectors: UL 268, 120-V ac with 9-V dc battery backup, ionization type, hardwired.
1. http://www.kidde.com/utcfs/ws-384/Assets/i12060_Sheet.pdf

2.2 NOTIFICATION APPLIANCES

A. Bells: Electric-vibrating type, with 85 dB at 10 feet.

2.3 WIRE AND CABLE

A. General: UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.

2. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and test systems according to NFPA 72. Comply with NECA 1.

B. Wiring Method: Install wiring in exposed on ceilings and walls where indicated.

C. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

END OF SECTION 283100

SECTION 321400 - UNIT PAVING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data

1.2 UNIT PAVERS

A. Rough-Stone Pavers: Rectangular paving stones, with split faces and edges, made from slate

1. Blue Stone Products:

a. Flynn Stone Company; flat stepping quarry stone

1.3 AGGREGATE SETTING-BED MATERIALS

A. Pressure Treated Plywood: ¾" pressure treated plywood/OSB board

B. Elastomeric grout:

1. Available Products:

1) PROLITE™ tile and stone mortar http://www.custombuildingproducts.com/docs/data_sheets/ProLite%2010%20Part%20Spec%2012-08.pdf?user=arc&lang=en

2) Or similar product

C. Sand for Joints: Fine, sharp, washed sand or crushed stone with 100 percent passing the No. 16 sieve and no more than 10 percent passing the No. 200 sieve.

PART 2 - EXECUTION

2.1 INSTALLATION, GENERAL

A. Proof-roll prepared above grade surface and correct deficiencies before installing unit pavers.

B. Cut unit pavers with masonry saw or block splitter.

C. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from level or indicated slope.

2.2 AGGREGATE SETTING-BED PAVER INSTALLATION

A. Place elastomeric base with trowel to a thickness of ¼ inch

B. Set pavers with a minimum joint width of 1/16 inch and a maximum of 3/32 inch. If pavers have spacer bars, place pavers hand-tight against spacer bars.

C. Spread dry sand and fill joints after pavers dry and then remove excess sand.

END OF SECTION 321400

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

C. Planting Restrictions: Plant during one of the following periods:

1. Spring Planting: March
2. Fall Planting: September

D. Maintain trees and shrubs until established, but not less than 12 months.

E. Maintain ground covers and plants until established, but not less than three months.

PART 2 - PRODUCTS

2.1 PLANTING MATERIALS

A. Tree and Shrub Material: Nursery grown, with healthy root systems, well shaped, fully branched, healthy, and free of insects, eggs, larvae, defects, and disfigurement.
1. Reference Construction Drawings
a. L-602 Xeriscape Plant Schedule
b. L-603 Bio-Intensive Plant Schedule
c. L-604 Sense Garden Plant Schedule
d. L-605 Wildlife Plant Schedule

B. Ground Covers and Plants: Established and well rooted in pots or similar containers.
1. Reference Construction Drawings
a. L-602 Xeriscape Plant Schedule
b. L-603 Bio-Intensive Plant Schedule
c. L-604 Sense Garden Plant Schedule
d. L-605 Wildlife Plant Schedule

C. Plant Suppliers
1. http://springhillnursery.com/
2. http://www.northeastnursery.com/plants/native.html
3. http://www.amandagarden.com/
4. http://www.newmoonnursery.com/
5. http://www.wakefieldvalleynursery.com/
6. http://www.meadowoodnursery.com/
7. Or equivalent suppliers.

2.2 SOIL AND AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter; pH range of 5.5 to 8.

B. Commercial Fertilizer: Commercial-grade complete fertilizer, consisting of 1 lb/2000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

C. Slow-Release Fertilizer: Granular fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium; 5 percent nitrogen; 10 percent phosphorous; 5 percent potassium; by weight.

2.3 PLANTING SOIL MIX

A. Mix topsoil with the following soil amendments and fertilizers in the following quantities:
1. Ratio of Loose Compost to Topsoil by Volume: 1:2
2. Weight of Slow-Release Fertilizer per 1000 Sq. Ft.: 0.5 lb.

PART 3 - EXECUTION

3.1 PREPARATION

A. Planting Bed Establishment: Loosen subgrade to a depth of 4 inches. Remove stones sticks, roots, and rubbish. Spread planting soil mixture to a depth of 4” but not less than required to meet finish grades. Work first layer into top of loosened subgrade.

B. Trees and Shrubs: Set root ball into planter with burlap still intact. Hold tree or shrub to height and position desired and install support ropes anchored to hook screws. Continue holding tree in place and proceed by filling planter with aggregate. Water until root ball is saturated and prune to preference.

C. Plant ground cover and plants 8” apart. Dig holes large enough to allow root spread. Plant stock working soil around roots and leave a slight depression around plants to hold water. Water after planting. Do not cover plant crowns with wet soil.

D. Mulching: Apply organic mulch, 1 inch thick, mineral mulch, 1 inch thick, and finish level with adjacent finish grades. Do not place mulch against trunks or stems.

E. Tree and Shrub Maintenance: Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, adjusting and repairing, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

F. Ground Cover and Plant Maintenance: Maintain and establish plantings by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

END OF SECTION 329300

SECTION 33 79 00 – SITE GROUNDING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. This section specifies general grounding and bonding requirements of and AC/DC electrical system.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTOR

A. PARTS
1. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 4 AWG and larger shall be permitted to be identified per NEC.
2. Main bonding conductors shall be ASTM B8 bare stranded copper,
3. System bonding conductors shall be 10 AWG ASTM B1 solid bare copper wire.

2.2 GROUNDING CONNECTORS

A. PARTS
1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

2.3 GROUNDING ELECTRODE

A. PARTS
1. Copper clad steel, 5/8-inch diameter by 8 feet long, conforming to UL 467.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ground in accordance with the NEC, as shown on drawings.

B. System Grounding:

1. AC grounding main bonding jumper will be on neutral bus in AC pnaleboard to ensure less than 150V to ground with 4 AWG copper grounding conductor to grounding electrode (NEC TABLE 250.66)

2. AC and DC system components grounded to bonding jumpers with a 10 AWG copper wire (NEC 250.122 and NEC 690.47(C))

C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

END OF SECTION 337900

SECTION 416219 – FORKLIFT TRUCKS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Material Handling Equipment: Telehandler
1. MANUFACTURER: JLG – Telehandler 534D9-45:
a. http://www.jlg.com/en-US/Model.html?BaseProductLineNodeId=c662180a-b3fa-45f8-b066-07980981e2ba&ProductLineNodeId=232c7281-6602-46d0-b734-eebe97cb6a53&GroupProductLineNodeId=cfeec282-89ec-440d-a0cb-884a41719ef4&ModelId=aa62e5d8-0143-48d8-9a26-b71fd8338773&ProductRootMenuId=d39badf6-70c2-4fa3-a03c-268cb1f085d7
2. OR EQUIVALENT

2.2 ACESSORIES

A. Material Handling Equipment: Forklift Hook
1. MANUFACTURER: Global Industrial 774165
a. http://www.globalindustrial.com/gcs/prod/30044133/i/productInfo.web
2. OR Equivalent

PART 3 - EXECUTION

3.1 EQUIPMENT USE

A. General: Use of the telehandler shall be per manufacturer instructions and with use of a certified operator.

B. When utilizing the forklift to hoist, or move materials with rigging such as strapping, or cabling, the forklift hook shall be utilized.

END OF SECTION 416219

SECTION 481916 – ELECTRICAL POWER GENERATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

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

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 DEVICES

A. DC-AC INVERTER:

1. Products

a. Xantrex GT5.0: An NEC compliant, integrated DC/AC disconnect, standard in the GT Series, eliminates the need for external DC (PV) disconnects, and in some jurisdictions, AC disconnects, NEMA 3R inverter enclosure, UL1741
1) http://www.xantrex.com/web/id/1416/DocServe.aspx

b. PV Powered PVP2000: ,NEMA 3R inverter enclosure, IEEE 1547-compliant, UL 1741
1) http://www.pvpowered.com/downloads/PVPowered-Residential-Inveters-Low-Power.pdf

c. Enphase Energy Inc. M190-72-240-s01: Outdoor – NEMA 6 inverter enclosure, UL1741/IEEE1547 Pending
1) http://www.sunwize.com/info_center/pdf/enphase-M190_3-09.pdf

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall-mounted Inverters: Securely anchor wall mounting bracket to manufacturer's specifications before attaching inverter. Verify all clearances for adequate ventilation.

B. Rack-mounted Inverters: Securely anchor mounting bracket to rack with manufacture's specifications before attaching the inverter.

C. Before testing any inverters ensure that all wires are properly connected and adequate circuit protection has been taken in accordance with NEC 690

END OF SECTION 481916

4.0 Structural Calculations

4.1 Project Overview

This project manual provided structural calculations and evaluation of atypical construction methods and loading conditions not covered in applicable building codes.

The objective of the structures group is to create a safe and sensible structural design that maximizes efficiency and minimizes the use of materials that require high energy during production.

The roofing system was designed to maximize its R-value, given deflection constraints for the additional loads of a green roof and height constraints during transportation.

High performance computer programs were used to evaluate all feasible load combinations to find and design to the critical load scenario. Some programs were commercially available, but when necessary, members of the structures group wrote custom computer programs. The main reason for the use of programs as opposed to hand calculations was to provide the designers with flexibility throughout the process. Alterations are easy to implement and check.

4.2 Load Summary

The structural design must accommodate multiple phases of loading. Construction is done in a modular building facility. The building shell must be transportable on U.S. highways. The service loads include a three week duration on the National Mall with elevated load criteria and a permanent location in Pennsylvania, using conservative values. A change in final geographic location will require re-evaluation.

4.2.1 General

Occupancy Category: II (ASCE 7-05 Table 1-1)

4.2.2 Construction Loads

Construction Live Load

20 psf

4.2.3 Transportation Loads

(See Appendices A.1; B.1.3.6; B.1.3.7)

Wind Load: Service wind load assumed to control (See Appendix A.4)

Braking Force:

Travelling Speed, V_trailer = 65 mph

Deceleration rate, a = 11.2 ft/s2

Base Shear Force: 1500 lbs

4.2.4 Seismic Loads

Maximum 0.2 second horizontal acceleration with 2% probability of exceedance in 50 years is 0.2g for Pennsylvania. (See Appendix A.2)

$0.2(32.2\ ft/s^2) = 6.4\ ft/s^2 < 11.2\ ft/s^2$ therefore braking forces control.

4.2.5 Dead Loads

Roof (See Appendix A.3)

15 psf

Floor (See Appendix A.3)

20 psf Dead

Decks and Ramps (See Appendix E)

10 psf

4.2.6 Live Loads

Service:

Roof

40 psf Greenroof

20 psf (SD2009 Building Code v1.0 6-2)

Floor

40 psf (ASCE 7-05)

15 psf Water

National Mall:

Roof

40 psf Greenroof

20 psf (SD2009 Building Code v1.0 6-2)

Floor/Decks and Ramps

50 psf live load for living areas. (SD2009 Building Code v1.0 5-2)

100 psf live load for egress locations. (SD2009 Building Code v1.0 5-2)

4.2.7 Wind Loads

(See Appendix A.4)

Method: 2

Design Wind Speed, V = 90 mph (ASCE 7-05 Figure 6-1)

National Mall Design Wind Speed, V = 60 mph (SD2009 Building Code 6.2)

Exposure Category: C

Importance Factor, I = 1.00

Kd = .85

Kz = .85

Kh = .85

Kzt = 1.00

Gcpi = +/- .18

qz = qh = 15 psf

MWRFS: See end of Appendix A.4

Components and Cladding: Use 20 psf

4.2.8 Snow Loads

(See Appendix A.5)

Ground Snow Load: pg = 30 psf (ASCE 7-05 Figure 7-1)

Exposure Factor: C, Partial (ASCE 7-05 Table 7-2), Ce = 1.0

Thermal Factor: Ct = 1.00 (ASCE 7-05 Table 7-3)

Importance Factor: I = 1.00 (ASCE 7-05 Table 7-4)

Flat Roof Snow Load: pf = 21 psf (ASCE 7-05 7-1)

Note: Upper roof considered Flat (<5)

Sloped Roof Factor: Cs = .9 (ASCE 7-05 7.4.1, Fig. 7-2)

Sloped Roof Snow Load: ps = 18.9 psf (ASCE 7-05 7-2)

Drift Snow Load: pd = 16.9 psf triangular load (ASCE 7-05 7-3)

Note: Lower roof considered Sloped (=11.3>5)

4.2.9 Load Combinations

Dead + Snow	(See Appendix B.1.3.1)
Dead + Wind (N-S)	(See Appendix B.1.3.2)
Dead + Snow + Wind (N-S)	(See Appendix B.1.3.3)
Dead + Wind (S-N)	(See Appendix B.1.3.4)
Dead + Snow + Wind (S-N)	(See Appendix B.1.3.5)
Transportation + Wind (N-S)	(See Appendix B.1.3.6)
Transportation + Wind (S-N)	(See Appendix B.1.3.7)

4.3 Specifications

4.3.1 Deflection Criteria

Roof: L/360

Floor: L/360

4.3.2 Roof

(See Appendix D)

The deflection is limited to L/360 using the formula $5wL^4/384EI$ and assuming composite action. Two spans are considered; 8ft and 12ft.

w=11.67 lbs/in

L=96 in ; 144 in

$E_{wood}=0.7x10^6$ psi

$E_{foam}=2.0x10^3$ psi (from physical testing)

4.3.3 Frames

4.3.3.1 Wood Members

Eastern white pine, #2

Green (wet)

4.3.3.2 Connections

Hardware:

1/4” Steel side plates

2 5/8” Shear plates

3/4” Bolts

Edge distances:

Loaded edge: 2 3/4”

Unloaded edge: 1 3/4”

End distances:

Loaded edge: 4”

Unloaded edge: 5”

Spacing:

Load parallel to grain:

Parallel: 6 3/4”

Perpendicular: 3 1/2”

Load perpendicular to grain:

Parallel: 3 1/2”

Perpendicular: 4 1/4”

Maximum Moments:

Beam	L/C	Node	Mz kip-in
1	1 DEAD + SNOW	1	21.657
		6	42.821
3	1 DEAD + SNOW	1	21.657
		4	59.748
4	1 DEAD + SNOW	4	-68.618
		5	-47.921
6	1 DEAD + SNOW	6	-50.124
		4	9.344
7	1 DEAD + SNOW	6	-92.945
		2	-57.065
10	5 DEAD + SNOW + WIND(S-N)	2	-57.065
		8	-49.038
11	3 DEAD + SNOW + WIND(N-S)	5	47.921
		9	44.486

Coefficients:

Coefficients are used in accordance with NDS 2005. Each load case was evaluated using the following duration factors:

Load Case 1 (D+S): 1.15

Load Case 2 (D+W): 1.60

Load Case 3 (D+S+W): 1.60

Load Case 4 (D+W): 1.60

Load Case 5 (D+S+W): 1.60

Load Case 6 (T+W): 2.00

Load Case 7 (T+W): 2.00

4.3.4 Shear Walls

The south shear wall was designed as a shear collector for the southern face. The shear area for the south shear wall is small in comparison to the north, and governs the design. The north wall is to be constructed similar to the south.

Base shear, V=5 kips (See Appendix A.1)

4.3.5 Floor Joists

9 1/4" Openjoist with 2x3 flanges will be used to span the ~14' width. Floors will be designed to meet the more stringent criteria of the competition with an additional support at midspan that runs the length of the house and is installed on-site. The floors themselves will be designed for in-service loads at its permanent location, as per ASCE-07 loading criteria, to span the entire width. This will allow for the most efficient use of insulation in the floor depth while constricting height for transportation needs. It will also provide an increased flexibility for future building owners.

Open joists will be utilized for the floor system. Selection is shown in the following span table, provided by Universal Forest Products.

9-1/4" Depth Maximum Live Load Deflection (L/360 & L/480, 1-1/2" Minimum Bearing Each End)

Chord* Size	Chord* Grade	Loading (PSF)		12" o.c.		16" o.c.		19.2" o.c.		24" o.c.	
		Live	Dead	L/360	L/480	L/360	L/480	L/360	L/480	L/360	L/480
3x2	#2	40	15	15'-9"	15'-9"	15'-9"	14'-11"	15'-6"	14'-0"	14'-3"	12'-10"
4x2	MSR 2100	40	15	19'-9"	19'-5"	19'-1"	17'-3"	17'11"	16'-6"	16'-11"	
3x2	#2	50	15	15'-9"	15'-3"	15'-3"	13'-9"	14'-3"	12'-10"	13'-2"	11'-11"
4x2	MSR 2100	50	15	19'-9"	17'-11"	17'-11"	16'-4"	16'-11"			
3x2	#2	100	15	13'-2"	11'-11"	11'-11"	10'-8"	11'-1"	9'-11"	9'-3"	8'-9"

Figure 1: Open joist span chart (www.ufpi.com)

The use of water storage in the floor system necessitates the use of 50 psf Live Load. 16" O.C. spacing has been selected for fabrication speed, however 19.2" O.C. is acceptable.

4.3.6 Decking

Decking: Black Locust

5/4 x 6 wide face

Decking Support: Southern Pine No. 2

2x8 Joists @ 16” O.C. Selection 1 (5 ft span)

2x10 Joists @ 16” O.C. Selection 2 (7 ft span)

2x10 Girders (5 ft span)

(See Appendix E)

4.3.7 Foundations

Maximum Allowable Soil Bearing Pressure: 1500 psf (SD2009 Building Code 6.2)

Maximum Pad Load: 5500 lbs

Maximum Soil Bearing Pressure: 1475 psf

Minimum Pad Load: 320 lbs

4.3.7.1 Jacks

The maximum point load to the jacks is 5500 lbs.

4.3.7.2 Pads

Allowable load on the soil of the National Mall in Washington D.C. is 1500 lb/ft^2. The maximum point load to the pads is 5500 lbs. The footing area required is 3.667 ft^2. The footings will be square and must have a minimum length per side of 1.915 ft. In the event of circular footings, the minimum diameter is 2.161 ft. See Structural Appendix F.2 for calculations.

4.3.7.3 Deck Posts

All deck posts to be 4x4 pressure treated lumber, connected to the girders using AC4SS Post Caps by Simpson Strong-Tie for the edges and ACE4SS Post Caps by Simpson Strong-Tie for the corners. The posts shall connect to horizontally laid 6x6 pressure treated lumber pads using A23 Angles by Simpson Strong-Tie, two per 4x4 post. Lengths of 4x4 posts to be cut on-site according to grade changes. Lengths of 6x6 pads shall be cut according to the table in Appendix F.3.

4.4 Structural Appendices

A. Load Calculations

A.1 Transportation Loads

Braking Forces

handled by the shear resistance of the structure. Shear walls in the longitudinal direction will be designed for the maximum of braking force analysis or E-W prevailing winds at design speed.

Sections (roof, walls, floor) will be kept separate for a more accurate analysis of the work required by the longitudinal shear resisting system.

Structure will be assumed to act as a rigid body.

Weight at various building heights:

$$W := \begin{pmatrix} 3850 \\ 1850 \\ 4050 \\ 1200 \\ 800 \\ 150 \\ 2200 \end{pmatrix} \cdot lb \qquad h := \begin{pmatrix} .5 \\ 3 \\ 5 \\ 6 \\ 9 \\ 10 \\ 11 \end{pmatrix} \cdot ft$$

Corresponding mass:

$$m := \frac{W}{g} \qquad m = \begin{pmatrix} 119.662 \\ 57.5 \\ 125.878 \\ 37.297 \\ 24.865 \\ 4.662 \\ 68.378 \end{pmatrix} \frac{lb \cdot s^2}{ft}$$

$$W_total := W_0 + W_1 + W_2 + W_3 + W_4 + W_5 + W_6$$

$$m_total := \frac{W_total}{g}$$

Traveling Speed:

$v_trailer := 65mph$ (conservative assumption)

The following formula for stopping sight distance uses an assumption of 2.5 sec reaction time and a constant deceleration rate of 11.2 ft/s^2 on a 5% downgrade. These are conservative, but typical scenarios.

Stopping Sight Distance:

$$d_stopping := 1.47 \cdot \left(\frac{v_trailer}{mph}\right) \cdot 2.5 \cdot ft + \frac{ft\left(\frac{v_trailer}{mph}\right)^2}{30 \cdot \left(\frac{11.2}{32.2} - .05\right)}$$

$d_stopping = 711.746\,ft$

$$t_stopping := \frac{2 \cdot d_stopping}{v_trailer}$$

$t_stopping = 14.932\,s$

$$a_stopping := 11.2\,\frac{ft}{s^2}$$

$a_stopping = 11.2\,\frac{ft}{s^2}$

$$F_stopping := m \cdot a_stopping$$

$$F_stopping = \begin{pmatrix} 1.34 \times 10^3 \\ 643.997 \\ 1.41 \times 10^3 \\ 417.728 \\ 278.485 \\ 52.216 \\ 765.835 \end{pmatrix} lb$$

Is friction on bed high enough to keep house from slipping upon braking?

$\mu s := .2$

$Fn := W_total$

$Fn = 1.41 \times 10^4\,lb$

$f := \mu s \cdot Fn$

$f = 2.82 \times 10^3\,lb$

$F_total := m_total \cdot a_stopping$

$F_total = 4.908 \times 10^3\,lb$

$$Slip := \begin{cases} \text{"no slip"} & \text{if } F_total < f \\ \text{"NG"} & \text{otherwise} \end{cases}$$

$Slip = \text{"NG"}$

What is the necessary support resistance to keep the house on the trailer at critical stopping rate?

$S := F_total - f$

$S = 2.088 \times 10^3\,lb$

Base shear = sum(F_stopping) = 5 kips

Which control for the design for longitudinal shear resistance? wind or braking forces?

Equivalent pressures for comparison:

Due to Braking Force:

$$F_mid := \frac{\sum_{i=0}^{6} \left(F_stopping_i \cdot h_i\right)}{2 \cdot 5 \cdot ft}$$

$$F_mid = 2.361 \times 10^3\ lb$$

$$CS := (16 \cdot ft) \cdot (10 \cdot ft)$$

$$p_braking := \frac{F_mid}{CS}$$

$$p_braking = 14.756\ \frac{lb}{ft^2}$$

Due to wind:

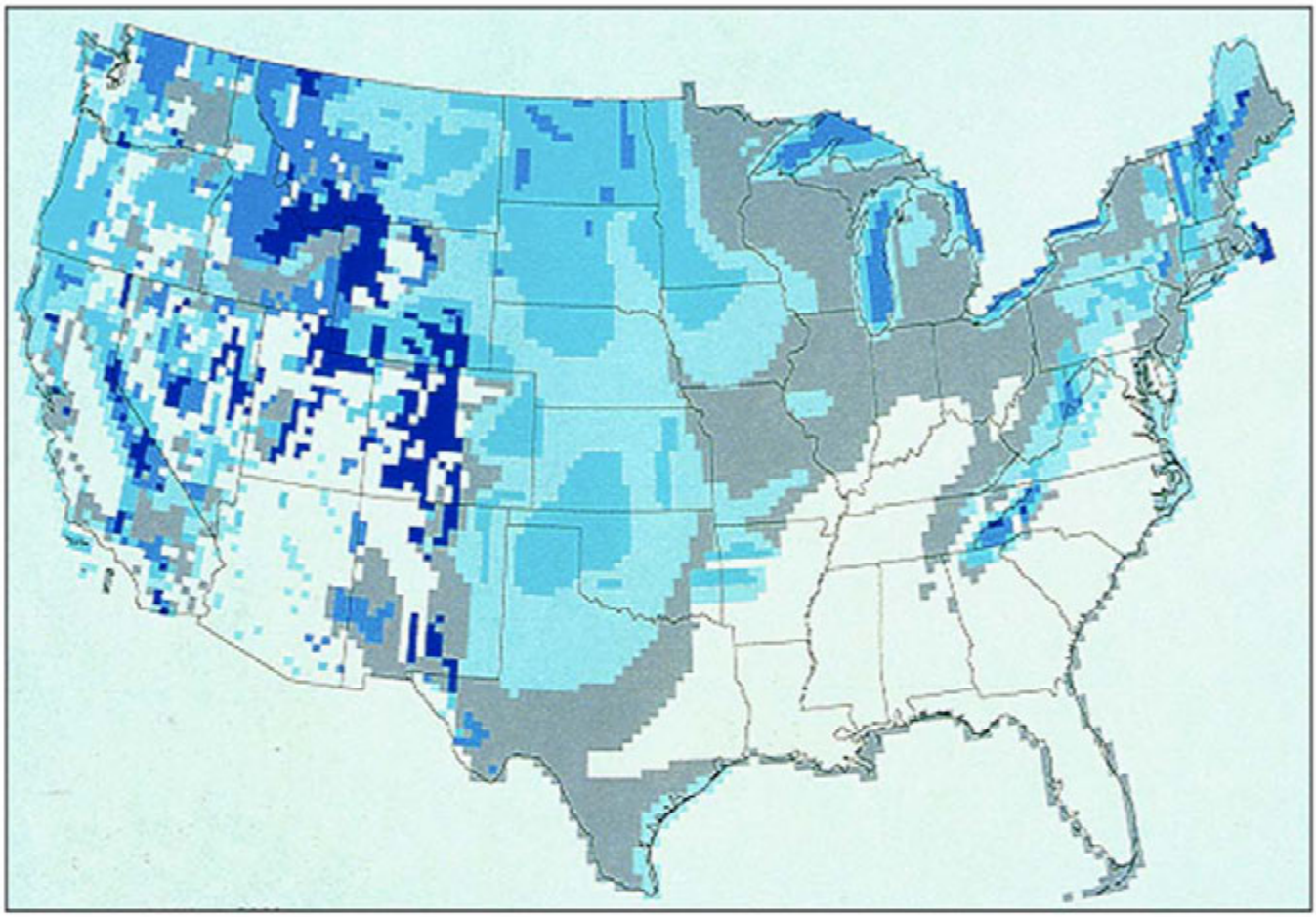
$$p_driving := 12 \cdot \frac{lb}{ft^2}$$

$$p_suction := 3.7\ \frac{lb}{ft^2}$$

$$p_wind := p_driving + p_suction$$

$$p_wind = 15.7\ \frac{lb}{ft^2}$$

Average Wind Speeds in the U.S.



Power Class	Wind Power (W/m2)	Speed* (m/s)
1	<200	<5.6
2	200-300	5.6-6.4
3	300-400	6.4-7.0
4	400-500	7.0-7.5
5	500-600	7.5-8.0
6	600-800	8.0-8.8
7	>800	>8.8

*Equivalent wind speed at sea level for a Rayleigh Distribution

Average Wind Speed

$$v_{avg} = 7.0\frac{m}{s}$$

from American Wind Energy Association: www.awea.org/faq/usresource

$$= 7.0\frac{m}{s}\left(\frac{0.000621371192mile}{1m}\right)\left(\frac{3600\sec}{1hr}\right) = 15.6586mph$$

Max Travel Speed

$v^{*}_{truck} = 65mph$ *Conservative

$65mph + 15.7mph = 80.7mph$

Design Wind Speed=90mph

The design wind speed accounts for conservative travel speed + 160% of the average wind speed for the most conservative region traveled. No modification for transportation needed.

Floor Level (h~1ft)

Designation	*Empty/Transport*	*Full/Service*	
P-1	29	29	lbs
P-2	6.5	6.5	lbs
P-3	6	6	lbs
FTR-1	50	50	lbs
Shower	174	250	lbs
Total	265.5	341.5	lbs

Midheight (h~3ft)

Designation	*Empty/Transport*	*Full/Service*	
WH-1	220	880	lbs
Refrigerator	400	1500	lbs
Bed	150	150	lbs
Washer/Dryer	250	400	lbs
Dishwasher	50	120	lbs
Microwave	21	21	lbs
Stove	100	200	lbs
Living Room Furniture	500	500	lbs
Kitchen Table	150	150	lbs
Total	1841	3921	lbs

Wall Mount (h~6ft)

Designation	*Empty/Transport*	*Full/Service*	
ET-1	10	10	lbs
TWH-1	40	40	lbs
ERV-1	27	27	lbs
SS-1	25	25	lbs
SS-2	25	25	lbs
SS-3	25	25	lbs
OTP-1	20	20	lbs
Cabinetry	1000	1500	lbs
Total	1172	1672	lbs

Roof Level (h~10ft)

Designation	*Empty/Transport*	*Full/Service*	
ETA-1	57	57	lbs
ETA-2	57	57	lbs
Total	114	114	lbs

Exterior Wall Cladding (h~5ft)

Designation	Thickness (in)	Area (ft^2)	Specific Gravity	Weight (lbs)
Wood	0.75	1005	0.5	1959.75

Section	Type	Volume (ft^3)	density (pcf)	Weight (lbs)
Wall (h~5ft)				
	Spray	175	2.2	385
	Poly-Iso	90	2.5	225
			Total Wall	610
Roof (h~11ft)				
	Spray	250	2.2	550
			Total Roof	550
Floor (h~.5ft)				
	Spray	450	2.2	990
			Total Floor	990
			Total Insulation	2150

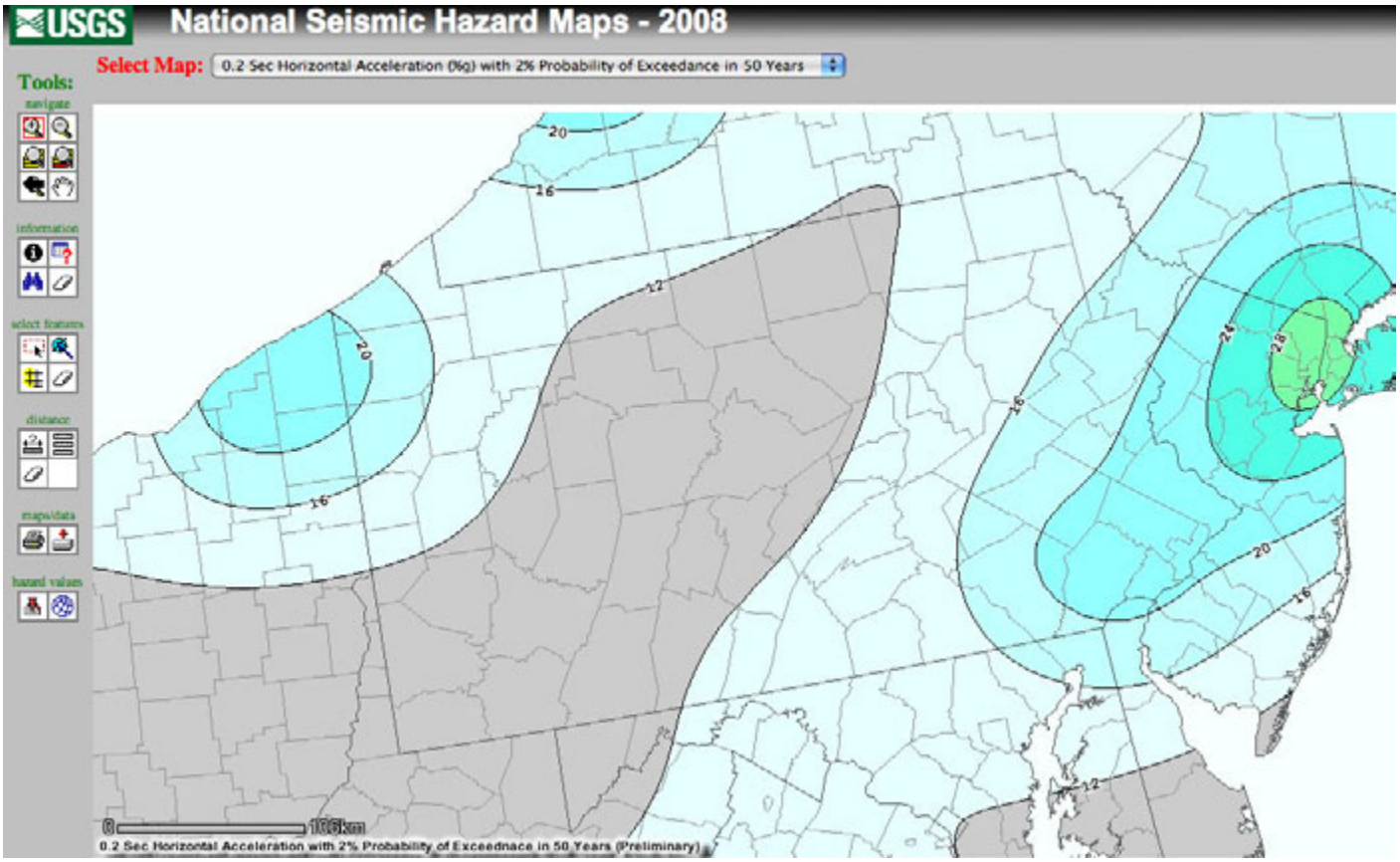
Designation	Dimension (nominal)	Length (ft)	Quantity	Unit Weight (plf)	Weight (lbs)
Floor (h~.5ft)					
G1	2 x 12	16	14	3.07125	687.96
R1	2 x 12	43.5	2	3.07125	267.19875
J1	2 x 12	8	70	3.07125	1719.9
J2	2 x 12	4	11	3.07125	135.135
J3	2 x 8	4	6	1.97925	47.502
				Total floor	2857.69575
Truss (h~9ft)					
T1	2 x 6	2	8	1.5015	24.024
T2	2 x 6	1.33	8	1.5015	15.97596
T3	2 x 6	9	8	1.5015	108.108
T4	2 x 6	11.33	8	1.5015	136.09596
T5	2 x 6	4	8	1.5015	48.048
C1	2 x 4	10.5	8	0.9555	80.262
C2	2 x 4	10	16	0.9555	152.88
C3	2 x 4	9	8	0.9555	68.796
C4	2 x 4	8	16	0.9555	122.304
				Total Truss	756.49392
Walls(h~5ft)					
W1	2 x 4	9	81	0.9555	696.5595
W2	2 x 3	11	26	0.6825	195.195
TP1	2 x 4	300	1	0.9555	286.65
BP1	2 x 4	300	1	0.9555	286.65
				Total Wall	1465.0545
Roof (h~11ft)					
B1	2 x 8	8	8	1.97925	126.672
B2	2 x 12	8	8	3.07125	196.56
B3	2 x 12	8	4	3.07125	98.28
B4	2 x 8	10.5	6	1.97925	124.69275
B5	2 x 12	10.5	1	3.07125	32.248125
P1	2 x 12	8	11	3.07125	270.27
P2	2 x 6	4	17	1.5015	102.102
P3	2 x 12	12	8	3.07125	294.84
P4	2 x 12	10	12	3.07125	368.55
				Total Roof	1614.21488
				Total Lumber	6693.45905

Summary of Transportation Loads

Height (ft)	Weight (lbs)
0.5	3847.69575
3	1841
5	4034.8045
6	1172
9	756.49392
10	114
11	2164.214875

Total building weight during transportation: 14,000 lbs

A.2 Seismic Loads



A.3 Dead Loads

Floor

	Thickness (in)	Density (pcf)	Pressure (psf)
Finish Floor	0,75		4
Subfloor	0,75		3
Open Joists			2
Bladders			2
Bladder Support	0,5		2
Foam Infill	8	1,9	1,266666667
Allowance			5
Subtotal			19,26666667
Dead Load			20

Water	2	62,4	10,4
Water Load			15

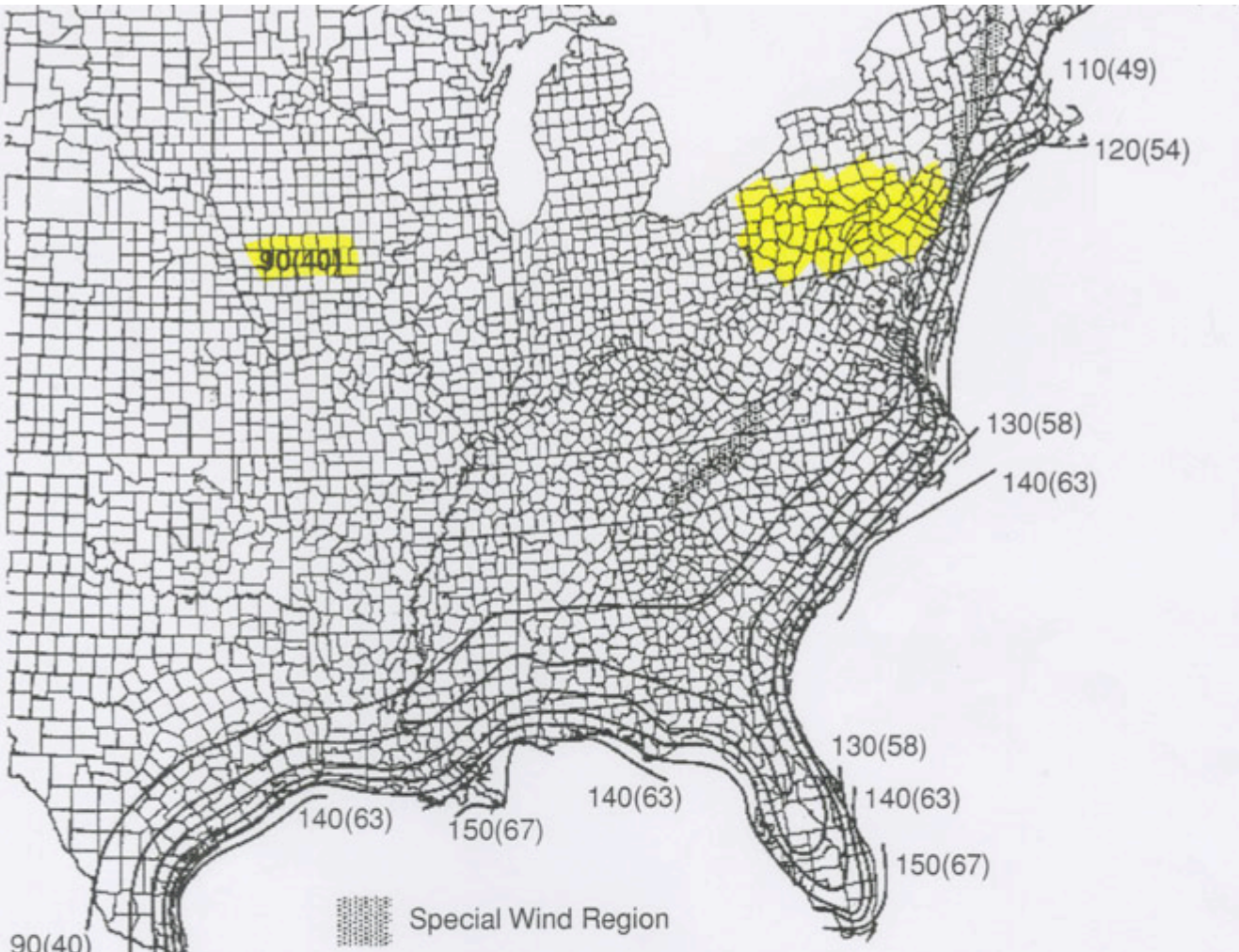
Roof

	Component	Thickness, in.	Density (pcf)	Load (psf)
8' span				
	Top Foam Layer	1,0	2,7	0,225
	OSB	0,6	48,0	2,5
	2x6 @ 24" O.C.			2
	Foam Infill	5,0	1,9	0,791666667
	Drywall	0,6	48,0	2,5
	Allowance			3
	Dry Soil	4,0	5,2	1,733333333
	Subtotal			12,75
12' span				
	Top Foam Layer	1,0	2,7	0,225
	OSB	0,6	48,0	2,5
	2x6 @ 24" O.C.			2
	Foam Infill	5,0	1,9	0,791666667
	OSB	0,6	48,0	2,5
	Drywall	0,6	48,0	2,5
	Allowance			3
	Dry Soil	4,0	5,2	1,733333333
	Subtotal			15,25
	Dead Load			15

A.4 Wind Loads

Structure Type	Directionality Factor K_d*
Buildings	
Main Wind Force Resisting System	0.85
Components and Cladding	0.85
Arched Roofs	0.85
Chimneys, Tanks, and Similar Structures	
Square	0.90
Hexagonal	0.95
Round	0.95
Solid Signs	0.85
Open Signs and Lattice Framework	0.85
Trussed Towers	
Triangular, square, rectangular	0.85
All other cross sections	0.95

*Directionality Factor K_d has been calibrated with combinations of loads specified in Section 2. This factor shall only be applied when used in conjunction with load combinations specified in 2.3 and 2.4.



Location	V mph	(m/s)
Hawaii	105	(47)
Puerto Rico	145	(65)
Guam	170	(76)
Virgin Islands	145	(65)
American Samoa	125	(56)

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10 m) above ground for Exposure C category.
2. Linear interpolation between wind contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

FIGURE 6-1 continued
BASIC WIND SPEED

Minimum Design Loads for Buildings and Other Structures

Category	Non-Hurricane Prone Regions and Hurricane Prone Regions with V = 85-100 mph and Alaska	Hurricane Prone Regions with V > 100 mph
I	0.87	0.77
II	1.00	1.00
III	1.15	1.15
IV	1.15	1.15

Note:

1. The building and structure classification categories are listed in Table 1-1.

Velocity Pressure Exposure Coefficients, K_h and K_z

Table 6-3

Height above ground level, z		Exposure (Note 1)			
		B		C	D
ft	(m)	Case 1	Case 2	Cases 1 & 2	Cases 1 & 2
0-15	(0-4.6)	0.70	0.57	0.85	1.03
20	(6.1)	0.70	0.62	0.90	1.08
25	(7.6)	0.70	0.66	0.94	1.12
30	(9.1)	0.70	0.70	0.98	1.16
40	(12.2)	0.76	0.76	1.04	1.22
50	(15.2)	0.81	0.81	1.09	1.27
60	(18)	0.85	0.85	1.13	1.31
70	(21.3)	0.89	0.89	1.17	1.34
80	(24.4)	0.93	0.93	1.21	1.38
90	(27.4)	0.96	0.96	1.24	1.40
100	(30.5)	0.99	0.99	1.26	1.43
120	(36.6)	1.04	1.04	1.31	1.48
140	(42.7)	1.09	1.09	1.36	1.52
160	(48.8)	1.13	1.13	1.39	1.55
180	(54.9)	1.17	1.17	1.43	1.58
200	(61.0)	1.20	1.20	1.46	1.61
250	(76.2)	1.28	1.28	1.53	1.68
300	(91.4)	1.35	1.35	1.59	1.73
350	(106.7)	1.41	1.41	1.64	1.78
400	(121.9)	1.47	1.47	1.69	1.82
450	(137.2)	1.52	1.52	1.73	1.86
500	(152.4)	1.56	1.56	1.77	1.89

Notes:

1. **Case 1:** a. All components and cladding.
   b. Main wind force resisting system in low-rise buildings designed using Figure 6-10.

   Case 2: a. All main wind force resisting systems in buildings except those in low-rise buildings designed using Figure 6-10.
   b. All main wind force resisting systems in other structures.

2. The velocity pressure exposure coefficient K_z may be determined from the following formula:

   For 15 ft. $\leq z \leq z_g$ For $z < 15$ ft.

   $K_z = 2.01\ (z/z_g)^{2/\alpha}$ $K_z = 2.01\ (15/z_g)^{2/\alpha}$

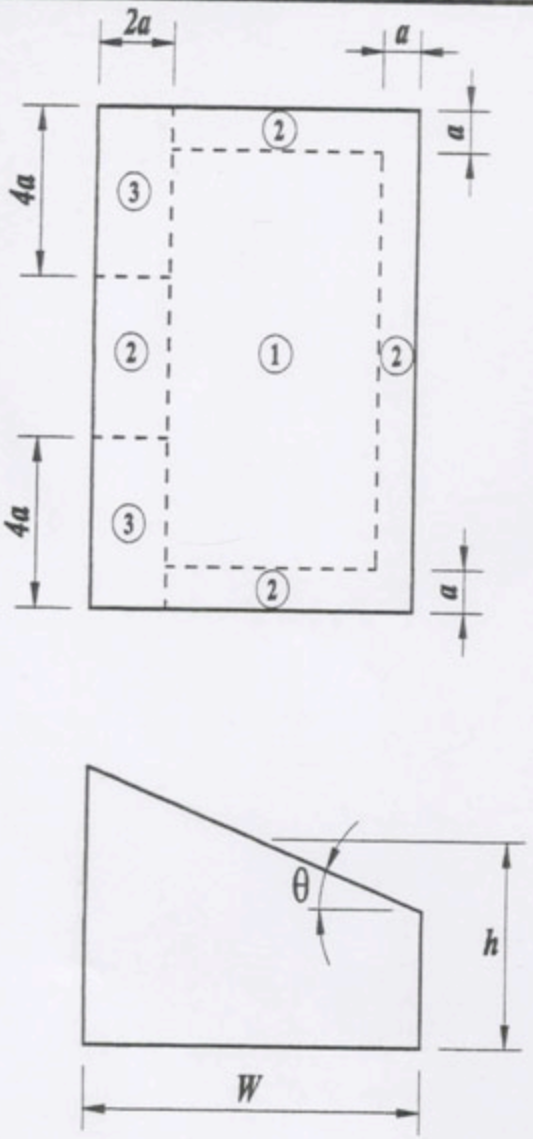
   Note: z shall not be taken less than 30 feet for Case 1 in exposure B.

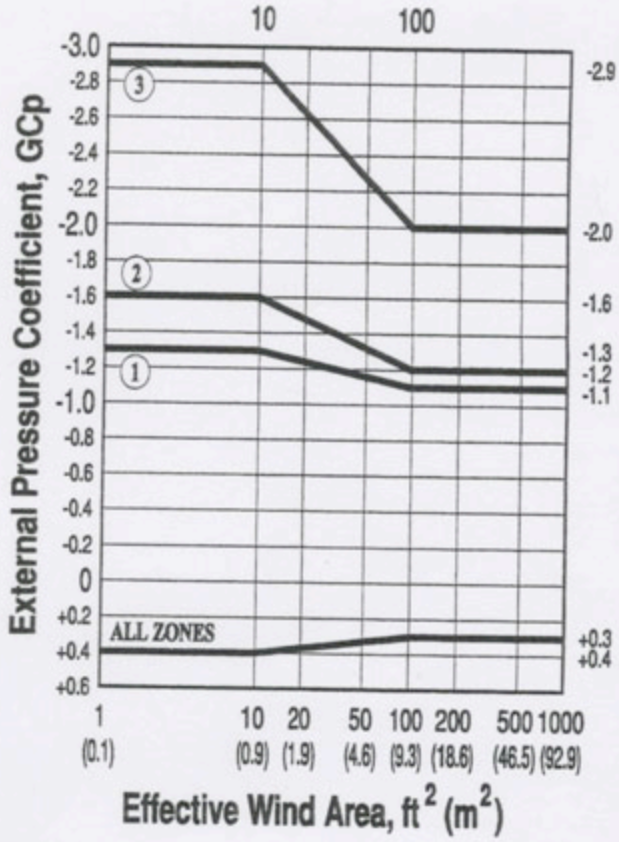
3. α and z_g are tabulated in Table 6-2.

4. Linear interpolation for intermediate values of height z is acceptable.

5. Exposure categories are defined in 6.5.6.

Components and Cladding – Method 2		h ≤ 60 ft.
Figure 6-14B	External Pressure Coefficients, GC_p	Monoslope Roofs
Enclosed, Partially Enclosed Buildings		10° < θ ≤ 30°





Notes:

1. Vertical scale denotes GC_p to be used with q_h.
2. Horizontal scale denotes effective wind area A, in square feet (square meters).
3. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
4. Each component shall be designed for maximum positive and negative pressures.
5. Notation:
   - a: 10 percent of least horizontal dimension or $0.4h$, whichever is smaller, but not less than either 4 percent of least horizontal dimension or 3 ft (0.9 m).
   - h: Mean roof height, in feet (meters).
   - W: Building width, in feet (meters).
   - θ: Angle of plane of roof from horizontal, in degrees.

Main Wind Force Resisting System – Method 2		All Heights
Figure 6-6 (con't)	External Pressure Coefficients, C_p	Walls & Roofs
Enclosed, Partially Enclosed Buildings		

Wall Pressure Coefficients, C_p

Surface	L/B	C_p	Use With
Windward Wall	All values	0.8	q_z
Leeward Wall	0-1	-0.5	q_h
	2	-0.3	
	≥4	-0.2	
Side Wall	All values	-0.7	q_h

Roof Pressure Coefficients, C_p, for use with q_h

Wind Direction	Windward									Leeward		
	Angle, θ (degrees)									Angle, θ (degrees)		
	h/L	10	15	20	25	30	35	45	≥60#	10	15	≥20
Normal to ridge for θ ≥ 10°	≤0.25	-0.7 -0.18	-0.5 0.0*	-0.3 0.2	-0.2 0.3	-0.2 0.3	0.0* 0.4	0.4	0.01 θ	-0.3	-0.5	-0.6
	0.5	-0.9 -0.18	-0.7 -0.18	-0.4 0.0*	-0.3 0.2	-0.2 0.2	-0.2 0.3	0.0* 0.4	0.01 θ	-0.5	-0.5	-0.6
	≥1.0	-1.3** -0.18	-1.0 -0.18	-0.7 -0.18	-0.5 0.0*	-0.3 0.2	-0.2 0.2	0.0* 0.3	0.01 θ	-0.7	-0.6	-0.6

Wind Direction	h/L	Horiz distance from windward edge	C_p
Normal to ridge for θ < 10 and Parallel to ridge for all θ	≤ 0.5	0 to h/2	-0.9, -0.18
		h/2 to h	-0.9, -0.18
		h to 2 h	-0.5, -0.18
		> 2h	-0.3, -0.18
	≥ 1.0	0 to h/2	-1.3**, -0.18
		> h/2	-0.7, -0.18

*Value is provided for interpolation purposes.

**Value can be reduced linearly with area over which it is applicable as follows

Area (sq ft)	Reduction Factor
≤ 100 (9.3 sq m)	1.0
200 (23.2 sq m)	0.9
≥ 1000 (92.9 sq m)	0.8

Notes:

1. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
2. Linear interpolation is permitted for values of *L/B*, *h/L* and θ other than shown. Interpolation shall only be carried out between values of the same sign. Where no value of the same sign is given, assume 0.0 for interpolation purposes.
3. Where two values of C_p are listed, this indicates that the windward roof slope is subjected to either positive or negative pressures and the roof structure shall be designed for both conditions. Interpolation for intermediate ratios of h/L in this case shall only be carried out between C_p values of like sign.
4. For monoslope roofs, entire roof surface is either a windward or leeward surface.
5. For flexible buildings use appropriate G_f as determined by Section 6.5.8.
6. Refer to Figure 6-7 for domes and Figure 6-8 for arched roofs.
7. Notation:
   B: Horizontal dimension of building, in feet (meter), measured normal to wind direction.
   L: Horizontal dimension of building, in feet (meter), measured parallel to wind direction.
   h: Mean roof height in feet (meters), except that eave height shall be used for θ ≤ 10 degrees.
   z: Height above ground, in feet (meters).
   G: Gust effect factor.
   q_z, q_h: Velocity pressure, in pounds per square foot (N/m^2), evaluated at respective height.
   θ: Angle of plane of roof from horizontal, in degrees.
8. For mansard roofs, the top horizontal surface and leeward inclined surface shall be treated as leeward surfaces from the table.
9. Except for MWFRS's at the roof consisting of moment resisting frames, the total horizontal shear shall not be less than that determined by neglecting wind forces on roof surfaces.

#For roof slopes greater than 80°, use $C_p = 0.8$

Terrain Exposure Constants

Table 6-2

Exposure	α	z_g (ft)	$\hat{a}$	$\hat{b}$	$\bar{\alpha}$	$\bar{b}$	c	ℓ (ft)	$\bar{\epsilon}$	z_{min} (ft)*
B	7.0	1200	1/7	0.84	1/4.0	0.45	0.30	320	1/3.0	30
C	9.5	900	1/9.5	1.00	1/6.5	0.65	0.20	500	1/5.0	15
D	11.5	700	1/11.5	1.07	1/9.0	0.80	0.15	650	1/8.0	7

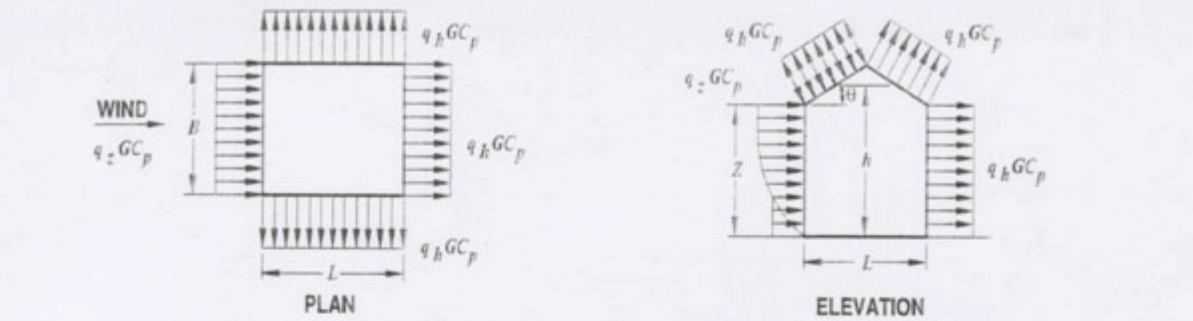
*z_{min} = minimum height used to ensure that the equivalent height $\bar{z}$ is greater of $0.6h$ or z_{min}.
For buildings with $h \leq z_{min}$, $\bar{z}$ shall be taken as z_{min}.

In metric

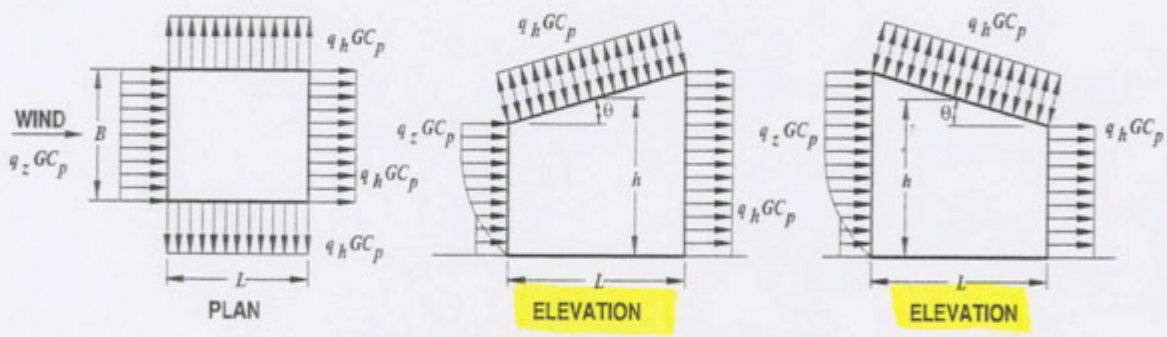
Exposure	α	z_g (m)	$\hat{a}$	$\hat{b}$	$\bar{\alpha}$	$\bar{b}$	c	ℓ (m)	$\bar{\epsilon}$	z_{min} (m)*
B	7.0	365.76	1/7	0.84	1/4.0	0.45	0.30	97.54	1/3.0	9.14
C	9.5	274.32	1/9.5	1.00	1/6.5	0.65	0.20	152.4	1/5.0	4.57
D	11.5	213.36	1/11.5	1.07	1/9.0	0.80	0.15	198.12	1/8.0	2.13

*z_{min} = minimum height used to ensure that the equivalent height $\bar{z}$ is greater of $0.6h$ or z_{min}.
For buildings with $h \leq z_{min}$, $\bar{z}$ shall be taken as z_{min}.

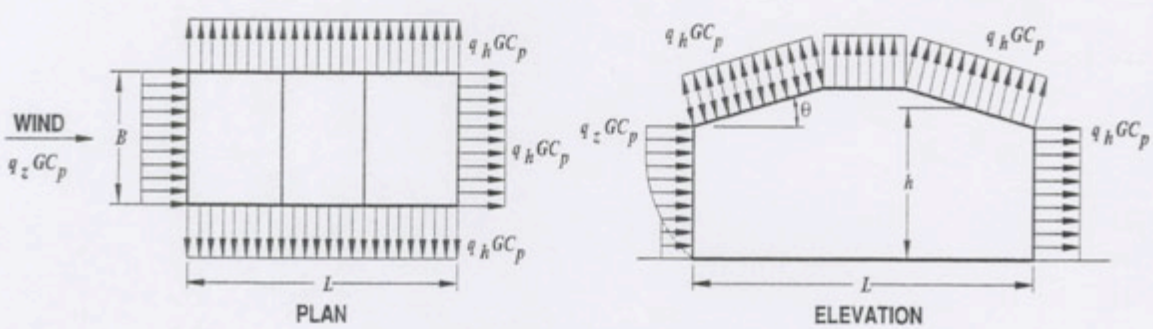
Main Wind Force Resisting System – Method 2		All Heights
Figure 6-6	External Pressure Coefficients, C_p	Walls & Roofs
Enclosed, Partially Enclosed Buildings		



GABLE, HIP ROOF



MONOSLOPE ROOF (NOTE 4)



MANSARD ROOF (NOTE 8)

loads exceed the specified allowable stresses for the materials of construction.

1.7 LOAD TESTS

A load test of any construction shall be conducted when required by the authority having jurisdiction whenever there is reason to question its safety for the intended occupancy or use.

1.8 CONSENSUS STANDARDS AND OTHER REFERENCED DOCUMENTS

This section lists the consensus standards and other documents which are adopted by reference within this chapter:

OSHA
Occupational Safety and Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

29 CFR 1910.1200 Appendix A with Amendments as of February 1, 2000.
Section 1.2
OSHA Standards for General Industry, 29 CFR (Code of Federal Regulations) Part 1910.1200 Appendix A, United States Department of Labor, Occupational Safety and Health Administration, Washington DC, 2005.

TABLE 1-1 OCCUPANCY CATEGORY OF BUILDINGS AND OTHER STRUCTURES FOR FLOOD, WIND, SNOW, EARTHQUAKE, AND ICE LOADS

Nature of Occupancy	Occupancy Category
Buildings and other structures that represent a low hazard to human life in the event of failure, including, but not limited to: • Agricultural facilities • Certain temporary facilities • Minor storage facilities	I
All buildings and other structures except those listed in Occupancy Categories I, III, and IV	II
Buildings and other structures that represent a substantial hazard to human life in the event of failure, including, but not limited to: • Buildings and other structures where more than 300 people congregate in one area • Buildings and other structures with daycare facilities with a capacity greater than 150 • Buildings and other structures with elementary school or secondary school facilities with a capacity greater than 250 • Buildings and other structures with a capacity greater than 500 for colleges or adult education facilities • Health care facilities with a capacity of 50 or more resident patients, but not having surgery or emergency treatment facilities • Jails and detention facilities Buildings and other structures, not included in Occupancy Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure, including, but not limited to: • Power generating stations[a] • Water treatment facilities • Sewage treatment facilities • Telecommunication centers Buildings and other structures not included in Occupancy Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released. Buildings and other structures containing toxic or explosive substances shall be eligible for classification as Occupancy Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the toxic or explosive substances does not pose a threat to the public.	III
Buildings and other structures designated as essential facilities, including, but not limited to: • Hospitals and other health care facilities having surgery or emergency treatment facilities • Fire, rescue, ambulance, and police stations and emergency vehicle garages • Designated earthquake, hurricane, or other emergency shelters • Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response • Power generating stations and other public utility facilities required in an emergency • Ancillary structures (including, but not limited to, communication towers, fuel storage tanks, cooling towers, electrical substation structures, fire water storage tanks or other structures housing or supporting water, or other fire-suppression material or equipment) required for operation of Occupancy Category IV structures during an emergency • Aviation control towers, air traffic control centers, and emergency aircraft hangars • Water storage facilities and pump structures required to maintain water pressure for fire suppression • Buildings and other structures having critical national defense functions Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing highly toxic substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction. Buildings and other structures containing highly toxic substances shall be eligible for classification as Occupancy Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2 that a release of the highly toxic substances does not pose a threat to the public. This reduced classification shall not be permitted if the buildings or other structures also function as essential facilities.	IV

[a] Cogeneration power plants that do not supply power on the national grid shall be designated Occupancy Category II.

Other Structures – Method 2		All Heights
Figure 6-22	Force Coefficients, C_f	Open Signs & Lattice Frameworks

ϵ	Flat-Sided Members	Rounded Members	
		$D\sqrt{q_z} \leq 2.5$ ($D\sqrt{q_z} \leq 5.3$)	$D\sqrt{q_z} > 2.5$ ($D\sqrt{q_z} > 5.3$)
< 0.1	2.0	1.2	0.8
0.1 to 0.29	1.8	1.3	0.9
0.3 to 0.7	1.6	1.5	1.1

Notes:

1. Signs with openings comprising 30% or more of the gross area are classified as open signs.
2. The calculation of the design wind forces shall be based on the area of all exposed members and elements projected on a plane normal to the wind direction. Forces shall be assumed to act parallel to the wind direction.
3. The area A_f consistent with these force coefficients is the solid area projected normal to the wind direction.
4. Notation:

   ϵ: ratio of solid area to gross area;

   D: diameter of a typical round member, in feet (meters);

   q_z: velocity pressure evaluated at height z above ground in pounds per square foot (N/m^2).

External Pressure Coefficients

6.5.11.2.1

	e-w	n-s	
L	48	16	(Length of Bldg parallel)
B	16	48	(Length of Bldg perp.)
h	11.5	11.5	(mean roof height [ft])

Wall

Windward

Cp	0.8	
Leeward: Wind blowing (e-w)		
L/B	3	
Cp	-0.25	interpolation for 2<L/B<4
Leeward: Wind blowing (n-s)		
L/B	0.3333	
Cp	-0.5	
Sidewalls		
Cp	-0.7	

Roof

Wind blowing (e-w), parallel to ridge for all angles

Windward:

h/L	0.239583333	<.5

				Cp	
0 to h/2	0	to	5.75	-0.9	-0.18
h/2 to h	5.75	to	11.5	-0.9	-0.18
h to 2h	11.5	to	23	-0.5	-0.18
>2h	23	to	48	-0.3	-0.18

Wind blowing (n-s), parallel to ridge for all angles

Windward:

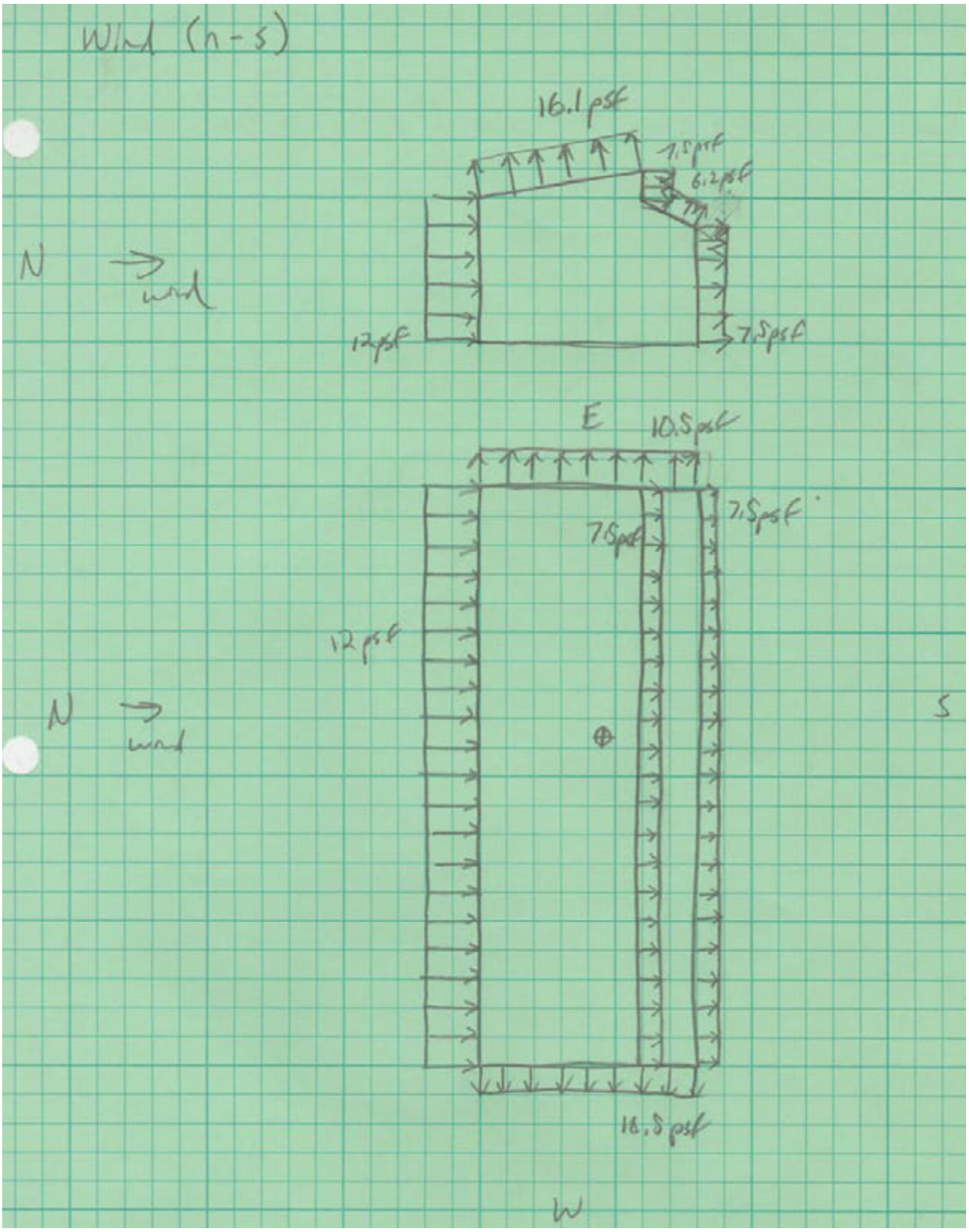
h/L	0.71875	>.5	interpolate between .5 and 1

	Cp	
10 degrees	-1.075	-0.18

Leeward:

h/L	0.71875	>.5	interpolate between .5 and 1

	Cp	
10 degrees	-0.4125	-0.18

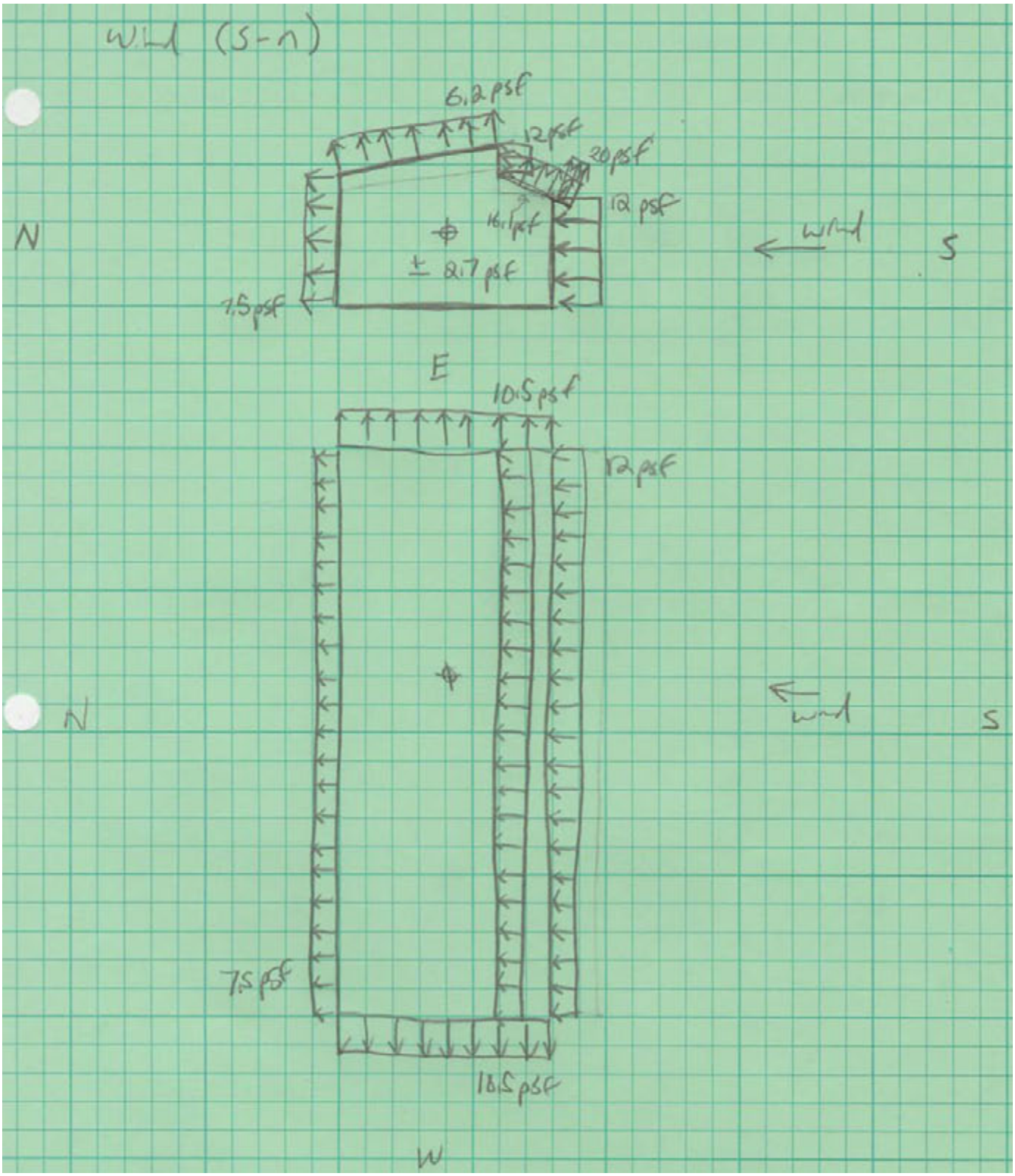

Wind (n-s)
16.1 psf
7.5 psf
6.2 psf
N
wind
12 psf
7.5 psf
E
10.5 psf
7.5 psf
7.5 psf
12 psf
N
wind
S
18.5 psf
W

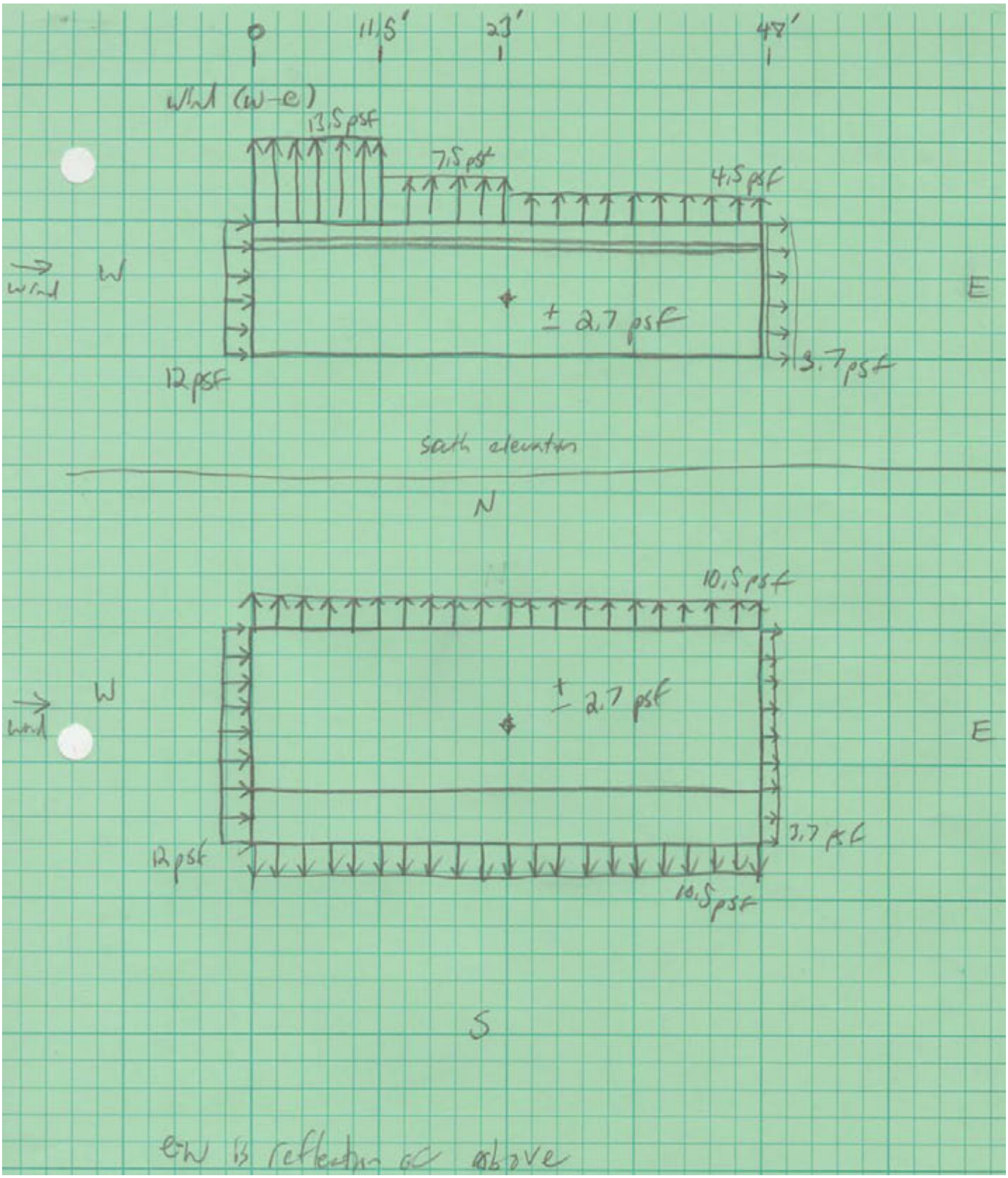
Wind Load Analysis using ASCE-07: Method 2

Overview

6.5.4	V =	90	mph	
6.5.4.4	Kd =	0.85		
6.5.5	I =	1.00		
6.5.6	Exposure Category C			
6.5.6.6	Kz =	0.85		
	Kh =	0.85		
6.5.7.2	Kzt =	1.00		
6.5.8	G =	0.85		
6.5.9	Gcpi =	0.18		Enclosed (Table 6.5)
		-0.18		

qz	14.98176	psf
qh	14.98176	psf


WLd (S-N)
6.2 psf
12 psf
20 psf
12 psf
16.1 psf
± 2.7 psf
7.5 psf
N
wind
S
E
10.5 psf
12 psf
N
wind
S
7.5 psf
18.5 psf
W


0
11.5'
23'
47'
wind (w-e)
13.5 psf
7.5 psf
4.5 psf
wind
W
E
± 2.7 psf
12 psf
3.7 psf
south elevation
N
10.5 psf
W
wind
± 2.7 psf
E
12 psf
3.7 psf
10.5 psf
S
ew is reflection of above

Summary of Design Wind Pressures

p=qGCp-qi(GCpi) psf

Walls

	p	(+/-)	
Windward	12.0	2.7	psf
Leeward			
n-s	-7.5	2.7	psf
e-w	-3.7	2.7	psf
Sidewalls	-10.5	2.7	psf

Parapets

Windward	27.0	psf
Leeward	-16.5	psf

Roof

Wind blowing e-w parallel to ridge for all angles

			p	(+/-)	
Windward					
0	to	5.75	-13.5	2.7	psf
5.75	to	11.5	-13.5	2.7	psf
11.5	to	23	-7.5	2.7	psf
23	to	48	-4.5	2.7	psf

Wind blowing n-s parallel to ridge for all angles

Windward	-16.105	2.697	psf	
Leeward	-6.18	2.697	psf	
Overhangs (Cp = .8)	11.9854	2.697	psf	***use 20psf**

A.5 Snow Load

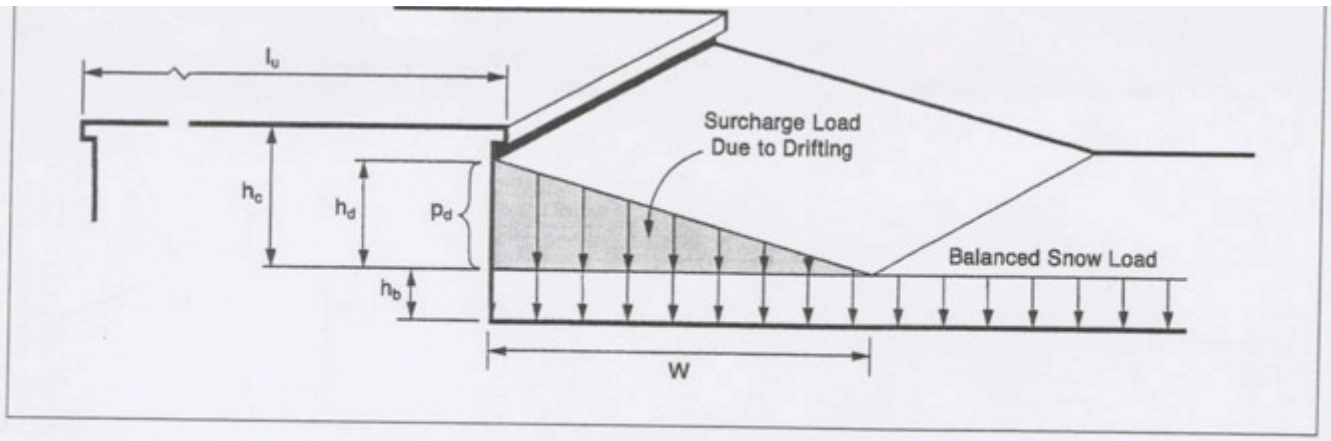
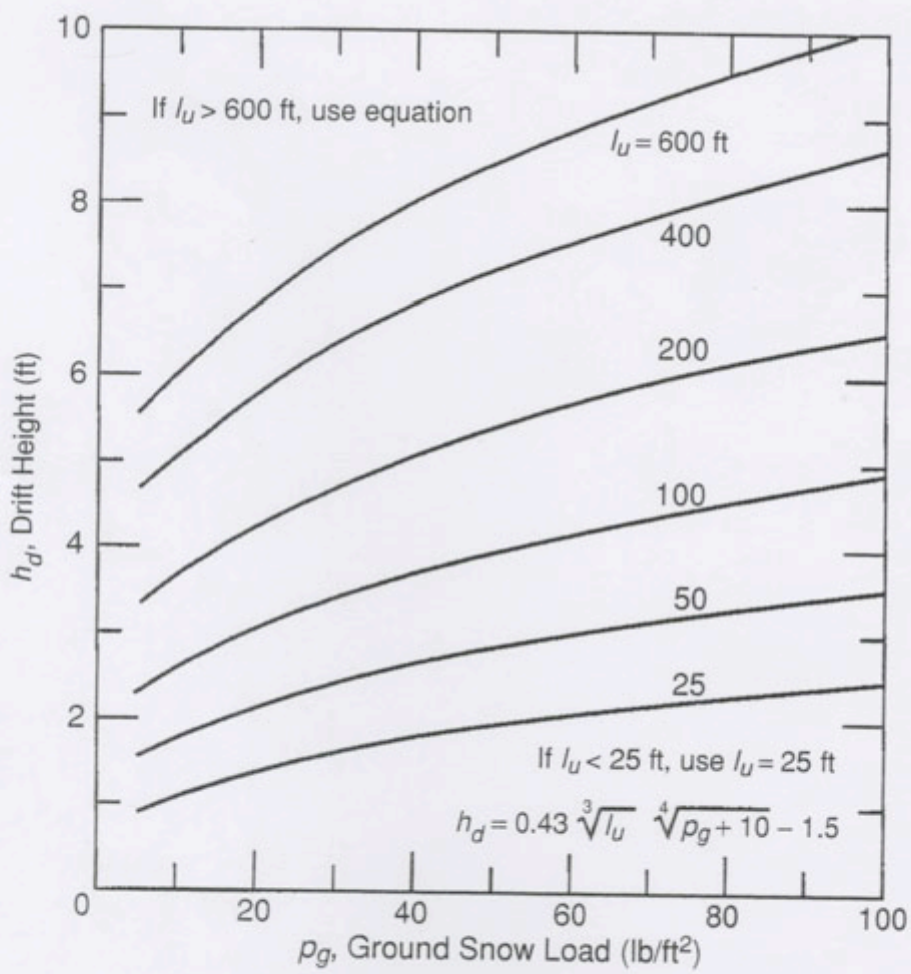


FIGURE 7-8 CONFIGURATION OF SNOW DRIFTS ON LOWER ROOFS



To convert lb/ft^2 to kN/m^2, multiply by 0.0479.
To convert ft to m, multiply by 0.3048.

FIGURE 7-9 GRAPH AND EQUATION FOR DETERMINING DRIFT HEIGHT, h_d

TABLE 7-1 GROUND SNOW LOADS, p_g, FOR ALASKAN LOCATIONS

Location	p_g lb/ft²	p_g (kN/m²)	Location	p_g lb/ft²	p_g (kN/m²)	Location	p_g lb/ft²	p_g (kN/m²)
Adak	30	(1.4)	Galena	60	(2.9)	Petersburg	150	(7.2)
Anchorage	50	(2.4)	Gulkana	70	(3.4)	St Paul	40	(1.9)
Angoon	70	(3.4)	Homer	40	(1.9)	Seward	50	(2.4)
Barrow	25	(1.2)	Juneau	60	(2.9)	Shemya	25	(1.2)
Barter	35	(1.7)	Kenai	70	(3.4)	Sitka	50	(2.4)
Bethel	40	(1.9)	Kodiak	30	(1.4)	Talkeetna	120	(5.8)
Big Delta	50	(2.4)	Kotzebue	60	(2.9)	Unalakleet	50	(2.4)
Cold Bay	25	(1.2)	McGrath	70	(3.4)	Valdez	160	(7.7)
Cordova	100	(4.8)	Nenana	80	(3.8)	Whittier	300	(14.4)
Fairbanks	60	(2.9)	Nome	70	(3.4)	Wrangell	60	(2.9)
Fort Yukon	60	(2.9)	Palmer	50	(2.4)	Yakutat	150	(7.2)

TABLE 7-2 EXPOSURE FACTOR, C_e

Terrain Category	Fully Exposed	Exposure of Roof[a] Partially Exposed	Sheltered
B (see Section 6.5.6)	0.9	1.0	1.2
C (see Section 6.5.6)	0.9	1.0	1.1
D (see Section 6.5.6)	0.8	0.9	1.0
Above the treeline in windswept mountainous areas.	0.7	0.8	N/A
In Alaska, in areas where trees do not exist within a 2-mile (3 km) radius of the site.	0.7	0.8	N/A

The terrain category and roof exposure condition chosen shall be representative of the anticipated conditions during the life of the structure. An exposure factor shall be determined for each roof of a structure.

[a]Definitions: Partially Exposed: All roofs except as indicated in the following text. Fully Exposed: Roofs exposed on all sides with no shelter[b] afforded by terrain, higher structures, or trees. Roofs that contain several large pieces of mechanical equipment, parapets that extend above the height of the balanced snow load (h_b), or other obstructions are not in this category. Sheltered: Roofs located tight in among conifers that qualify as obstructions.

[b]Obstructions within a distance of $10h_o$ provide "shelter," where h_o is the height of the obstruction above the roof level. If the only obstructions are a few deciduous trees that are leafless in winter, the "fully exposed" category shall be used. Note that these are heights above the roof. Heights used to establish the terrain category in Section 6.5.3 are heights above the ground.

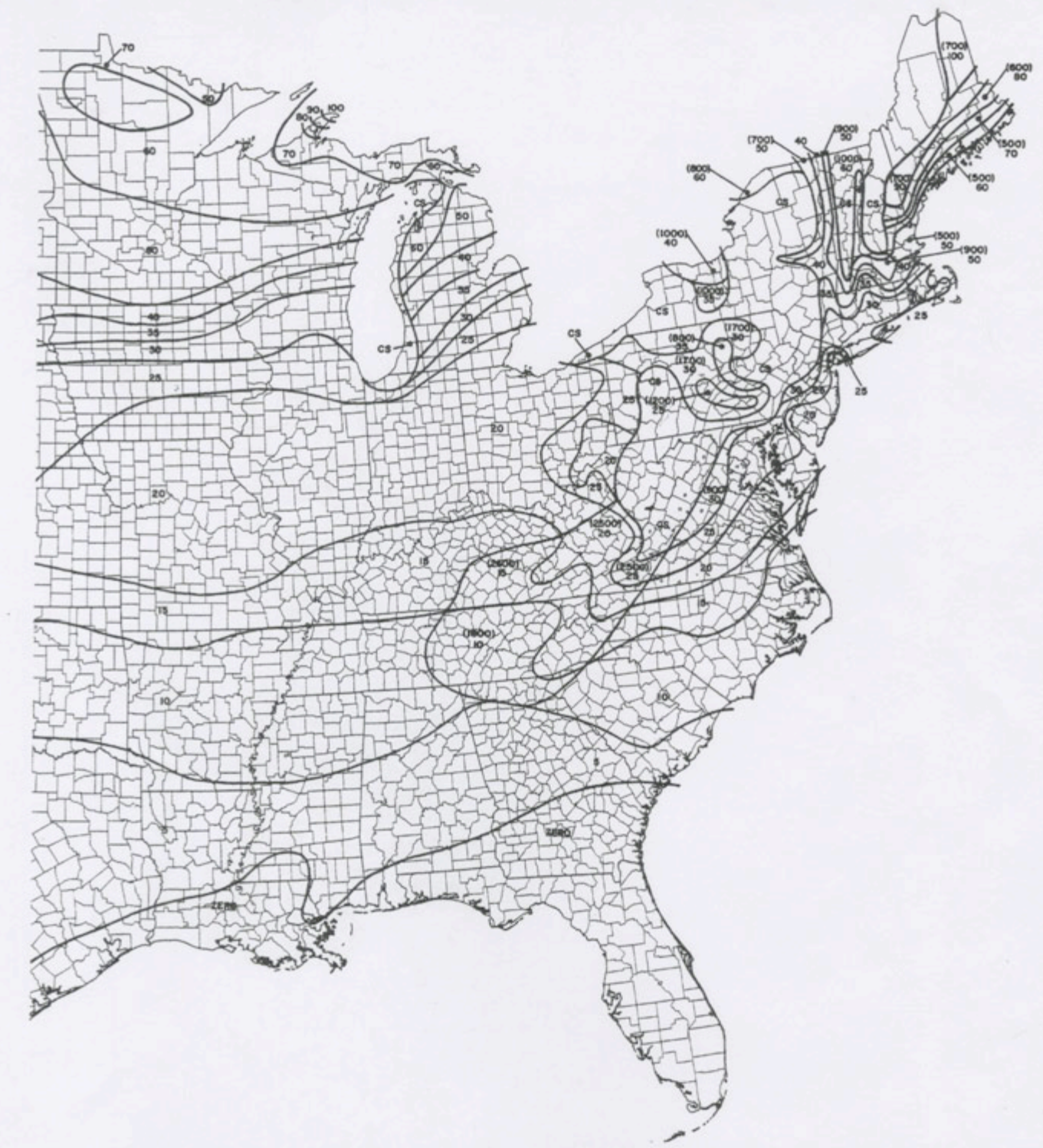


FIGURE 7-1 (continued) GROUND SNOW LOADS, p_g, FOR THE UNITED STATES (LB/FT^2)

TABLE 7-3 THERMAL FACTOR, C_t

Thermal Condition[a]	C_t
All structures except as indicated below:	1.0
Structures kept just above freezing and others with cold, ventilated roofs in which the thermal resistance (R-value) between the ventilated space and the heated space exceeds 25 °F× h× ft^2/Btu (4.4 K × m^2/W).	1.1
Unheated structures and structures intentionally kept below freezing.	1.2
Continuously heated greenhouses[b] with a roof having a thermal resistance (R-value) less than 2.0 °F× h× ft^2/Btu (0.4 K × m^2/W)	0.85

[a] These conditions shall be representative of the anticipated conditions during winters for the life of the structure.

[b] Greenhouses with a constantly maintained interior temperature of 50 °F (10 °C) or more at any point 3 ft above the floor level during winters and having either a maintenance attendant on duty at all times or a temperature alarm system to provide warning in the event of a heating failure.

TABLE 7-4 IMPORTANCE FACTOR, I (SNOW LOADS)

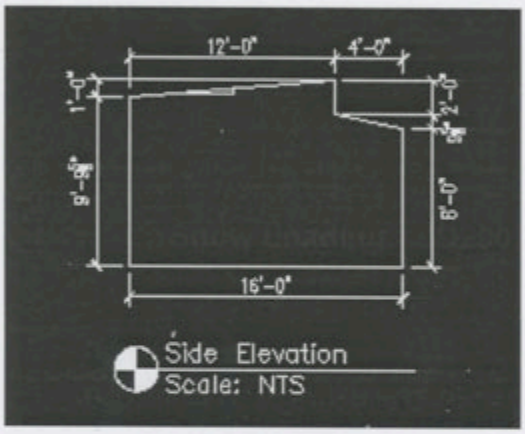
Category[a]	I
I	0.8
II	1.0
III	1.1
IV	1.2

[a] See Section 1.5 and Table 1-1.

Snow Loading - SD2009

General

$pg := 30psf$	Ground Snow Load	ASCE 7-05 Figure 7-1
$Ce := 1.0$	Exposure Factor, Exposure C, Partial	ASCE 7-05 Table 7-2
$Ct := 1.0$	Thermal Factor, Case I	ASCE 7-05 Table 7-3
$I := 1.0$	Importance Factor, Category II	ASCE 7-05 Table 7-4
$pf := 0.7 \cdot Ce \cdot Ct \cdot I \cdot pg$ $pf = 21\,psf$	Flat Roof Snow Load	ASCE 7-05 (7-1)
$Cs := 0.9$	Sloped Roof Factor	ASCE 7-05 §7.4.1, Fig. 7-2a
$ps := Cs \cdot pf$ $ps = 18.9\,psf$	Sloped Roof Snow Load	ASCE 7-05 (7-2)



Note: Higher Roof is considered Flat, as θ<5° (4.76°)
Note: Lower Roof is considered Sloped, θ=11.3°>5°

Drifts on Lower Roofs/Aerodynamic Shade

Windward Drift (Right-Left Wind) ASCE 7-05 Figure 7-8:

$\gamma := 0.13 \cdot ft^{-1} \cdot pg + 14pcf = 17.9\,pcf$ $\quad \gamma < 30pcf$ — ASCE 7-05 (7-3)

$hb := \frac{ps}{\gamma} = 1.056\,ft$ — ASCE 7-05 §7.7.1

$hc := 2ft - hb = 0.944\,ft$

$\frac{hc}{hb} = 0.894$ Therefore Drift must be considered (>0.2) — ASCE 7-05 §7.7.1

$lulower := 4ft$ Lower Roof Length (Horizontal Projection), use 0.75hd

$luupper := 12ft$ Upper Roof Length (Horizontal Projection), use 1.0 hd

$hdl := 0.43 \cdot ft^{\left(\frac{2}{3}\right)} \cdot (1psf)^{(-.25)}\, lulower^{\left(\frac{1}{3}\right)} \cdot (pg + 10psf)^{0.25} - 1.5ft = 0.217\,ft$

JUST A CONVERSION TO END UNITS

$0.75hdl = 0.162\,ft$

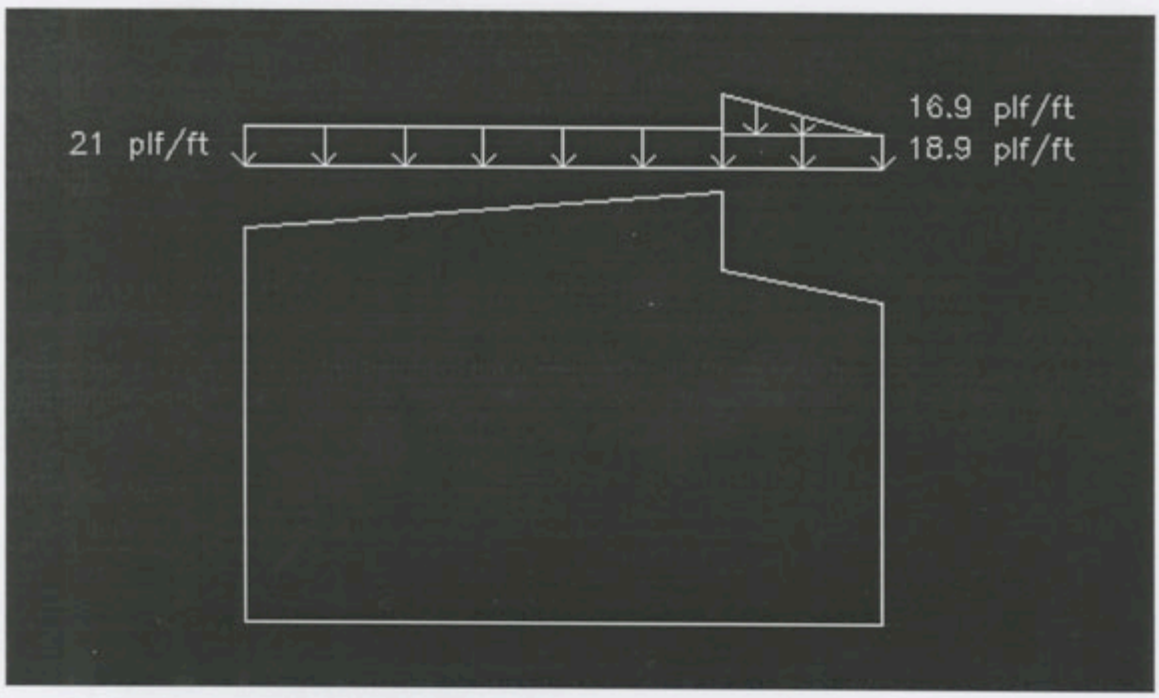
$$hdu := 0.43 \cdot ft^{\left(\frac{2}{3}\right)} \cdot (1psf)^{(-.25)}\, luupper^{\left(\frac{1}{3}\right)} \cdot (pg + 10psf)^{0.25} - 1.5ft = 0.976\,ft$$

Therefore, hdu governs as the height of the triangular load. Since hdu>hc, hdu is taken as hc and w=4hd^2/hc<8hc

$hd := hc = 0.944\,ft$

$$w := 4 \cdot \frac{hd^2}{hc} = 3.777\,ft$$

$pd := hd \cdot \gamma = 16.9\,psf$



B. Load Simulation

B.1 Computer Model Setup

Three models were made. The first model used rigid connections to find the greatest moments in each member to test for ultimate strength. The second used more realistic connections with moment release to test of deflections. The third was used to evaluate resistance to roll. Models were simulated using STAAD 2009.

B.1.1 Input Command Files

B.1.1.1 Model 1 - All Moments

```
STAAD PLANE

START JOB INFORMATION

JOB NAME f

ENGINEER DATE 14-Nov-08

END JOB INFORMATION

INPUT WIDTH 79

UNIT FEET POUND

JOINT COORDINATES

1 10.5 10.208 0; 2 0 9.333 0; 4 10.5 9.042 0; 5 14.5 8.5 0; 6 5.25 9.771 0;

8 0 0 0; 9 14.5 0 0;

MEMBER INCIDENCES

1 1 6; 3 1 4; 4 4 5; 6 6 4; 7 6 2; 10 2 8; 11 5 9;

SUPPORTS

8 9 FIXED

DEFINE MATERIAL START

ISOTROPIC EAWP_N1_6X8_BM

E 1.584e+008

POISSON 0.15

DENSITY 25
```

```
ALPHA 5.5e-006
ISOTROPIC EAWP_N1_6X10_BM
E 1.584e+008
POISSON 0.15
DENSITY 25
ALPHA 5.5e-006
END DEFINE MATERIAL
MEMBER PROPERTY AITC
10 11 TABLE ST EAWP_N1_6X8_BM
1 3 4 6 7 TABLE ST EAWP_N1_6X10_BM
LOAD 1 LOADTYPE None  TITLE DEAD + SNOW
MEMBER LOAD
4 UNI GY -50 0 4.03655
1 UNI GY -370 0 5.26816
7 UNI GY -370 0 5.26824
4 UNI GY -151.2 0 4.03655
1 UNI GY -168 0 5.26816
7 UNI GY -168 0 5.26824
4 TRAP GY -135.2 0 0 4.03655
LOAD 2 LOADTYPE None  TITLE DEAD + WIND(N-S)
MEMBER LOAD
4 UNI GY -50 0 4.03655
7 UNI GY -370 0 5.26824
1 UNI GY -370 0 5.26816
11 UNI Y 60 0 8.5
3 UNI Y 60 0 1.166
```

10 UNI Y 96 0 9.333

7 UNI Y 128.8 0 5.26824

1 UNI Y 128.8 0 5.26816

4 UNI Y 49.6 0 4.03655

LOAD 3 LOADTYPE None TITLE DEAD + SNOW + WIND(N-S)

MEMBER LOAD

4 UNI GY -50 0 4.03655

1 UNI GY -370 0 5.26816

7 UNI GY -370 0 5.26824

4 UNI GY -151.2 0 4.03655

1 UNI GY -168 0 5.26816

7 UNI GY -168 0 5.26824

4 TRAP GY -135.2 0 0 4.03655

11 UNI Y 60 0 8.5

3 UNI Y 60 0 1.166

10 UNI Y 96 0 9.333

7 UNI Y 128.8 0 5.26824

1 UNI Y 128.8 0 5.26816

4 UNI Y 49.6 0 4.03655

LOAD 4 LOADTYPE None TITLE DEAD + WIND(S-N)

MEMBER LOAD

4 UNI GY -50 0 4.03655

7 UNI GY -370 0 5.26824

1 UNI GY -370 0 5.26816

11 UNI Y -96 0 8.5

3 UNI Y -96 0 1.166

10 UNI Y -60 0 9.333

7 UNI Y 49.6 0 5.26824

1 UNI Y 49.6 0 5.26816

4 UNI Y 128.8 0 4.03655

LOAD 5 LOADTYPE None TITLE DEAD + SNOW + WIND(S-N)

MEMBER LOAD

4 UNI GY -50 0 4.03655

1 UNI GY -370 0 5.26816

7 UNI GY -370 0 5.26824

4 UNI GY -151.2 0 4.03655

1 UNI GY -168 0 5.26816

7 UNI GY -168 0 5.26824

4 TRAP GY -135.2 0 0 4.03655

11 UNI Y -96 0 8.5

3 UNI Y -96 0 1.166

10 UNI Y -60 0 9.333

7 UNI Y 49.6 0 5.26824

1 UNI Y 49.6 0 5.26816

4 UNI Y 128.8 0 4.03655

LOAD 6 LOADTYPE None TITLE TRANSPORTATION + WIND(N-S)

MEMBER LOAD

4 UNI GY -50 0 4.03655

7 UNI GY -50 0 5.26824

1 UNI GY -50 0 5.26816

11 UNI Y 60 0 8.5

3 UNI Y 60 0 1.166

```
10 UNI Y 96 0 9.333
7 UNI Y 128.8 0 5.26824
1 UNI Y 128.8 0 5.26816
4 UNI Y 49.6 0 4.03655
LOAD 7 LOADTYPE None  TITLE TRANSPORTATION + WIND(S-N)
MEMBER LOAD
4 UNI GY -50 0 4.03655
7 UNI GY -50 0 5.26824
1 UNI GY -50 0 5.26816
11 UNI Y -96 0 8.5
3 UNI Y -96 0 1.166
10 UNI Y -60 0 9.333
7 UNI Y 49.6 0 5.26824
1 UNI Y 49.6 0 5.26816
4 UNI Y 128.8 0 4.03655
PERFORM ANALYSIS PRINT ALL
FINISH
```

B.1.1.2 Model 2 - Moment Releases

```
STAAD PLANE

START JOB INFORMATION

JOB NAME f

ENGINEER DATE 14-Nov-08

END JOB INFORMATION

INPUT WIDTH 79

UNIT FEET POUND

JOINT COORDINATES

1 10.5 10.208 0; 2 0 9.333 0; 4 10.5 9.042 0; 5 14.5 8.5 0; 6 5.25 9.771 0;

8 0 0 0; 9 14.5 0 0;

MEMBER INCIDENCES

1 1 6; 3 1 4; 4 4 5; 6 6 4; 7 6 2; 10 2 8; 11 5 9;

SUPPORTS

8 9 FIXED

DEFINE MATERIAL START

ISOTROPIC EAWP_N1_6X8_BM

E 1.584e+008

POISSON 0.15

DENSITY 25

ALPHA 5.5e-006

ISOTROPIC EAWP_N1_6X10_BM

E 1.584e+008

POISSON 0.15

DENSITY 25

ALPHA 5.5e-006
```

```
END DEFINE MATERIAL

MEMBER PROPERTY AITC

10 11 TABLE ST EAWP_N1_6X8_BM

1 3 4 6 7 TABLE ST EAWP_N1_6X10_BM

MEMBER RELEASE

1 START MX MY MZ

3 START MX MY MZ

3 END MX MY MZ

11 END MPX 0.1 MPY 0.1 MPZ 0.1

LOAD 1 LOADTYPE None  TITLE DEAD + SNOW

MEMBER LOAD

4 UNI GY -50 0 4.03655

1 UNI GY -370 0 5.26816

7 UNI GY -370 0 5.26824

4 UNI GY -151.2 0 4.03655

1 UNI GY -168 0 5.26816

7 UNI GY -168 0 5.26824

4 TRAP GY -135.2 0 0 4.03655

LOAD 2 LOADTYPE None  TITLE DEAD + WIND(N-S)

MEMBER LOAD

4 UNI GY -50 0 4.03655

7 UNI GY -370 0 5.26824

1 UNI GY -370 0 5.26816

11 UNI Y 60 0 8.5

3 UNI Y 60 0 1.166

10 UNI Y 96 0 9.333
```

7 UNI Y 128.8 0 5.26824

1 UNI Y 128.8 0 5.26816

4 UNI Y 49.6 0 4.03655

LOAD 3 LOADTYPE None TITLE DEAD + SNOW + WIND(N-S)

MEMBER LOAD

4 UNI GY -50 0 4.03655

1 UNI GY -370 0 5.26816

7 UNI GY -370 0 5.26824

4 UNI GY -151.2 0 4.03655

1 UNI GY -168 0 5.26816

7 UNI GY -168 0 5.26824

4 TRAP GY -135.2 0 0 4.03655

11 UNI Y 60 0 8.5

3 UNI Y 60 0 1.166

10 UNI Y 96 0 9.333

7 UNI Y 128.8 0 5.26824

1 UNI Y 128.8 0 5.26816

4 UNI Y 49.6 0 4.03655

LOAD 4 LOADTYPE None TITLE DEAD + WIND(S-N)

MEMBER LOAD

4 UNI GY -50 0 4.03655

7 UNI GY -370 0 5.26824

1 UNI GY -370 0 5.26816

11 UNI Y -96 0 8.5

3 UNI Y -96 0 1.166

10 UNI Y -60 0 9.333

7 UNI Y 49.6 0 5.26824

1 UNI Y 49.6 0 5.26816

4 UNI Y 128.8 0 4.03655

LOAD 5 LOADTYPE None TITLE DEAD + SNOW + WIND(S-N)

MEMBER LOAD

4 UNI GY -50 0 4.03655

1 UNI GY -370 0 5.26816

7 UNI GY -370 0 5.26824

4 UNI GY -151.2 0 4.03655

1 UNI GY -168 0 5.26816

7 UNI GY -168 0 5.26824

4 TRAP GY -135.2 0 0 4.03655

11 UNI Y -96 0 8.5

3 UNI Y -96 0 1.166

10 UNI Y -60 0 9.333

7 UNI Y 49.6 0 5.26824

1 UNI Y 49.6 0 5.26816

4 UNI Y 128.8 0 4.03655

LOAD 6 LOADTYPE None TITLE TRANSPORTATION + WIND(N-S)

MEMBER LOAD

4 UNI GY -50 0 4.03655

7 UNI GY -50 0 5.26824

1 UNI GY -50 0 5.26816

11 UNI Y 60 0 8.5

3 UNI Y 60 0 1.166

10 UNI Y 96 0 9.333

```
7 UNI Y 128.8 0 5.26824

1 UNI Y 128.8 0 5.26816

4 UNI Y 49.6 0 4.03655

LOAD 7 LOADTYPE None  TITLE TRANSPORTATION + WIND(S-N)

MEMBER LOAD

4 UNI GY -50 0 4.03655

7 UNI GY -50 0 5.26824

1 UNI GY -50 0 5.26816

11 UNI Y -96 0 8.5

3 UNI Y -96 0 1.166

10 UNI Y -60 0 9.333

7 UNI Y 49.6 0 5.26824

1 UNI Y 49.6 0 5.26816

4 UNI Y 128.8 0 4.03655

PERFORM ANALYSIS PRINT ALL

FINISH
```

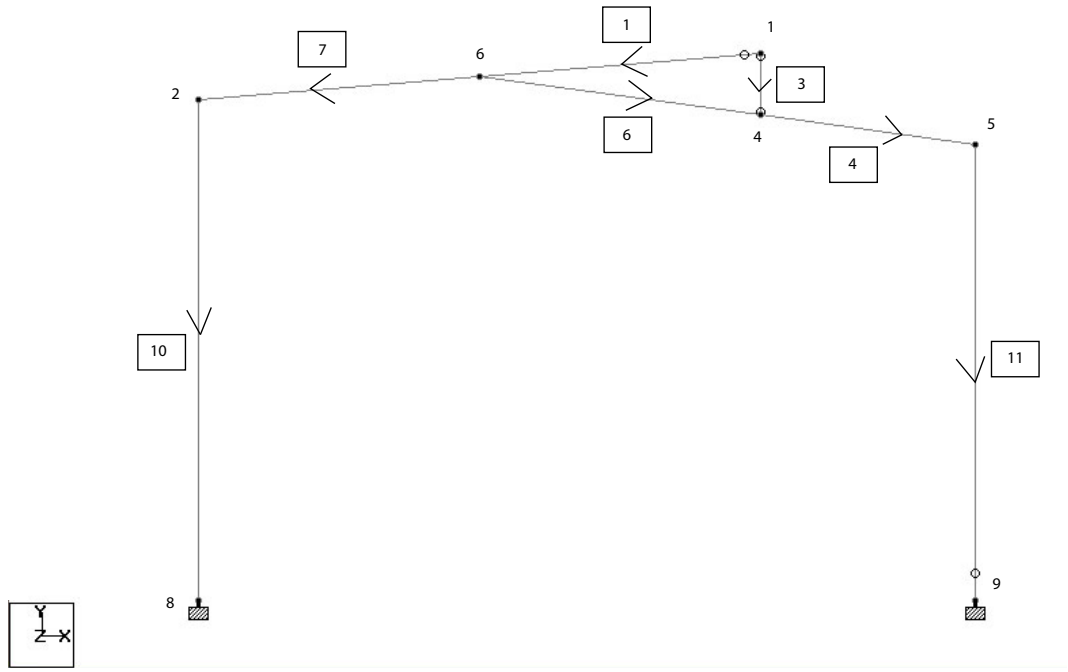
B.1.1.3 Model 3 - Resistance to Roll

```
STAAD PLANE
START JOB INFORMATION
JOB NAME f
ENGINEER DATE 14-Nov-08
END JOB INFORMATION
INPUT WIDTH 79
UNIT FEET POUND
JOINT COORDINATES
1 10.5 10.208 0; 2 0 9.333 0; 4 10.5 9.042 0; 5 14.5 8.5 0; 6 5.25 9.771 0;
8 0 0 0; 9 14.5 0 0; 10 0 -1.5 0; 11 14.5 -1.5 0; 12 7.25 0 0; 13 7.25 -1.5 0;
MEMBER INCIDENCES
1 1 6; 3 1 4; 4 4 5; 6 6 4; 7 6 2; 10 2 8; 11 5 9; 12 8 12; 13 8 10; 14 9 11;
15 12 9; 16 12 13;
SUPPORTS
10 11 13 PINNED
DEFINE MATERIAL START
ISOTROPIC EAWP_N1_6X8_BM
E 1.584e+008
POISSON 0.15
DENSITY 25
ALPHA 5.5e-006
ISOTROPIC EAWP_N1_6X10_BM
E 1.584e+008
POISSON 0.15
DENSITY 25
```

```
ALPHA 5.5e-006

END DEFINE MATERIAL

MEMBER PROPERTY AITC

10 TO 16 TABLE ST EAWP_N1_6X8_BM

1 3 4 6 7 TABLE ST EAWP_N1_6X10_BM

MEMBER RELEASE

1 START MX MY MZ

3 START MX MY MZ

3 END MX MY MZ

11 END MPX 0.1 MPY 0.1 MPZ 0.1

15 END MX MY MZ

16 START MX MY MZ

LOAD 2 LOADTYPE None  TITLE DEAD + WIND(N-S)

MEMBER LOAD

4 UNI GY -50 0 4.03655

7 UNI GY -100 0 5.26824

1 UNI GY -100 0 5.26816

11 UNI Y 60 0 8.5

3 UNI Y 60 0 1.166

10 UNI Y 96 0 9.333

7 UNI Y 128.8 0 5.26824

1 UNI Y 128.8 0 5.26816

4 UNI Y 49.6 0 4.03655

15 UNI GY -45 0 7.25

12 UNI GY -45 0 7.25

JOINT LOAD
```

```
5 FY -400

2 FY -560

8 9 FY -1750

LOAD 4 LOADTYPE None  TITLE DEAD + WIND(S-N)

MEMBER LOAD

4 UNI GY -50 0 4.03655

7 UNI GY -370 0 5.26824

1 UNI GY -370 0 5.26816

11 UNI Y -96 0 8.5

3 UNI Y -96 0 1.166

10 UNI Y -60 0 9.333

7 UNI Y 49.6 0 5.26824

1 UNI Y 49.6 0 5.26816

4 UNI Y 128.8 0 4.03655

15 UNI GY -45 0 7.25

12 UNI GY -45 0 7.25

JOINT LOAD

5 FY -400

2 FY -560

8 9 FY -1750

PERFORM ANALYSIS PRINT ALL

FINISH
```

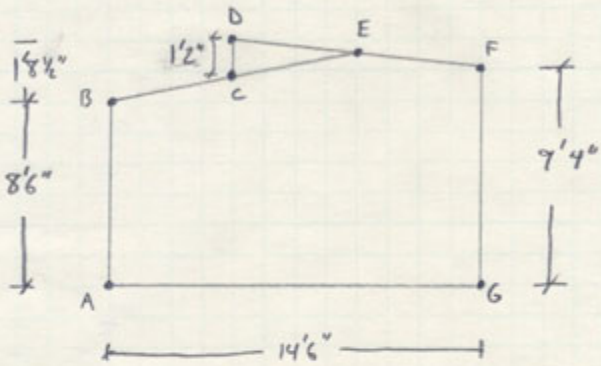
B.1.2 Geometry



Computer Model | Dimensions | SD 2009

Centerline Dimensioning for Computer Model:

nodes: ← 4' → ← 5'3" → ← 5'3" →



coordinates:

A ~ (0,0)
B ~ (0, 8'6")
C ~ (4', 9'½")
D ~ (4', 10'2½")
E ~ (9'3", 9'9¼")
F ~ (14'6", 9'4")
G ~ (14'6", 0)

Lengths:

AB ~ 8.5 ft
BC ~ 4.03655 ft
CE ~ 5.30037 ft
CD ~ 1.166 ft
DE ~ 5.26816 ft
EF ~ 5.2824 ft
FG ~ 9.333 ft

I initially make all connections rigid to size members to a maximum fracture state. (w/ 1-hour fire protection)

I then applied releases to all member-member connections except B, F, G to limit deflections to 1/360.

Material is Eastern White Pine No. 2

B.1.3 Load Cases

B.1.3.1 Dead + Snow

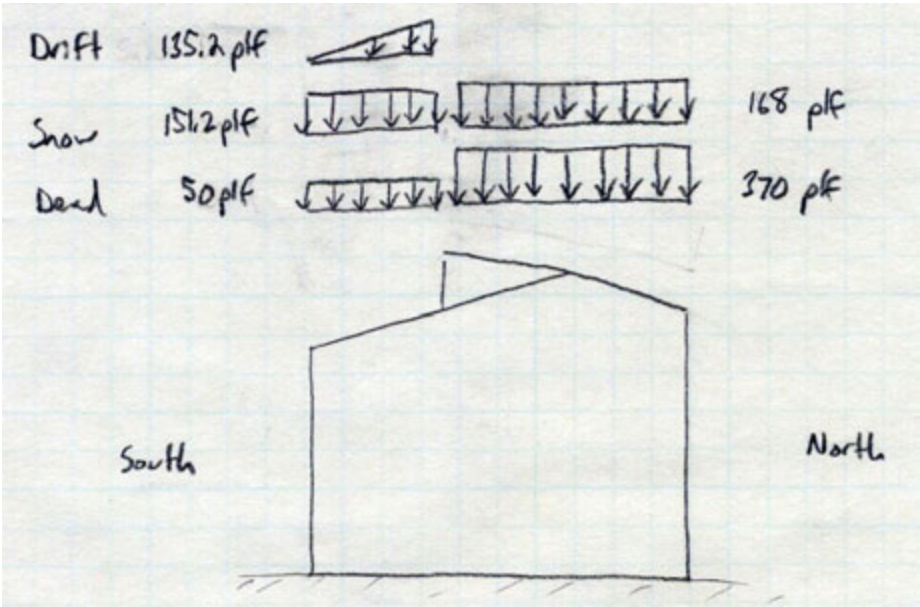


Figure 2: Load Case 1: Dead + Snow

B.1.3.3 Dead + Wind (N-S)

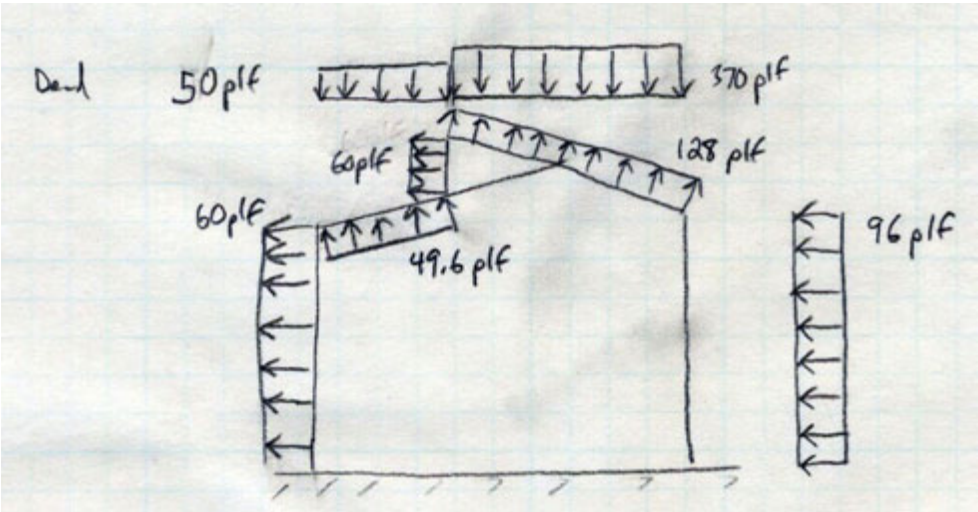


Figure 4: Load Case 2: Dead + Wind (N-S)

B.1.3.5 Dead + Snow + Wind (N-S)

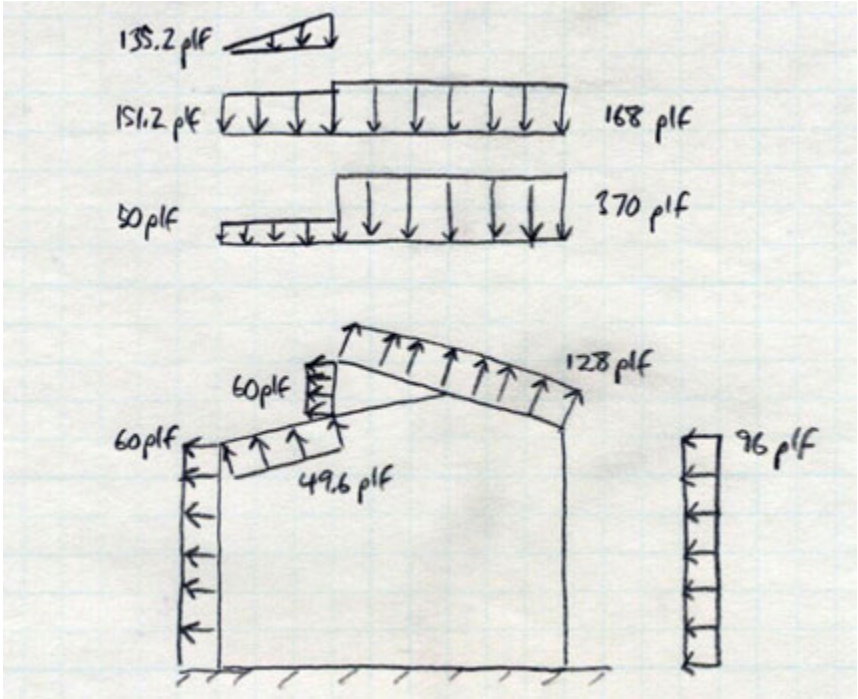


Figure 6: Load Case 3: Dead + Snow + Wind (N-S)

B.1.3.7 Dead + Wind (S-N)

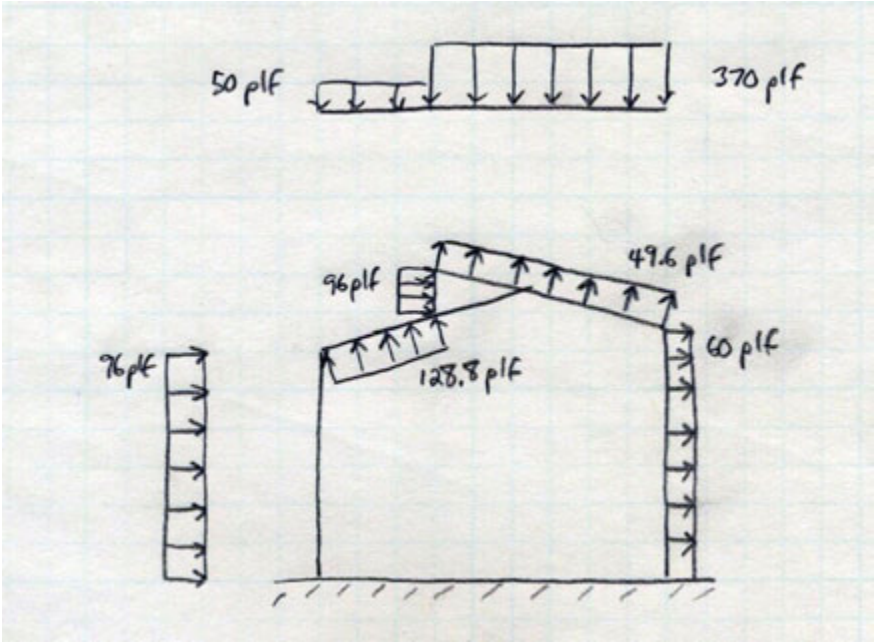


Figure 8: Load Case 4: Dead + Wind (S-N)

B.1.3.9 Dead + Snow + Wind (S-N)

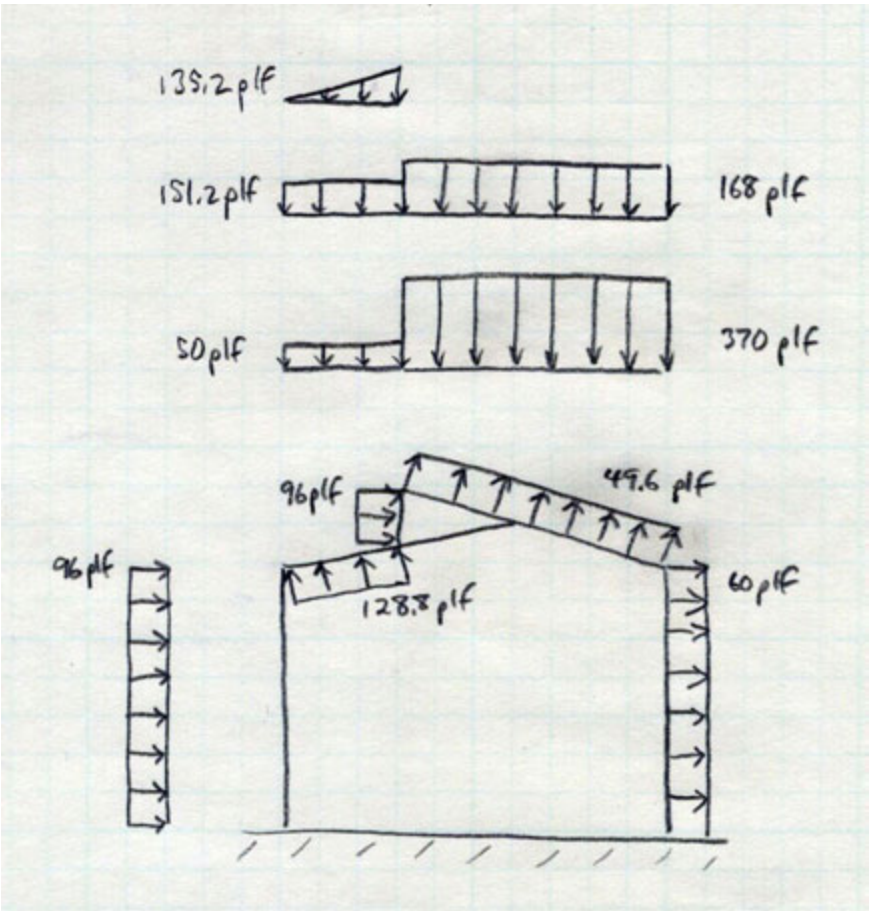


Figure 10: Load Case 5: Dead + Snow + Wind (S-N)

B.1.3.11 Transportation + Wind (N-S)

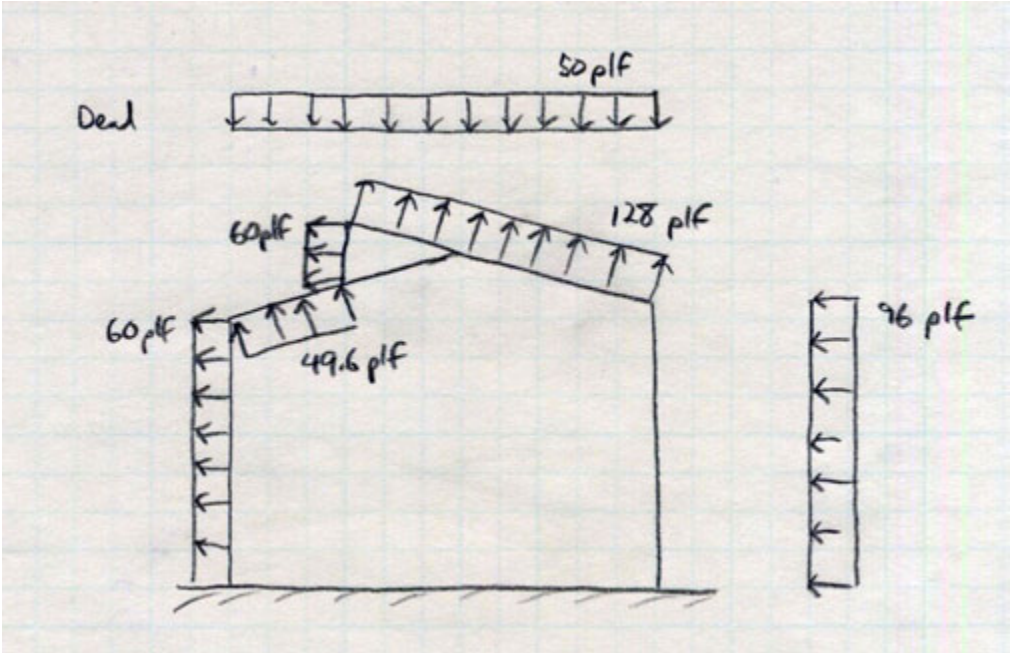


Figure 12: Load Case 6: Transportatin + Wind (N-S)

B.1.3.13 Transportation + Wind (S-N)

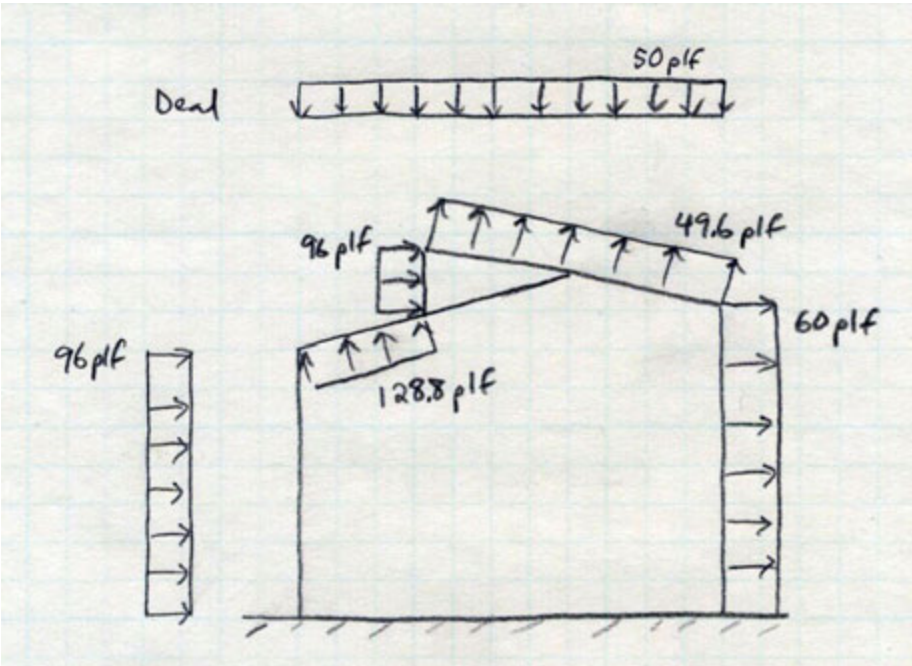


Figure 14: Load Case 7: Transportation + Wind (S-N)

B.2 Member Force Output

Beam	L/C	Dist ft	Axial Fx lb	Flexure Mz kip-in	Shear Fy lb
1	1 DEAD + SNOW	0	4227.456	21.583	2319.224
		1.211	4279.234	-7.398	1669.858
		2.422	4331.014	-26.943	1020.492
		3.632	4382.792	-37.054	371.126
		4.843	4434.571	-37.728	-278.065
	2 DEAD + WIND(N-S)	0	1339.333	9.72	1006.612
		1.211	1374.943	-2.795	715.977
		2.422	1410.553	-11.086	425.342
		3.632	1446.163	-15.155	134.707
		4.843	1481.773	-15.001	-155.849
	3 DEAD + SNOW + WIND(N-S)	0	2928.616	16.587	1755.407
		1.211	2980.395	-5.335	1261.996
		2.422	3032.174	-20.087	768.585
		3.632	3083.952	-27.67	275.174
		4.843	3135.731	-28.083	-218.104
	4 DEAD + WIND(S-N)	0	2385.761	12.283	1338.673
		1.211	2421.371	-4.359	952.14
		2.422	2456.981	-15.386	565.607
		3.632	2492.591	-20.796	179.075
		4.843	2528.201	-20.59	-207.354
	5 DEAD + SNOW + WIND(S-N)	0	3975.662	19.151	2087.575
		1.211	4027.441	-6.9	1498.266
		2.422	4079.22	-24.389	908.957
		3.632	4130.999	-33.315	319.649
		4.843	4182.778	-33.678	-269.502
	6 TRANSPORTATION + WIND(N-S)	0	-865.793	-2.972	-344.683
		1.211	-860.981	1.342	-249.078
		2.422	-856.168	4.266	-153.473
		3.632	-851.356	5.802	-57.868
		4.843	-846.544	5.948	37.712
	7 TRANSPORTATION + WIND(S-N)	0	181.254	-0.408	-12.515
		1.211	186.066	-0.224	-12.808
		2.422	190.878	-0.036	-13.101
		3.632	195.69	0.157	-13.393
		4.843	200.502	0.354	-13.686
3	1 DEAD + SNOW	0	1975.841	21.583	4398.435
		0.318	1975.841	4.811	4398.435
		0.635	1975.841	-11.96	4398.435
		0.953	1975.841	-28.731	4398.435
		1.271	1975.841	-45.502	4398.435
	2 DEAD + WIND(N-S)	0	896.962	9.72	1415.111

		0.318	896.962	4.288	1434.176
		0.635	896.962	-1.217	1453.241
		0.953	896.962	-6.795	1472.306
		1.271	896.962	-12.445	1491.371
	3 DEAD + SNOW + WIND(N-S)	0	1517.054	16.587	3058.887
		0.318	1517.054	4.887	3077.952
		0.635	1517.054	-6.886	3097.017
		0.953	1517.054	-18.731	3116.082
		1.271	1517.054	-30.649	3135.147
	4 DEAD + WIND(S-N)	0	1144.791	12.283	2484.623
		0.318	1144.791	2.868	2454.119
		0.635	1144.791	-6.432	2423.615
		0.953	1144.791	-15.615	2393.111
		1.271	1144.791	-24.682	2362.607
	5 DEAD + SNOW + WIND(S-N)	0	1764.94	19.151	4129.025
		0.318	1764.94	3.465	4098.52
		0.635	1764.94	-12.105	4068.017
		0.953	1764.94	-27.558	4037.512
		1.271	1764.94	-42.895	4007.008
	6 TRANSPORTATION + WIND(N-S)	0	-274.77	-2.972	-890.452
		0.318	-274.77	0.387	-871.387
		0.635	-274.77	3.673	-852.322
		0.953	-274.77	6.887	-833.257
		1.271	-274.77	10.028	-814.192
	7 TRANSPORTATION + WIND(S-N)	0	-26.883	-0.408	179.685
		0.318	-26.883	-1.035	149.181
		0.635	-26.883	-1.546	118.677
		0.953	-26.883	-1.94	88.173
		1.271	-26.883	-2.218	57.669
4	1 DEAD + SNOW	0	1280.442	-47.86	-1867.042
		0.94	1325.933	-25.108	-2162.42
		1.88	1371.423	0.799	-2426.549
		2.82	1416.913	29.51	-2659.431
		3.759	1462.403	60.67	-2860.974
	2 DEAD + WIND(N-S)	0	657.905	-9.429	-1003.964
		0.94	666.367	1.892	-1003.572
		1.88	674.828	13.209	-1003.179
		2.82	683.29	24.521	-1002.787
		3.759	691.751	35.828	-1002.395
	3 DEAD + SNOW + WIND(N-S)	0	1088.525	-30.144	-1517.65
		0.94	1134.015	-11.595	-1766.41
		1.88	1179.506	9.583	-1983.922
		2.82	1224.996	33.038	-2170.187

	3.759	1270.486	58.418	-2325.135
4 DEAD + WIND(S-N)	0	562.548	-25.891	-1104.599
	0.94	571.01	-13.855	-1029.769
	1.88	579.471	-2.663	-954.939
	2.82	587.932	7.685	-880.11
	3.759	596.394	17.189	-805.317
5 DEAD + SNOW + WIND(S-N)	0	992.735	-46.619	-1618.232
	0.94	1038.225	-27.356	-1792.555
	1.88	1083.716	-6.302	-1935.63
	2.82	1129.206	16.189	-2047.457
	3.759	1174.696	39.764	-2128.004
6 TRANSPORTATION + WIND(N-S)	0	-68.111	12.405	186.385
	0.94	-59.65	10.3	186.778
	1.88	-51.188	8.192	187.17
	2.82	-42.727	6.079	187.562
	3.759	-34.265	3.961	187.954
7 TRANSPORTATION + WIND(S-N)	0	-163.901	-4.07	85.803
	0.94	-155.44	-5.46	160.633
	1.88	-146.978	-7.693	235.462
	2.82	-138.517	-10.771	310.292
	3.759	-130.055	-14.693	385.085
6 1 DEAD + SNOW	0	-3401.59	-44.593	-717.019
	1.227	-3401.59	-34.034	-717.019
	2.454	-3401.59	-23.475	-717.019
	3.681	-3401.59	-12.917	-717.019
	4.909	-3401.59	-2.358	-717.019
2 DEAD + WIND(N-S)	0	-970.443	-19.994	-390.644
	1.227	-970.443	-14.241	-390.644
	2.454	-970.443	-8.489	-390.644
	3.681	-970.443	-2.736	-390.644
	4.909	-970.443	3.016	-390.644
3 DEAD + SNOW + WIND(N-S)	0	-2268.306	-34.303	-590.938
	1.227	-2268.306	-25.601	-590.938
	2.454	-2268.306	-16.899	-590.938
	3.681	-2268.306	-8.197	-590.938
	4.909	-2268.306	0.505	-590.938
4 DEAD + WIND(S-N)	0	-1967.416	-25.055	-404.818
	1.227	-1967.416	-19.093	-404.818
	2.454	-1967.416	-13.132	-404.818
	3.681	-1967.416	-7.171	-404.818
	4.909	-1967.416	-1.21	-404.818
5 DEAD + SNOW + WIND(S-N)	0	-3266.338	-39.368	-605.117
	1.227	-3266.338	-30.457	-605.117

		2.454	-3266.338	-21.546	-605.117
		3.681	-3266.338	-12.635	-605.117
		4.909	-3266.338	-3.724	-605.117
	6 TRANSPORTATION + WIND(N-S)	0	782.224	6.092	63.06
		1.227	782.224	5.163	63.06
		2.454	782.224	4.234	63.06
		3.681	782.224	3.306	63.06
		4.909	782.224	2.377	63.06
	7 TRANSPORTATION + WIND(S-N)	0	-215.807	1.027	48.882
		1.227	-215.807	0.307	48.882
		2.454	-215.807	-0.413	48.882
		3.681	-215.807	-1.132	48.882
		4.909	-215.807	-1.852	48.882
7	1 DEAD + SNOW	0	965.322	-82.321	-458.842
		1.518	1034.046	-66.545	-1272.836
		3.037	1102.769	-35.938	-2086.83
		4.555	1171.493	9.501	-2900.824
		6.074	1240.216	69.772	-3714.531
	2 DEAD + WIND(N-S)	0	443.514	-34.995	-26.859
		1.518	490.777	-31.187	-391.101
		3.037	538.041	-20.743	-755.343
		4.555	585.304	-3.662	-1119.586
		6.074	632.567	20.056	-1483.7
	3 DEAD + SNOW + WIND(N-S)	0	792.834	-62.387	-228.976
		1.518	861.557	-52.581	-847.402
		3.037	930.281	-31.506	-1465.828
		4.555	999.004	0.836	-2084.255
		6.074	1067.728	44.446	-2702.463
	4 DEAD + WIND(S-N)	0	524.467	-45.645	-321.627
		1.518	571.73	-35.37	-806.126
		3.037	618.994	-16.268	-1290.624
		4.555	666.257	11.661	-1775.122
		6.074	713.521	48.419	-2259.449
	5 DEAD + SNOW + WIND(S-N)	0	873.383	-73.046	-523.908
		1.518	942.106	-56.77	-1262.59
		3.037	1010.83	-27.035	-2001.273
		4.555	1079.553	16.159	-2739.955
		6.074	1148.277	72.812	-3478.377
	6 TRANSPORTATION + WIND(N-S)	0	-75.381	12.039	178.341
		1.518	-68.994	7.698	298.259
		3.037	-62.607	1.171	418.176
		4.555	-56.22	-7.541	538.094
		6.074	-49.833	-18.438	657.97

	7 TRANSPORTATION + WIND(S-N)	0	5.168	1.381	-116.591
		1.518	11.555	3.508	-116.93
		3.037	17.942	5.642	-117.268
		4.555	24.329	7.781	-117.606
		6.074	30.716	9.927	-117.944
10	1 DEAD + SNOW	0	3805.707	-69.772	-923.295
		2.434	3805.707	-42.809	-923.295
		4.867	3805.707	-15.846	-923.295
		7.301	3805.707	11.117	-923.295
		9.734	3805.707	38.08	-923.295
	2 DEAD + WIND(N-S)	0	1531.66	-20.056	-505.493
		2.434	1531.66	-8.706	-271.869
		4.867	1531.66	-4.177	-38.246
		7.301	1531.66	-6.472	195.377
		9.734	1531.66	-14.926	326.059
	3 DEAD + SNOW + WIND(N-S)	0	2782.715	-44.446	-836.569
		2.434	2782.715	-23.427	-602.946
		4.867	2782.715	-9.231	-369.322
		7.301	2782.715	-1.857	-135.699
		9.734	2782.715	-1.305	97.895
	4 DEAD + WIND(S-N)	0	2311.471	-48.419	-520.891
		2.434	2311.471	-31.076	-666.905
		4.867	2311.471	-9.468	-812.92
		7.301	2311.471	16.404	-958.934
		9.734	2311.471	46.539	-1104.931
	5 DEAD + SNOW + WIND(S-N)	0	3562.654	-72.812	-851.55
		2.434	3562.654	-45.812	-997.565
		4.867	3562.654	-14.548	-1143.579
		7.301	3562.654	20.979	-1289.594
		9.734	3562.654	60.771	-1435.59
	6 TRANSPORTATION + WIND(N-S)	0	-659.83	18.438	-5.702
		2.434	-659.83	15.193	227.921
		4.867	-659.83	5.126	461.544
		7.301	-659.83	-11.763	695.168
		9.734	-659.83	-35.476	928.762
	7 TRANSPORTATION + WIND(S-N)	0	120.11	-9.927	-20.684
		2.434	120.11	-7.191	-166.698
		4.867	120.11	-0.191	-312.713
		7.301	120.11	11.073	-458.727
		9.734	120.11	26.601	-604.724
11	1 DEAD + SNOW	0	3077.551	60.67	923.295
		2.171	3077.551	36.622	923.295
		4.341	3077.551	12.574	923.295

	6.512	3077.551	-11.474	923.295
	8.682	3077.551	-35.523	923.295
2 DEAD + WIND(N-S)	0	1110.578	35.828	499.932
	2.171	1110.578	21.111	630.162
	4.341	1110.578	3.002	760.392
	6.512	1110.578	-18.499	890.622
	8.682	1110.578	-43.392	1019.652
3 DEAD + SNOW + WIND(N-S)	0	2515.912	58.418	831.008
	2.171	2515.912	35.077	961.238
	4.341	2515.912	8.345	1091.468
	6.512	2515.912	-21.779	1221.698
	8.682	2515.912	-55.296	1350.728
4 DEAD + WIND(S-N)	0	899.55	17.189	441.623
	2.171	899.55	8.4	233.255
	4.341	899.55	5.039	24.887
	6.512	899.55	7.104	-183.481
	8.682	899.55	14.596	-389.929
5 DEAD + SNOW + WIND(S-N)	0	2304.754	39.764	772.283
	2.171	2304.754	22.363	563.915
	4.341	2304.754	10.389	355.547
	6.512	2304.754	3.842	147.179
	8.682	2304.754	2.722	-59.269
6 TRANSPORTATION + WIND(N-S)	0	-191.052	3.961	0.141
	2.171	-191.052	2.261	130.371
	4.341	-191.052	-2.83	260.602
	6.512	-191.052	-11.314	390.832
	8.682	-191.052	-23.189	519.862
7 TRANSPORTATION + WIND(S-N)	0	-402.21	-14.693	-58.584
	2.171	-402.21	-10.453	-266.952
	4.341	-402.21	-0.787	-475.32
	6.512	-402.21	14.307	-683.688
	8.682	-402.21	34.828	-890.136

C. Main Wind Force Resistance System

C.1 Transverse Resistance to Roll

The minimum service gravity loads (National Mall) coupled with maximum lateral loads were analyzed for North-South and South-North predominant winds to check if ties are necessary to counter uplift forces.

Minimum Reaction Forces

Node	L/C	Horizontal Fx lb	Vertical Fy lb	Horizontal Fz lb	Moment Mx kip-in	My kip-in	Mz kip-in
10	2 DEAD + WIND(N-S)	-1349.22	1877.74	0.000	0.000	0.000	0.000
	4 DEAD + WIND(S-N)	1207.39	2743.40	0.000	0.000	0.000	0.000
11	2 DEAD + WIND(N-S)	-40.89	2939.43	0.000	0.000	0.000	0.000
	4 DEAD + WIND(S-N)	254.12	320.90	0.000	0.000	0.000	0.000

No uplift. Tie downs are not necessary. Sand bags recommended on the South foundation pads.

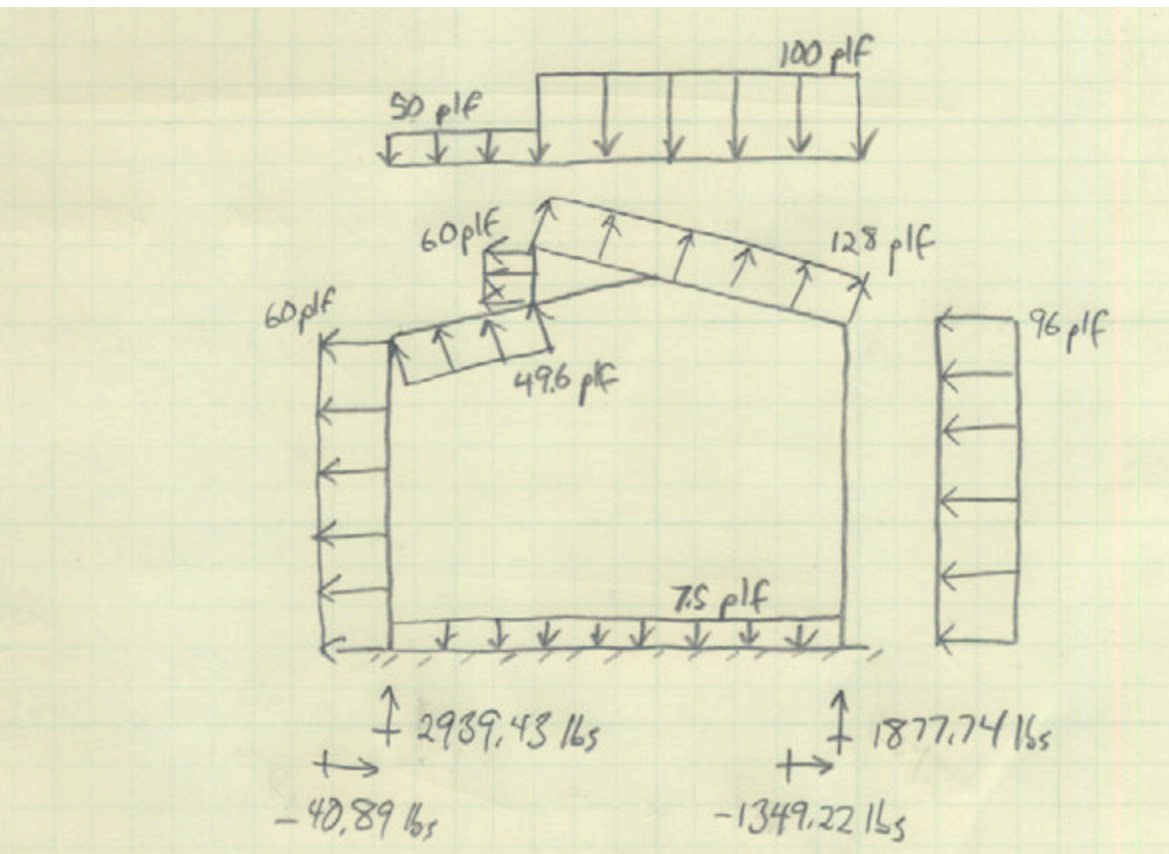


Figure 15: Resistance to roll: Dead + Wind (N-S)

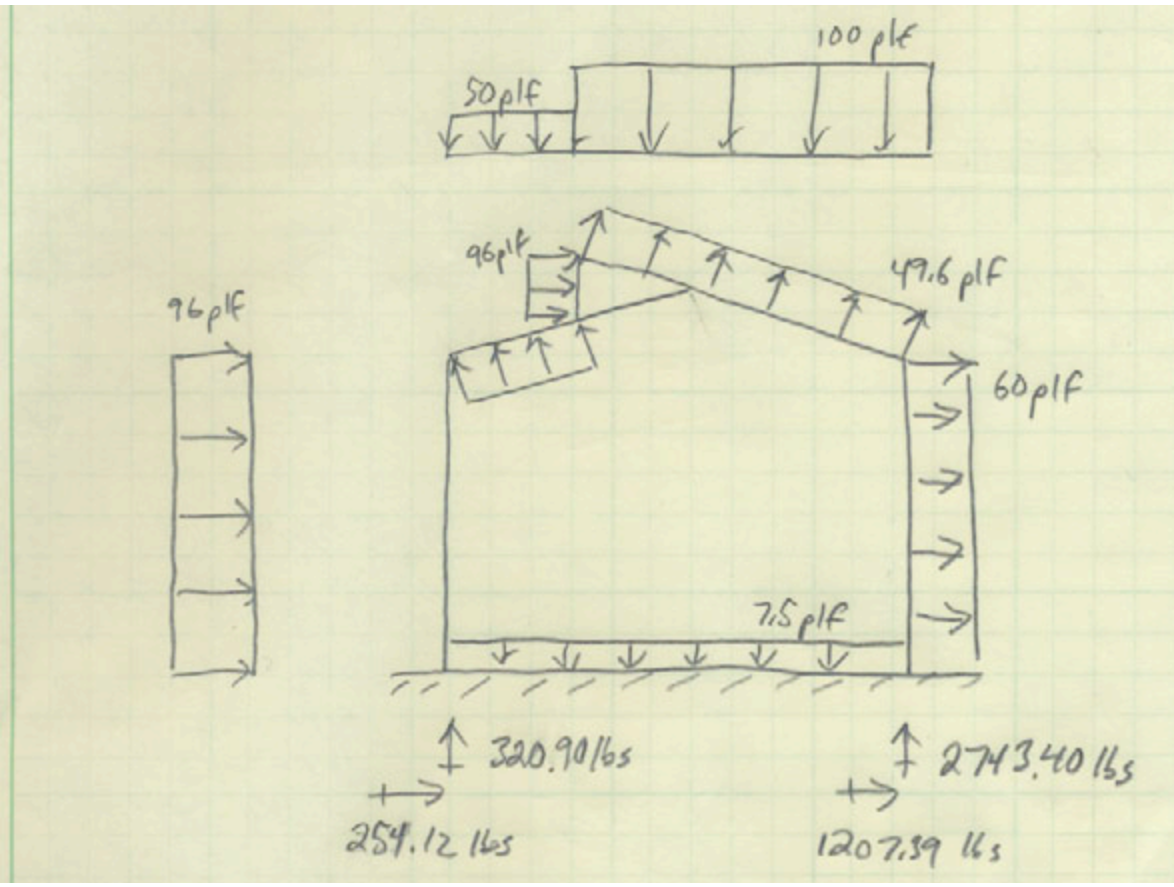


Figure 16: Resistance to roll: Dead + Wind (S-N)

C.2 Frames

See Drawing S-201 Frame Elevation.

C.2.1 Wood Members

C.2.1.1 Forces

See Member Force Output

C.2.1.2 Reference Design Values

Beam	L/C	Dist ft	Type	Finish	c	Species	Grade	Fb	Ft	Fv	Fcperp	Fc	E	Emin
1	1 DEAD + SNOW	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.211	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.422	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.632	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.843	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	2 DEAD + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.211	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.422	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.632	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.843	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	3 DEAD + SNOW + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.211	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.422	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.632	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.843	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	4 DEAD + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.211	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.422	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.632	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.843	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	5 DEAD + SNOW + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.211	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.422	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.632	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.843	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	6 TRANSPORTATION + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.211	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.422	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.632	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.843	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	7 TRANSPORTATION + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.211	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.422	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.632	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.843	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
3	1 DEAD + SNOW	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.318	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.635	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.953	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.271	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	2 DEAD + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.318	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.635	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.953	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.271	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	3 DEAD + SNOW + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.318	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.635	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.953	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.271	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000

	4 DEAD + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.318	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.635	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.953	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.271	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	5 DEAD + SNOW + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.318	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.635	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.953	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.271	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	6 TRANSPORTATION + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.318	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.635	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.953	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.271	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	7 TRANSPORTATION + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.318	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.635	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.953	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.271	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
4	1 DEAD + SNOW	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.94	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.88	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.82	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.759	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	2 DEAD + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.94	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.88	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.82	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.759	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	3 DEAD + SNOW + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.94	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.88	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.82	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.759	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	4 DEAD + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.94	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.88	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.82	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.759	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	5 DEAD + SNOW + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.94	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.88	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.82	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.759	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	6 TRANSPORTATION + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		0.94	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.88	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.82	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.759	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	7 TRANSPORTATION + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000

		0.94	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.88	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.82	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.759	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
6	1 DEAD + SNOW	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.227	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.454	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.681	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.909	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	2 DEAD + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.227	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.454	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.681	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.909	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	3 DEAD + SNOW + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.227	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.454	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.681	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.909	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	4 DEAD + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.227	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.454	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.681	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.909	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	5 DEAD + SNOW + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.227	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.454	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.681	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.909	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	6 TRANSPORTATION + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.227	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.454	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.681	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.909	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	7 TRANSPORTATION + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.227	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.454	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.681	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.909	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
7	1 DEAD + SNOW	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.518	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.037	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.555	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.074	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	2 DEAD + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.518	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.037	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.555	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.074	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	3 DEAD + SNOW + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.518	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000

		3.037	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.555	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.074	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	4 DEAD + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.518	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.037	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.555	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.074	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	5 DEAD + SNOW + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.518	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.037	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.555	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.074	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	6 TRANSPORTATION + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.518	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.037	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.555	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.074	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	7 TRANSPORTATION + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		1.518	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		3.037	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.555	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.074	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
10	1 DEAD + SNOW	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.434	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.867	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		7.301	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		9.734	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	2 DEAD + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.434	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.867	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		7.301	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		9.734	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	3 DEAD + SNOW + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.434	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.867	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		7.301	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		9.734	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	4 DEAD + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.434	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.867	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		7.301	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		9.734	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	5 DEAD + SNOW + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.434	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.867	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		7.301	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		9.734	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	6 TRANSPORTATION + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.434	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.867	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000

		7.301	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		9.734	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	7 TRANSPORTATION + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.434	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.867	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		7.301	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		9.734	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
11	1 DEAD + SNOW	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.171	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.341	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.512	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		8.682	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	2 DEAD + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.171	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.341	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.512	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		8.682	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	3 DEAD + SNOW + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.171	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.341	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.512	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		8.682	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	4 DEAD + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.171	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.341	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.512	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		8.682	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	5 DEAD + SNOW + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.171	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.341	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.512	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		8.682	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	6 TRANSPORTATION + WIND(N-S)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.171	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.341	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.512	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		8.682	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
	7 TRANSPORTATION + WIND(S-N)	0	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		2.171	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		4.341	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		6.512	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000
		8.682	softwood	sawn	0.8	Estrn Wht Pine	No. 1	800	525	125	350	625	1E+06	400000

C.2.1.3 Factors

Beam	L/C	Dist ft	CD	CM	Ct (Ft,E,Emin)	Ct (Fb,Fv,Fc,Fcperp)	CL	CF	Cfu	Ci	Cr	Cp	KM	KT	CT	Cb	Fb* (psi)	Fb' (psi)	Ft' (psi)	Fv' (psi)	Fcperp' (psi)	Fc* (psi)	Fc' (psi)	E' (psi)	Emin' (psi)
1	1 DEAD + SNOW	0	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
		1.211	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
		2.422	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
		3.632	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
		4.843	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	2 DEAD + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		1.211	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		2.422	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		3.632	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		4.843	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	3 DEAD + SNOW + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		1.211	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		2.422	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		3.632	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		4.843	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4 DEAD + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		1.211	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		2.422	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		3.632	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		4.843	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	5 DEAD + SNOW + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		1.211	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		2.422	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		3.632	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
		4.843	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	6 TRANSPORTATION + WIND(N-S)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
		1.211	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
		2.422	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
		3.632	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
		4.843	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	7 TRANSPORTATION + WIND(S-N)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
		1.211	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
		2.422	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
		3.632	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
		4.843	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
3	1 DEAD + SNOW	0	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1200	0.59	1.06	1.00	920	916	604	144	350	719	709	1100000	423238
		0.318	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1200	0.59	1.06	1.00	920	916	604	144	350	719	709	1100000	423238
		0.635	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1200	0.59	1.06	1.00	920	916	604	144	350	719	709	1100000	423238
		0.953	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1200	0.59	1.06	1.00	920	916	604	144	350	719	709	1100000	423238
		1.271	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1200	0.59	1.06	1.00	920	916	604	144	350	719	709	1100000	423238
	2 DEAD + WIND(N-S)	0	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.318	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.635	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.953	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		1.271	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
	3 DEAD + SNOW + WIND(N-S)	0	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.318	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.635	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.953	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		1.271	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
	4 DEAD + WIND(S-N)	0	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.318	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.635	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.953	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		1.271	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
	5 DEAD + SNOW + WIND(S-N)	0	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.318	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.635	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		0.953	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
		1.271	1.60	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.98	1200	0.59	1.06	1.00	1280	1272	840	200	350	1000	980	1100000	423238
	6 TRANSPORTATION + WIND(N-S)	0	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
		0.318	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
		0.635	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
		0.953	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
		1.271	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
	7 TRANSPORTATION + WIND(S-N)	0	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
		0.318	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
		0.635	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
		0.953	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
		1.271	2.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	0.97	1200	0.59	1.06	1.00	1600	1587	1050	250	350	1250	1219	1100000	423238
4	1 DEAD + SNOW	0	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
		0.94	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
		1.88	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
		2.82	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
		3.759	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	2 DEAD + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000

	0.94	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	1.88	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.82	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	3.759	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
3 DEAD + SNOW + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	0.94	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	1.88	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.82	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	3.759	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
4 DEAD + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	0.94	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	1.88	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.82	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	3.759	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
5 DEAD + SNOW + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	0.94	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	1.88	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.82	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	3.759	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
6 TRANSPORTATION + WIND(N-S)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	0.94	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	1.88	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	2.82	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	3.759	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
7 TRANSPORTATION + WIND(S-N)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	0.94	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	1.88	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	2.82	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	3.759	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
6 1 DEAD + SNOW	0	1.15	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.72	1200	0.59	1.18	1.00	920	905	604	144	350	719	521	1100000	471002
	1.227	1.15	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.72	1200	0.59	1.18	1.00	920	905	604	144	350	719	521	1100000	471002
	2.454	1.15	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.72	1200	0.59	1.18	1.00	920	905	604	144	350	719	521	1100000	471002
	3.681	1.15	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.72	1200	0.59	1.18	1.00	920	905	604	144	350	719	521	1100000	471002
	4.909	1.15	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.72	1200	0.59	1.18	1.00	920	905	604	144	350	719	521	1100000	471002
2 DEAD + WIND(N-S)	0	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	1.227	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	2.454	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	3.681	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	4.909	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
3 DEAD + SNOW + WIND(N-S)	0	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	1.227	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	2.454	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	3.681	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	4.909	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
4 DEAD + WIND(S-N)	0	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	1.227	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	2.454	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	3.681	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	4.909	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
5 DEAD + SNOW + WIND(S-N)	0	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	1.227	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	2.454	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	3.681	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
	4.909	1.60	1.00	1.00	1.00	0.98	1.00	1.00	1.00	1.00	0.61	1200	0.59	1.18	1.00	1280	1251	840	200	350	1000	607	1100000	471002
6 TRANSPORTATION + WIND(N-S)	0	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
	1.227	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
	2.454	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
	3.681	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
	4.909	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
7 TRANSPORTATION + WIND(S-N)	0	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
	1.227	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
	2.454	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
	3.681	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
	4.909	2.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	0.52	1200	0.59	1.18	1.00	1600	1554	1050	250	350	1250	653	1100000	471002
7 1 DEAD + SNOW	0	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	1.518	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	3.037	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	4.555	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	6.074	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
2 DEAD + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	1.518	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	3.037	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.555	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	6.074	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
3 DEAD + SNOW + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	1.518	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	3.037	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000

	4.555	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	6.074	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
4 DEAD + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	1.518	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	3.037	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.555	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	6.074	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
5 DEAD + SNOW + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	1.518	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	3.037	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.555	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	6.074	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
6 TRANSPORTATION + WIND(N-S)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	1.518	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	3.037	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	4.555	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	6.074	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
7 TRANSPORTATION + WIND(S-N)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	1.518	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	3.037	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	4.555	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	6.074	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
10 1 DEAD + SNOW	0	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	2.434	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	4.867	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	7.301	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	9.734	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
2 DEAD + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.434	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.867	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	7.301	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	9.734	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
3 DEAD + SNOW + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.434	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.867	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	7.301	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	9.734	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
4 DEAD + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.434	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.867	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	7.301	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	9.734	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
5 DEAD + SNOW + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.434	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.867	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	7.301	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	9.734	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
6 TRANSPORTATION + WIND(N-S)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	2.434	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	4.867	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	7.301	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	9.734	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
7 TRANSPORTATION + WIND(S-N)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	2.434	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	4.867	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	7.301	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	9.734	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
11 1 DEAD + SNOW	0	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	2.171	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	4.341	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	6.512	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
	8.682	1.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	920	920	604	144	350	719	719	1100000	400000
2 DEAD + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.171	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.341	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	6.512	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	8.682	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
3 DEAD + SNOW + WIND(N-S)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.171	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.341	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	6.512	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	8.682	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
4 DEAD + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.171	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.341	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	6.512	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	8.682	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000

5 DEAD + SNOW + WIND(S-N)	0	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	2.171	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	4.341	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	6.512	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
	8.682	1.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1280	1280	840	200	350	1000	1000	1100000	400000
6 TRANSPORTATION + WIND(N-S)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	2.171	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	4.341	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	6.512	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	8.682	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
7 TRANSPORTATION + WIND(S-N)	0	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	2.171	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	4.341	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	6.512	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000
	8.682	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1200	0.59	1.00	1.00	1600	1600	1050	250	350	1250	1250	1100000	400000

C.2.1.4 Stress Evaluation Check

			Axial	Design Strength				Flexure	Design Strength	
Beam	L/C	Dist ft	fx (psi)	Fc' (psi)	OK?	Ft' (psi)	OK?	fz psi	Fb' (psi)	OK?
1	1 DEAD + SNOW	0	139.75	718.8	okay	603.8	okay	129.60	920.0	okay
		1.211	141.46	718.8	okay	603.8	okay	-44.42	920.0	okay
		2.422	143.17	718.8	okay	603.8	okay	-161.78	920.0	okay
		3.632	144.89	718.8	okay	603.8	okay	-222.49	920.0	okay
		4.843	146.60	718.8	okay	603.8	okay	-226.54	920.0	okay
	2 DEAD + WIND(N-S)	0	44.28	1000.0	okay	840.0	okay	58.36	1280.0	okay
		1.211	45.45	1000.0	okay	840.0	okay	-16.78	1280.0	okay
		2.422	46.63	1000.0	okay	840.0	okay	-66.57	1280.0	okay
		3.632	47.81	1000.0	okay	840.0	okay	-91.00	1280.0	okay
		4.843	48.98	1000.0	okay	840.0	okay	-90.07	1280.0	okay
	3 DEAD + SNOW + WIND(N-S)	0	96.81	1000.0	okay	840.0	okay	99.60	1280.0	okay
		1.211	98.53	1000.0	okay	840.0	okay	-32.03	1280.0	okay
		2.422	100.24	1000.0	okay	840.0	okay	-120.61	1280.0	okay
		3.632	101.95	1000.0	okay	840.0	okay	-166.14	1280.0	okay
		4.843	103.66	1000.0	okay	840.0	okay	-168.62	1280.0	okay
	4 DEAD + WIND(S-N)	0	78.87	1000.0	okay	840.0	okay	73.75	1280.0	okay
		1.211	80.05	1000.0	okay	840.0	okay	-26.17	1280.0	okay
		2.422	81.22	1000.0	okay	840.0	okay	-92.39	1280.0	okay
		3.632	82.40	1000.0	okay	840.0	okay	-124.87	1280.0	okay
		4.843	83.58	1000.0	okay	840.0	okay	-123.63	1280.0	okay
	5 DEAD + SNOW + WIND(S-N)	0	131.43	1000.0	okay	840.0	okay	114.99	1280.0	okay
		1.211	133.14	1000.0	okay	840.0	okay	-41.43	1280.0	okay
		2.422	134.85	1000.0	okay	840.0	okay	-146.44	1280.0	okay
		3.632	136.56	1000.0	okay	840.0	okay	-200.04	1280.0	okay
		4.843	138.27	1000.0	okay	840.0	okay	-202.22	1280.0	okay
	6 TRANSPORTATION + WIND(N-S)	0	-28.62	1250.0	okay	1050.0	okay	-17.85	1600.0	okay
		1.211	-28.46	1250.0	okay	1050.0	okay	8.06	1600.0	okay
		2.422	-28.30	1250.0	okay	1050.0	okay	25.62	1600.0	okay
		3.632	-28.14	1250.0	okay	1050.0	okay	34.84	1600.0	okay
		4.843	-27.98	1250.0	okay	1050.0	okay	35.71	1600.0	okay
	7 TRANSPORTATION + WIND(S-N)	0	5.99	1250.0	okay	1050.0	okay	-2.45	1600.0	okay
		1.211	6.15	1250.0	okay	1050.0	okay	-1.35	1600.0	okay
		2.422	6.31	1250.0	okay	1050.0	okay	-0.22	1600.0	okay
		3.632	6.47	1250.0	okay	1050.0	okay	0.94	1600.0	okay
		4.843	6.63	1250.0	okay	1050.0	okay	2.13	1600.0	okay
3	1 DEAD + SNOW	0	65.32	708.7	okay	603.8	okay	129.60	915.6	okay
		0.318	65.32	708.7	okay	603.8	okay	28.89	915.6	okay
		0.635	65.32	708.7	okay	603.8	okay	-71.81	915.6	okay
		0.953	65.32	708.7	okay	603.8	okay	-172.52	915.6	okay
		1.271	65.32	708.7	okay	603.8	okay	-273.22	915.6	okay
	2 DEAD + WIND(N-S)	0	29.65	980.2	okay	840.0	okay	58.36	1271.5	okay

	0.318	29.65	980.2	okay	840.0	okay	25.75	1271.5	okay
	0.635	29.65	980.2	okay	840.0	okay	-7.31	1271.5	okay
	0.953	29.65	980.2	okay	840.0	okay	-40.80	1271.5	okay
	1.271	29.65	980.2	okay	840.0	okay	-74.73	1271.5	okay
3 DEAD + SNOW + WIND(N-S)	0	50.15	980.2	okay	840.0	okay	99.60	1271.5	okay
	0.318	50.15	980.2	okay	840.0	okay	29.34	1271.5	okay
	0.635	50.15	980.2	okay	840.0	okay	-41.35	1271.5	okay
	0.953	50.15	980.2	okay	840.0	okay	-112.47	1271.5	okay
	1.271	50.15	980.2	okay	840.0	okay	-184.03	1271.5	okay
4 DEAD + WIND(S-N)	0	37.84	980.2	okay	840.0	okay	73.75	1271.5	okay
	0.318	37.84	980.2	okay	840.0	okay	17.22	1271.5	okay
	0.635	37.84	980.2	okay	840.0	okay	-38.62	1271.5	okay
	0.953	37.84	980.2	okay	840.0	okay	-93.76	1271.5	okay
	1.271	37.84	980.2	okay	840.0	okay	-148.20	1271.5	okay
5 DEAD + SNOW + WIND(S-N)	0	58.35	980.2	okay	840.0	okay	114.99	1271.5	okay
	0.318	58.35	980.2	okay	840.0	okay	20.81	1271.5	okay
	0.635	58.35	980.2	okay	840.0	okay	-72.68	1271.5	okay
	0.953	58.35	980.2	okay	840.0	okay	-165.47	1271.5	okay
	1.271	58.35	980.2	okay	840.0	okay	-257.56	1271.5	okay
6 TRANSPORTATION + WIND(N-S)	0	-9.08	1218.5	okay	1050.0	okay	-17.85	1586.7	okay
	0.318	-9.08	1218.5	okay	1050.0	okay	2.32	1586.7	okay
	0.635	-9.08	1218.5	okay	1050.0	okay	22.05	1586.7	okay
	0.953	-9.08	1218.5	okay	1050.0	okay	41.35	1586.7	okay
	1.271	-9.08	1218.5	okay	1050.0	okay	60.21	1586.7	okay
7 TRANSPORTATION + WIND(S-N)	0	-0.89	1218.5	okay	1050.0	okay	-2.45	1586.7	okay
	0.318	-0.89	1218.5	okay	1050.0	okay	-6.21	1586.7	okay
	0.635	-0.89	1218.5	okay	1050.0	okay	-9.28	1586.7	okay
	0.953	-0.89	1218.5	okay	1050.0	okay	-11.65	1586.7	okay
	1.271	-0.89	1218.5	okay	1050.0	okay	-13.32	1586.7	okay
4 1 DEAD + SNOW	0	42.33	718.8	okay	603.8	okay	-287.38	920.0	okay
	0.94	43.83	718.8	okay	603.8	okay	-150.76	920.0	okay
	1.88	45.34	718.8	okay	603.8	okay	4.80	920.0	okay
	2.82	46.84	718.8	okay	603.8	okay	177.19	920.0	okay
	3.759	48.34	718.8	okay	603.8	okay	364.29	920.0	okay
2 DEAD + WIND(N-S)	0	21.75	1000.0	okay	840.0	okay	-56.62	1280.0	okay
	0.94	22.03	1000.0	okay	840.0	okay	11.36	1280.0	okay
	1.88	22.31	1000.0	okay	840.0	okay	79.31	1280.0	okay
	2.82	22.59	1000.0	okay	840.0	okay	147.24	1280.0	okay
	3.759	22.87	1000.0	okay	840.0	okay	215.13	1280.0	okay
3 DEAD + SNOW + WIND(N-S)	0	35.98	1000.0	okay	840.0	okay	-181.00	1280.0	okay
	0.94	37.49	1000.0	okay	840.0	okay	-69.62	1280.0	okay
	1.88	38.99	1000.0	okay	840.0	okay	57.54	1280.0	okay
	2.82	40.50	1000.0	okay	840.0	okay	198.38	1280.0	okay

	3.759	42.00	1000.0	okay	840.0	okay	350.77	1280.0	okay
4 DEAD + WIND(S-N)	0	18.60	1000.0	okay	840.0	okay	-155.46	1280.0	okay
	0.94	18.88	1000.0	okay	840.0	okay	-83.19	1280.0	okay
	1.88	19.16	1000.0	okay	840.0	okay	-15.99	1280.0	okay
	2.82	19.44	1000.0	okay	840.0	okay	46.14	1280.0	okay
	3.759	19.72	1000.0	okay	840.0	okay	103.21	1280.0	okay
5 DEAD + SNOW + WIND(S-N)	0	32.82	1000.0	okay	840.0	okay	-279.92	1280.0	okay
	0.94	34.32	1000.0	okay	840.0	okay	-164.26	1280.0	okay
	1.88	35.83	1000.0	okay	840.0	okay	-37.84	1280.0	okay
	2.82	37.33	1000.0	okay	840.0	okay	97.21	1280.0	okay
	3.759	38.83	1000.0	okay	840.0	okay	238.76	1280.0	okay
6 TRANSPORTATION + WIND(N-S)	0	-2.25	1250.0	okay	1050.0	okay	74.49	1600.0	okay
	0.94	-1.97	1250.0	okay	1050.0	okay	61.85	1600.0	okay
	1.88	-1.69	1250.0	okay	1050.0	okay	49.19	1600.0	okay
	2.82	-1.41	1250.0	okay	1050.0	okay	36.50	1600.0	okay
	3.759	-1.13	1250.0	okay	1050.0	okay	23.78	1600.0	okay
7 TRANSPORTATION + WIND(S-N)	0	-5.42	1250.0	okay	1050.0	okay	-24.44	1600.0	okay
	0.94	-5.14	1250.0	okay	1050.0	okay	-32.78	1600.0	okay
	1.88	-4.86	1250.0	okay	1050.0	okay	-46.19	1600.0	okay
	2.82	-4.58	1250.0	okay	1050.0	okay	-64.67	1600.0	okay
	3.759	-4.30	1250.0	okay	1050.0	okay	-88.22	1600.0	okay
6 1 DEAD + SNOW	0	-112.45	520.9	okay	603.8	okay	-267.76	904.8	okay
	1.227	-112.45	520.9	okay	603.8	okay	-204.36	904.8	okay
	2.454	-112.45	520.9	okay	603.8	okay	-140.96	904.8	okay
	3.681	-112.45	520.9	okay	603.8	okay	-77.56	904.8	okay
	4.909	-112.45	520.9	okay	603.8	okay	-14.16	904.8	okay
2 DEAD + WIND(N-S)	0	-32.08	607.4	okay	840.0	okay	-120.05	1250.5	okay
	1.227	-32.08	607.4	okay	840.0	okay	-85.51	1250.5	okay
	2.454	-32.08	607.4	okay	840.0	okay	-50.97	1250.5	okay
	3.681	-32.08	607.4	okay	840.0	okay	-16.43	1250.5	okay
	4.909	-32.08	607.4	okay	840.0	okay	18.11	1250.5	okay
3 DEAD + SNOW + WIND(N-S)	0	-74.99	607.4	okay	840.0	okay	-205.97	1250.5	okay
	1.227	-74.99	607.4	okay	840.0	okay	-153.72	1250.5	okay
	2.454	-74.99	607.4	okay	840.0	okay	-101.47	1250.5	okay
	3.681	-74.99	607.4	okay	840.0	okay	-49.22	1250.5	okay
	4.909	-74.99	607.4	okay	840.0	okay	3.03	1250.5	okay
4 DEAD + WIND(S-N)	0	-65.04	607.4	okay	840.0	okay	-150.44	1250.5	okay
	1.227	-65.04	607.4	okay	840.0	okay	-114.64	1250.5	okay
	2.454	-65.04	607.4	okay	840.0	okay	-78.85	1250.5	okay
	3.681	-65.04	607.4	okay	840.0	okay	-43.06	1250.5	okay
	4.909	-65.04	607.4	okay	840.0	okay	-7.27	1250.5	okay
5 DEAD + SNOW + WIND(S-N)	0	-107.98	607.4	okay	840.0	okay	-236.39	1250.5	okay
	1.227	-107.98	607.4	okay	840.0	okay	-182.88	1250.5	okay

		2.454	-107.98	607.4	okay	840.0	okay	-129.37	1250.5	okay
		3.681	-107.98	607.4	okay	840.0	okay	-75.87	1250.5	okay
		4.909	-107.98	607.4	okay	840.0	okay	-22.36	1250.5	okay
	6 TRANSPORTATION + WIND(N-S)	0	25.86	652.7	okay	1050.0	okay	36.58	1554.0	okay
		1.227	25.86	652.7	okay	1050.0	okay	31.00	1554.0	okay
		2.454	25.86	652.7	okay	1050.0	okay	25.42	1554.0	okay
		3.681	25.86	652.7	okay	1050.0	okay	19.85	1554.0	okay
		4.909	25.86	652.7	okay	1050.0	okay	14.27	1554.0	okay
	7 TRANSPORTATION + WIND(S-N)	0	-7.13	652.7	okay	1050.0	okay	6.17	1554.0	okay
		1.227	-7.13	652.7	okay	1050.0	okay	1.84	1554.0	okay
		2.454	-7.13	652.7	okay	1050.0	okay	-2.48	1554.0	okay
		3.681	-7.13	652.7	okay	1050.0	okay	-6.80	1554.0	okay
		4.909	-7.13	652.7	okay	1050.0	okay	-11.12	1554.0	okay
7	1 DEAD + SNOW	0	31.91	718.8	okay	603.8	okay	-494.30	920.0	okay
		1.518	34.18	718.8	okay	603.8	okay	-399.57	920.0	okay
		3.037	36.46	718.8	okay	603.8	okay	-215.79	920.0	okay
		4.555	38.73	718.8	okay	603.8	okay	57.05	920.0	okay
		6.074	41.00	718.8	okay	603.8	okay	418.95	920.0	okay
	2 DEAD + WIND(N-S)	0	14.66	1000.0	okay	840.0	okay	-210.13	1280.0	okay
		1.518	16.22	1000.0	okay	840.0	okay	-187.26	1280.0	okay
		3.037	17.79	1000.0	okay	840.0	okay	-124.55	1280.0	okay
		4.555	19.35	1000.0	okay	840.0	okay	-21.99	1280.0	okay
		6.074	20.91	1000.0	okay	840.0	okay	120.43	1280.0	okay
	3 DEAD + SNOW + WIND(N-S)	0	26.21	1000.0	okay	840.0	okay	-374.60	1280.0	okay
		1.518	28.48	1000.0	okay	840.0	okay	-315.72	1280.0	okay
		3.037	30.75	1000.0	okay	840.0	okay	-189.18	1280.0	okay
		4.555	33.02	1000.0	okay	840.0	okay	5.02	1280.0	okay
		6.074	35.30	1000.0	okay	840.0	okay	266.88	1280.0	okay
	4 DEAD + WIND(S-N)	0	17.34	1000.0	okay	840.0	okay	-274.08	1280.0	okay
		1.518	18.90	1000.0	okay	840.0	okay	-212.38	1280.0	okay
		3.037	20.46	1000.0	okay	840.0	okay	-97.68	1280.0	okay
		4.555	22.03	1000.0	okay	840.0	okay	70.02	1280.0	okay
		6.074	23.59	1000.0	okay	840.0	okay	290.73	1280.0	okay
	5 DEAD + SNOW + WIND(S-N)	0	28.87	1000.0	okay	840.0	okay	-438.60	1280.0	okay
		1.518	31.14	1000.0	okay	840.0	okay	-340.88	1280.0	okay
		3.037	33.42	1000.0	okay	840.0	okay	-162.33	1280.0	okay
		4.555	35.69	1000.0	okay	840.0	okay	97.03	1280.0	okay
		6.074	37.96	1000.0	okay	840.0	okay	437.20	1280.0	okay
	6 TRANSPORTATION + WIND(N-S)	0	-2.49	1250.0	okay	1050.0	okay	72.29	1600.0	okay
		1.518	-2.28	1250.0	okay	1050.0	okay	46.22	1600.0	okay
		3.037	-2.07	1250.0	okay	1050.0	okay	7.03	1600.0	okay
		4.555	-1.86	1250.0	okay	1050.0	okay	-45.28	1600.0	okay
		6.074	-1.65	1250.0	okay	1050.0	okay	-110.71	1600.0	okay

	7 TRANSPORTATION + WIND(S-N)	0	0.17	1250.0	okay	1050.0	okay	8.29	1600.0	okay
		1.518	0.38	1250.0	okay	1050.0	okay	21.06	1600.0	okay
		3.037	0.59	1250.0	okay	1050.0	okay	33.88	1600.0	okay
		4.555	0.80	1250.0	okay	1050.0	okay	46.72	1600.0	okay
		6.074	1.02	1250.0	okay	1050.0	okay	59.61	1600.0	okay
10	1 DEAD + SNOW	0	125.81	718.8	okay	603.8	okay	-418.95	920.0	okay
		2.434	125.81	718.8	okay	603.8	okay	-257.05	920.0	okay
		4.867	125.81	718.8	okay	603.8	okay	-95.15	920.0	okay
		7.301	125.81	718.8	okay	603.8	okay	66.75	920.0	okay
		9.734	125.81	718.8	okay	603.8	okay	228.65	920.0	okay
	2 DEAD + WIND(N-S)	0	50.63	1000.0	okay	840.0	okay	-120.43	1280.0	okay
		2.434	50.63	1000.0	okay	840.0	okay	-52.28	1280.0	okay
		4.867	50.63	1000.0	okay	840.0	okay	-25.08	1280.0	okay
		7.301	50.63	1000.0	okay	840.0	okay	-38.86	1280.0	okay
		9.734	50.63	1000.0	okay	840.0	okay	-89.62	1280.0	okay
	3 DEAD + SNOW + WIND(N-S)	0	91.99	1000.0	okay	840.0	okay	-266.88	1280.0	okay
		2.434	91.99	1000.0	okay	840.0	okay	-140.67	1280.0	okay
		4.867	91.99	1000.0	okay	840.0	okay	-55.43	1280.0	okay
		7.301	91.99	1000.0	okay	840.0	okay	-11.15	1280.0	okay
		9.734	91.99	1000.0	okay	840.0	okay	-7.84	1280.0	okay
	4 DEAD + WIND(S-N)	0	76.41	1000.0	okay	840.0	okay	-290.73	1280.0	okay
		2.434	76.41	1000.0	okay	840.0	okay	-186.60	1280.0	okay
		4.867	76.41	1000.0	okay	840.0	okay	-56.85	1280.0	okay
		7.301	76.41	1000.0	okay	840.0	okay	98.50	1280.0	okay
		9.734	76.41	1000.0	okay	840.0	okay	279.44	1280.0	okay
	5 DEAD + SNOW + WIND(S-N)	0	117.77	1000.0	okay	840.0	okay	-437.20	1280.0	okay
		2.434	117.77	1000.0	okay	840.0	okay	-275.08	1280.0	okay
		4.867	117.77	1000.0	okay	840.0	okay	-87.35	1280.0	okay
		7.301	117.77	1000.0	okay	840.0	okay	125.97	1280.0	okay
		9.734	117.77	1000.0	okay	840.0	okay	364.90	1280.0	okay
	6 TRANSPORTATION + WIND(N-S)	0	-21.81	1250.0	okay	1050.0	okay	110.71	1600.0	okay
		2.434	-21.81	1250.0	okay	1050.0	okay	91.23	1600.0	okay
		4.867	-21.81	1250.0	okay	1050.0	okay	30.78	1600.0	okay
		7.301	-21.81	1250.0	okay	1050.0	okay	-70.63	1600.0	okay
		9.734	-21.81	1250.0	okay	1050.0	okay	-213.02	1600.0	okay
	7 TRANSPORTATION + WIND(S-N)	0	3.97	1250.0	okay	1050.0	okay	-59.61	1600.0	okay
		2.434	3.97	1250.0	okay	1050.0	okay	-43.18	1600.0	okay
		4.867	3.97	1250.0	okay	1050.0	okay	-1.15	1600.0	okay
		7.301	3.97	1250.0	okay	1050.0	okay	66.49	1600.0	okay
		9.734	3.97	1250.0	okay	1050.0	okay	159.73	1600.0	okay
11	1 DEAD + SNOW	0	101.74	718.8	okay	603.8	okay	364.29	920.0	okay
		2.171	101.74	718.8	okay	603.8	okay	219.90	920.0	okay
		4.341	101.74	718.8	okay	603.8	okay	75.50	920.0	okay

	6.512	101.74	718.8	okay	603.8	okay	-68.90	920.0	okay
	8.682	101.74	718.8	okay	603.8	okay	-213.30	920.0	okay
2 DEAD + WIND(N-S)	0	36.71	1000.0	okay	840.0	okay	215.13	1280.0	okay
	2.171	36.71	1000.0	okay	840.0	okay	126.76	1280.0	okay
	4.341	36.71	1000.0	okay	840.0	okay	18.03	1280.0	okay
	6.512	36.71	1000.0	okay	840.0	okay	-111.08	1280.0	okay
	8.682	36.71	1000.0	okay	840.0	okay	-260.55	1280.0	okay
3 DEAD + SNOW + WIND(N-S)	0	83.17	1000.0	okay	840.0	okay	350.77	1280.0	okay
	2.171	83.17	1000.0	okay	840.0	okay	210.62	1280.0	okay
	4.341	83.17	1000.0	okay	840.0	okay	50.11	1280.0	okay
	6.512	83.17	1000.0	okay	840.0	okay	-130.77	1280.0	okay
	8.682	83.17	1000.0	okay	840.0	okay	-332.03	1280.0	okay
4 DEAD + WIND(S-N)	0	29.74	1000.0	okay	840.0	okay	103.21	1280.0	okay
	2.171	29.74	1000.0	okay	840.0	okay	50.44	1280.0	okay
	4.341	29.74	1000.0	okay	840.0	okay	30.26	1280.0	okay
	6.512	29.74	1000.0	okay	840.0	okay	42.66	1280.0	okay
	8.682	29.74	1000.0	okay	840.0	okay	87.64	1280.0	okay
5 DEAD + SNOW + WIND(S-N)	0	76.19	1000.0	okay	840.0	okay	238.76	1280.0	okay
	2.171	76.19	1000.0	okay	840.0	okay	134.28	1280.0	okay
	4.341	76.19	1000.0	okay	840.0	okay	62.38	1280.0	okay
	6.512	76.19	1000.0	okay	840.0	okay	23.07	1280.0	okay
	8.682	76.19	1000.0	okay	840.0	okay	16.34	1280.0	okay
6 TRANSPORTATION + WIND(N-S)	0	-6.32	1250.0	okay	1050.0	okay	23.78	1600.0	okay
	2.171	-6.32	1250.0	okay	1050.0	okay	13.58	1600.0	okay
	4.341	-6.32	1250.0	okay	1050.0	okay	-16.99	1600.0	okay
	6.512	-6.32	1250.0	okay	1050.0	okay	-67.93	1600.0	okay
	8.682	-6.32	1250.0	okay	1050.0	okay	-139.24	1600.0	okay
7 TRANSPORTATION + WIND(S-N)	0	-13.30	1250.0	okay	1050.0	okay	-88.22	1600.0	okay
	2.171	-13.30	1250.0	okay	1050.0	okay	-62.77	1600.0	okay
	4.341	-13.30	1250.0	okay	1050.0	okay	-4.73	1600.0	okay
	6.512	-13.30	1250.0	okay	1050.0	okay	85.91	1600.0	okay
	8.682	-13.30	1250.0	okay	1050.0	okay	209.12	1600.0	okay

			Shear	Design Strength		Bending / Axial Interaction		
Beam	L/C	Dist ft	fy (psi)	Fv' (psi)	OK?	ompressio	Tension	OK?
1	1 DEAD + SNOW	0	115.00	143.8	okay	0.17867	0	okay
		1.211	82.80	143.8	okay	0.08702	0	okay
		2.422	50.60	143.8	okay	0.21553	0	okay
		3.632	18.40	143.8	okay	0.28247	0	okay
		4.843	13.79	143.8	okay	0.28784	0	okay
	2 DEAD + WIND(N-S)	0	49.91	200.0	okay	0.04756	0	okay
		1.211	35.50	200.0	okay	0.01518	0	okay
		2.422	21.09	200.0	okay	0.05418	0	okay
		3.632	6.68	200.0	okay	0.07338	0	okay
		4.843	7.73	200.0	okay	0.07277	0	okay
	3 DEAD + SNOW + WIND(N-S)	0	87.04	200.0	okay	0.08718	0	okay
		1.211	62.58	200.0	okay	0.03473	0	okay
		2.422	38.11	200.0	okay	0.10428	0	okay
		3.632	13.64	200.0	okay	0.14019	0	okay
		4.843	10.82	200.0	okay	0.14248	0	okay
	4 DEAD + WIND(S-N)	0	66.38	200.0	okay	0.06384	0	okay
		1.211	47.21	200.0	okay	0.02686	0	okay
		2.422	28.05	200.0	okay	0.07877	0	okay
		3.632	8.88	200.0	okay	0.10434	0	okay
		4.843	10.28	200.0	okay	0.10357	0	okay
	5 DEAD + SNOW + WIND(S-N)	0	103.52	200.0	okay	0.10711	0	okay
		1.211	74.29	200.0	okay	0.05009	0	okay
		2.422	45.07	200.0	okay	0.13259	0	okay
		3.632	15.85	200.0	okay	0.17493	0	okay
		4.843	13.36	200.0	okay	0.1771	0	okay
	6 TRANSPORTATION + WIND(N-S)	0	17.09	250.0	okay	0	0.038411704	okay
		1.211	12.35	250.0	okay	0	0.032143117	okay
		2.422	7.61	250.0	okay	0	0.042964816	okay
		3.632	2.87	250.0	okay	0	0.04857764	okay
		4.843	1.87	250.0	okay	0	0.048974051	okay
	7 TRANSPORTATION + WIND(S-N)	0	0.62	250.0	okay	0.00155	0	okay
		1.211	0.64	250.0	okay	0.00086	0	okay
		2.422	0.65	250.0	okay	0.00016	0	okay
		3.632	0.66	250.0	okay	0.00062	0	okay
		4.843	0.68	250.0	okay	0.00136	0	okay
3	1 DEAD + SNOW	0	218.10	143.8	NOT OK	0.15091	0	okay
		0.318	218.10	143.8	NOT OK	0.04024	0	okay
		0.635	218.10	143.8	NOT OK	0.08741	0	okay
		0.953	218.10	143.8	NOT OK	0.19807	0	okay
		1.271	218.10	143.8	NOT OK	0.30873	0	okay
	2 DEAD + WIND(N-S)	0	70.17	200.0	okay	0.04694	0	okay

	0.318	71.12	200.0	okay	0.02122	0	okay
	0.635	72.06	200.0	okay	0.00668	0	okay
	0.953	73.01	200.0	okay	0.03309	0	okay
	1.271	73.95	200.0	okay	0.05985	0	okay
3 DEAD + SNOW + WIND(N-S)	0	151.68	200.0	okay	0.08132	0	okay
	0.318	152.63	200.0	okay	0.02581	0	okay
	0.635	153.57	200.0	okay	0.03529	0	okay
	0.953	154.52	200.0	okay	0.09149	0	okay
	1.271	155.46	200.0	okay	0.14804	0	okay
4 DEAD + WIND(S-N)	0	123.20	200.0	okay	0.0597	0	okay
	0.318	121.69	200.0	okay	0.01508	0	okay
	0.635	120.18	200.0	okay	0.03197	0	okay
	0.953	118.67	200.0	okay	0.07549	0	okay
	1.271	117.15	200.0	okay	0.11846	0	okay
5 DEAD + SNOW + WIND(S-N)	0	204.75	200.0	NOT OK	0.09448	0	okay
	0.318	203.23	200.0	NOT OK	0.02	0	okay
	0.635	201.72	200.0	NOT OK	0.06102	0	okay
	0.953	200.21	200.0	NOT OK	0.1344	0	okay
	1.271	198.69	200.0	okay	0.20722	0	okay
6 TRANSPORTATION + WIND(N-S)	0	44.15	250.0	okay	0	0.019804132	okay
	0.318	43.21	250.0	okay	0	0.010103107	okay
	0.635	42.26	250.0	okay	0	0.022434855	okay
	0.953	41.32	250.0	okay	0	0.034496402	okay
	1.271	40.37	250.0	okay	0	0.046283992	okay
7 TRANSPORTATION + WIND(S-N)	0	8.91	250.0	okay	0	0.002377524	okay
	0.318	7.40	250.0	okay	0	0.004730539	okay
	0.635	5.88	250.0	okay	0	0.006648227	okay
	0.953	4.37	250.0	okay	0	0.008126836	okay
	1.271	2.86	250.0	okay	0	0.009170118	okay
4 1 DEAD + SNOW	0	92.58	143.8	okay	0.31583	0	okay
	0.94	107.23	143.8	okay	0.16759	0	okay
	1.88	120.32	143.8	okay	0.00919	0	okay
	2.82	131.87	143.8	okay	0.19685	0	okay
	3.759	141.87	143.8	okay	0.40049	0	okay
2 DEAD + WIND(N-S)	0	49.78	200.0	okay	0.0447	0	okay
	0.94	49.76	200.0	okay	0.00936	0	okay
	1.88	49.74	200.0	okay	0.06246	0	okay
	2.82	49.72	200.0	okay	0.11554	0	okay
	3.759	49.71	200.0	okay	0.16859	0	okay
3 DEAD + SNOW + WIND(N-S)	0	75.26	200.0	okay	0.1427	0	okay
	0.94	87.59	200.0	okay	0.0558	0	okay
	1.88	98.38	200.0	okay	0.04647	0	okay
	2.82	107.61	200.0	okay	0.15662	0	okay

	3.759	115.30	200.0	okay	0.2758	0	okay
4 DEAD + WIND(S-N)	0	54.77	200.0	okay	0.1218	0	okay
	0.94	51.06	200.0	okay	0.06535	0	okay
	1.88	47.35	200.0	okay	0.01286	0	okay
	2.82	43.64	200.0	okay	0.03643	0	okay
	3.759	39.93	200.0	okay	0.08102	0	okay
5 DEAD + SNOW + WIND(S-N)	0	80.24	200.0	okay	0.21977	0	okay
	0.94	88.89	200.0	okay	0.12951	0	okay
	1.88	95.98	200.0	okay	0.03085	0	okay
	2.82	101.53	200.0	okay	0.07734	0	okay
	3.759	105.52	200.0	okay	0.18804	0	okay
6 TRANSPORTATION + WIND(N-S)	0	9.24	250.0	okay	0	0.048698049	okay
	0.94	9.26	250.0	okay	0	0.040531991	okay
	1.88	9.28	250.0	okay	0	0.032354643	okay
	2.82	9.30	250.0	okay	0	0.024158563	okay
	3.759	9.32	250.0	okay	0	0.015943687	okay
7 TRANSPORTATION + WIND(S-N)	0	4.25	250.0	okay	0	0.02043416	okay
	0.94	7.97	250.0	okay	0	0.025384189	okay
	1.88	11.68	250.0	okay	0	0.033497809	okay
	2.82	15.39	250.0	okay	0	0.044782589	okay
	3.759	19.10	250.0	okay	0	0.059234714	okay
6 1 DEAD + SNOW	0	35.55	143.8	okay	0	0.477293551	okay
	1.227	35.55	143.8	okay	0	0.408378821	okay
	2.454	35.55	143.8	okay	0	0.339464092	okay
	3.681	35.55	143.8	okay	0	0.270555889	okay
	4.909	35.55	143.8	okay	0	0.201641159	okay
2 DEAD + WIND(N-S)	0	19.37	200.0	okay	0	0.131983601	okay
	1.227	19.37	200.0	okay	0	0.104996172	okay
	2.454	19.37	200.0	okay	0	0.078013435	okay
	3.681	19.37	200.0	okay	0	0.051026007	okay
	4.909	19.37	200.0	okay	0	0.052339492	okay
3 DEAD + SNOW + WIND(N-S)	0	29.30	200.0	okay	0	0.25018424	okay
	1.227	29.30	200.0	okay	0	0.209362999	okay
	2.454	29.30	200.0	okay	0	0.168541758	okay
	3.681	29.30	200.0	okay	0	0.127720518	okay
	4.909	29.30	200.0	okay	0	0.091637205	okay
4 DEAD + WIND(S-N)	0	20.07	200.0	okay	0	0.194960302	okay
	1.227	20.07	200.0	okay	0	0.166992452	okay
	2.454	20.07	200.0	okay	0	0.139029292	okay
	3.681	20.07	200.0	okay	0	0.111066132	okay
	4.909	20.07	200.0	okay	0	0.083102972	okay
5 DEAD + SNOW + WIND(S-N)	0	30.01	200.0	okay	0	0.313221383	okay
	1.227	30.01	200.0	okay	0	0.271419719	okay

		2.454	30.01	200.0	okay	0	0.229618055	okay
		3.681	30.01	200.0	okay	0	0.187816392	okay
		4.909	30.01	200.0	okay	0	0.146014728	okay
	6 TRANSPORTATION + WIND(N-S)	0	3.13	250.0	okay	0.0259	0	okay
		1.227	3.13	250.0	okay	0.02219	0	okay
		2.454	3.13	250.0	okay	0.01848	0	okay
		3.681	3.13	250.0	okay	0.01477	0	okay
		4.909	3.13	250.0	okay	0.01106	0	okay
	7 TRANSPORTATION + WIND(S-N)	0	2.42	250.0	okay	0	0.010648537	okay
		1.227	2.42	250.0	okay	0	0.00794651	okay
		2.454	2.42	250.0	okay	0	0.008344308	okay
		3.681	2.42	250.0	okay	0	0.011042582	okay
		4.909	2.42	250.0	okay	0	0.013744609	okay
7	1 DEAD + SNOW	0	22.75	143.8	okay	0.53925	0	okay
		1.518	63.12	143.8	okay	0.43658	0	okay
		3.037	103.48	143.8	okay	0.23713	0	okay
		4.555	143.84	143.8	NOT OK	0.06491	0	okay
		6.074	184.19	143.8	NOT OK	0.45863	0	okay
	2 DEAD + WIND(N-S)	0	1.33	200.0	okay	0.16438	0	okay
		1.518	19.39	200.0	okay	0.14656	0	okay
		3.037	37.46	200.0	okay	0.09762	0	okay
		4.555	55.52	200.0	okay	0.01755	0	okay
		6.074	73.57	200.0	okay	0.09452	0	okay
	3 DEAD + SNOW + WIND(N-S)	0	11.35	200.0	okay	0.29335	0	okay
		1.518	42.02	200.0	okay	0.24747	0	okay
		3.037	72.69	200.0	okay	0.14874	0	okay
		4.555	103.35	200.0	okay	0.00501	0	okay
		6.074	134.01	200.0	okay	0.20974	0	okay
	4 DEAD + WIND(S-N)	0	15.95	200.0	okay	0.21442	0	okay
		1.518	39.97	200.0	okay	0.16628	0	okay
		3.037	64.00	200.0	okay	0.07673	0	okay
		4.555	88.02	200.0	okay	0.05519	0	okay
		6.074	112.04	200.0	okay	0.22769	0	okay
	5 DEAD + SNOW + WIND(S-N)	0	25.98	200.0	okay	0.34349	0	okay
		1.518	62.61	200.0	okay	0.26728	0	okay
		3.037	99.24	200.0	okay	0.12794	0	okay
		4.555	135.87	200.0	okay	0.07708	0	okay
		6.074	172.48	200.0	okay	0.343	0	okay
	6 TRANSPORTATION + WIND(N-S)	0	8.84	250.0	okay	0	0.047553405	okay
		1.518	14.79	250.0	okay	0	0.031061351	okay
		3.037	20.74	250.0	okay	0	0.006365644	okay
		4.555	26.68	250.0	okay	0	0.030069987	okay
		6.074	32.63	250.0	okay	0	0.070763321	okay

	7 TRANSPORTATION + WIND(S-N)	0	5.78	250.0	okay	0.00518	0	okay
		1.518	5.80	250.0	okay	0.01316	0	okay
		3.037	5.81	250.0	okay	0.02117	0	okay
		4.555	5.83	250.0	okay	0.0292	0	okay
		6.074	5.85	250.0	okay	0.03725	0	okay
10	1 DEAD + SNOW	0	45.78	143.8	okay	0.48601	0	okay
		2.434	45.78	143.8	okay	0.31004	0	okay
		4.867	45.78	143.8	okay	0.13406	0	okay
		7.301	45.78	143.8	okay	0.10319	0	okay
		9.734	45.78	143.8	okay	0.27917	0	okay
	2 DEAD + WIND(N-S)	0	25.07	200.0	okay	0.09665	0	okay
		2.434	13.48	200.0	okay	0.0434	0	okay
		4.867	1.90	200.0	okay	0.02216	0	okay
		7.301	9.69	200.0	okay	0.03292	0	okay
		9.734	16.17	200.0	okay	0.07258	0	okay
	3 DEAD + SNOW + WIND(N-S)	0	41.48	200.0	okay	0.21696	0	okay
		2.434	29.90	200.0	okay	0.11836	0	okay
		4.867	18.31	200.0	okay	0.05177	0	okay
		7.301	6.73	200.0	okay	0.01717	0	okay
		9.734	4.85	200.0	okay	0.01458	0	okay
	4 DEAD + WIND(S-N)	0	25.83	200.0	okay	0.23297	0	okay
		2.434	33.07	200.0	okay	0.15162	0	okay
		4.867	40.31	200.0	okay	0.05025	0	okay
		7.301	47.55	200.0	okay	0.08279	0	okay
		9.734	54.79	200.0	okay	0.22415	0	okay
	5 DEAD + SNOW + WIND(S-N)	0	42.23	200.0	okay	0.35543	0	okay
		2.434	49.47	200.0	okay	0.22878	0	okay
		4.867	56.71	200.0	okay	0.08212	0	okay
		7.301	63.95	200.0	okay	0.11228	0	okay
		9.734	71.19	200.0	okay	0.29895	0	okay
	6 TRANSPORTATION + WIND(N-S)	0	0.28	250.0	okay	0	0.089968264	okay
		2.434	11.30	250.0	okay	0	0.077790381	okay
		4.867	22.89	250.0	okay	0	0.040010796	okay
		7.301	34.47	250.0	okay	0	0.064918227	okay
		9.734	46.05	250.0	okay	0	0.15390872	okay
	7 TRANSPORTATION + WIND(S-N)	0	1.03	250.0	okay	0.03726	0	okay
		2.434	8.27	250.0	okay	0.027	0	okay
		4.867	15.51	250.0	okay	0.00073	0	okay
		7.301	22.75	250.0	okay	0.04157	0	okay
		9.734	29.99	250.0	okay	0.09984	0	okay
11	1 DEAD + SNOW	0	45.78	143.8	okay	0.41601	0	okay
		2.171	45.78	143.8	okay	0.25905	0	okay
		4.341	45.78	143.8	okay	0.1021	0	okay

	6.512	45.78	143.8	okay	0.09492	0	okay
	8.682	45.78	143.8	okay	0.25188	0	okay
2 DEAD + WIND(N-S)	0	24.79	200.0	okay	0.16942	0	okay
	2.171	31.25	200.0	okay	0.10038	0	okay
	4.341	37.71	200.0	okay	0.01543	0	okay
	6.512	44.16	200.0	okay	0.08813	0	okay
	8.682	50.56	200.0	okay	0.2049	0	okay
3 DEAD + SNOW + WIND(N-S)	0	41.21	200.0	okay	0.28096	0	okay
	2.171	47.66	200.0	okay	0.17146	0	okay
	4.341	54.12	200.0	okay	0.04606	0	okay
	6.512	60.58	200.0	okay	0.10908	0	okay
	8.682	66.98	200.0	okay	0.26631	0	okay
4 DEAD + WIND(S-N)	0	21.90	200.0	okay	0.08152	0	okay
	2.171	11.57	200.0	okay	0.04029	0	okay
	4.341	1.23	200.0	okay	0.02452	0	okay
	6.512	9.10	200.0	okay	0.03421	0	okay
	8.682	19.34	200.0	okay	0.06935	0	okay
5 DEAD + SNOW + WIND(S-N)	0	38.30	200.0	okay	0.19234	0	okay
	2.171	27.96	200.0	okay	0.11071	0	okay
	4.341	17.63	200.0	okay	0.05454	0	okay
	6.512	7.30	200.0	okay	0.02383	0	okay
	8.682	2.94	200.0	okay	0.01857	0	okay
6 TRANSPORTATION + WIND(N-S)	0	0.01	250.0	okay	0	0.020879916	okay
	2.171	6.46	250.0	okay	0	0.014500132	okay
	4.341	12.92	250.0	okay	0	0.016635483	okay
	6.512	19.38	250.0	okay	0	0.048474362	okay
	8.682	25.78	250.0	okay	0	0.093039036	okay
7 TRANSPORTATION + WIND(S-N)	0	2.90	250.0	okay	0	0.067803151	okay
	2.171	13.24	250.0	okay	0	0.051891217	okay
	4.341	23.57	250.0	okay	0	0.015616511	okay
	6.512	33.90	250.0	okay	0	0.066354565	okay
	8.682	44.14	250.0	okay	0	0.143366073	okay

C.2.2 Connections

Preliminary

Connection	Moment Arm (in)	# bolts	Z' (lbs/bolt)	Mn (lb-in)	Mu (lb-in)	Plate Depth (in)	S plate (in^3)	fy = Mu/S (psi)	Fy = 36 ksi
A	12	4	1636.8	78566.4	49000	6.5	1.76	27834.32	
B	12	4	1636.8	78566.4	57000	7	2.04	27918.37	
C	12	4	1636.8	78566.4	93000	10	4.17	22320.00	
D	12	4	1636.8	78566.4	22000	10	4.17	5280.00	
E	12	4	1636.8	78566.4	69000	10	4.17	16560.00	
F	12	4	1636.8	78566.4	48000	7	2.04	23510.20	

Checks

A

Locating Center of Moment

	x (in)	y (in)
bolt 1	0	0
bolt 2	5	0
bolt 3	14.75	11.75
bolt 4	14.75	16.75
center	8.625	7.125

Force in Each Bolt

Moment (lb-in)	1 Radius (in)	1 # bolts	1 F bolt (lbs)	2 Radius (in)	2 # bolts	2 F bolt (lbs)
49000	8.0625	2	1031.137212	11.25	2	1438.796109

B

Locating Center of Moment

	x (in)	y (in)
bolt 1	0	0
bolt 2	0	5
bolt 3	10.75	17.6875
bolt 4	15.75	18.125
center	6.625	10.203125

Force in Each Bolt

Moment (lb-in)	1 Radius (in)	1 # bolts	1 F bolt (lbs)	2 Radius (in)	2 # bolts	2 F bolt (lbs)
57000	8.4375	2	1094.4	12.1875	2	1580.8

F

Locating Center of Moment

	x (in)	y (in)
bolt 1	0	0
bolt 2	0	5
bolt 3	9.75	16.125
bolt 4	14.6875	16.8125
center	6.109375	9.484375

Force in Each Bolt

Moment (lb-in)	1 Radius (in)	1 # bolts	1 F bolt (lbs)	2 Radius (in)	2 # bolts	2 F bolt (lbs)
48000	7.5625	2	980.2118054	11.3125	2	1466.267246

C-D-E

2

	x (in)	y (in)
bolt 1	0	0
bolt 2	0	5
bolt 3	9.75	16.125
bolt 4	14.6875	16.8125
center	6.109375	9.484375

Force in Each Bolt

Moment (lb-in)	1 Radius (in)	1 # bolts	1 F bolt (lbs)	2 Radius (in)	2 # bolts	2 F bolt (lbs)
48000	7.5625	2	980.2118054	11.3125	2	1466.267246

C.3 Shear Walls

C.3.1 South Shear Wall

Beams over south door/windows act as collectors with south shear wall resisting E-W wind and longitudinal braking forces.

Due to sudden start and stop, the loads will be analyzed as seismic.

$b := 10.5 \cdot ft$ shear wall length, ft.

$h := 8 \cdot ft$ shear wall height, ft.

$w := 8 \cdot ft$ tributary width, ft.

End Posts:

$A := 3.5 \cdot in \cdot 3 \cdot in$ doubled 2 x 4s

$E := 1400000 \cdot \frac{lb}{in^2}$ modulus of elasticity of end posts, psi

Wind Pressures:

$p_driving := 12 \cdot \frac{lb}{ft^2}$

$p_suction := 3.7 \cdot \frac{lb}{ft^2}$

$p := p_driving + p_suction$ $\qquad p = 15.7 \frac{lb}{ft^2}$

$C := p \cdot w \cdot h$

$T := C$ $\qquad C = 1.005 \times 10^3 \, lb$

Unit Shear Capacity:

$\Omega := 2$

$v := \frac{T}{b}$ $\qquad v = 95.695 \frac{lb}{ft}$

Specific Gravity Adjustment Factor:

$G := .42$ For Spruce Pine Fir

$SGAF := 1 - (.5 - G)$

$SGAF = 0.92$

3/8" OSB Structural Sheathing nailed at 6 in O.C. with 6d common or galvanized box nails.

(Table 4.3A of NDS Supplement)

$v_resisting := 390 \frac{lb}{ft}$

$v_all := \frac{v_resisting \cdot SGAF}{\Omega}$

$v_all = 179.4 \frac{lb}{ft}$

$GvTv := 77500 \frac{lb}{in}$

$t := \frac{3}{8} \cdot in$

$spacing := 6 \cdot in$

$spacing = 0.5\, ft$

Deflection:

Apparent Shear Wall Stiffness (Tables 4.3A, 4.3B, 4.3C)

$Ga := .4 \cdot 13000 \cdot \frac{lb}{in}$

$Ga = 6.24 \times 10^{4} \frac{lb}{ft}$

Deflection of anchorage (assumption):

$d_a := .5in$

Nail Slip:

$Vn := 1.4 \cdot v \cdot spacing$

$Vn = 66.987\, lb$

$e_n := \left(\frac{Vn}{456 \cdot lb}\right)^{3.144}$

$e_n = 2.405 \times 10^{-3}$

Deflection:

$$\Delta := \frac{8 \cdot v \cdot h^3}{E \cdot A \cdot b} + \frac{v \cdot h}{GvTv} + .75 \cdot h \cdot e_n + d_a$$

Where:

A=area of the boundary element (vertical member of the shear wall boundary) (in^2)
b= width of the shear wall segment (ft)
d_a=deflection due to the anchorage detail (hard to get)
E=modulus of elasticity of the vertical stud on the wall edge (boundary element) (psi)
e_n=nail slip (in)
G=shear modulus of the sheathing (psi)
h=wall height (ft)
t=effective thickness of the structural panel for shear (in)
v=maximum shear at the top of the wall (lb/ft)
Δ=deflection (in)

$$\Delta = 0.059\,\text{ft}$$

Chord Check:

$$T = 1.005 \times 10^3\,\text{lb}$$

$$Ft := 450 \cdot \frac{lb}{in^2}$$

$$Areq := \frac{T}{Ft}$$

$$Areq = 0.016\,\text{ft}^2$$

$$A1 := 1.5 \cdot in \cdot 3.5 \cdot in$$

$$A1 = 0.036\,\text{ft}^2$$

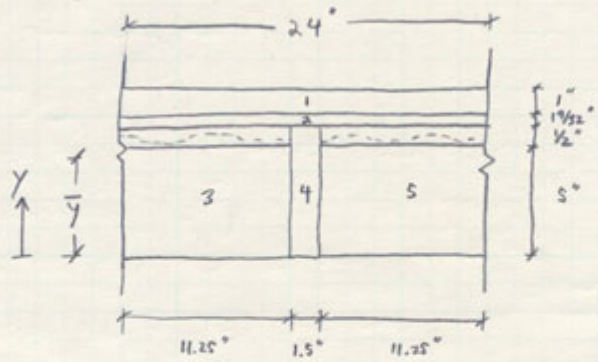
Use 2 x 4 Spruce Pine Fir Framing @ 16" OC with 3/8" OSB nailed @ 6" for all walls.

C.3.2 North Shear Wall

The shear area on the North Wall is much greater than that of the South Wall collector. Therefore, it will be adequate to the same specifications.

D. Roof Calculations

8' Span | Roof | SD 2009 | 1



$A_1 = 24\ in^2$ $\quad y_1 = 6.594\ in$ $\quad E_1 = 2000\ psi$

$A_2 = 14.25\ in^2$ $\quad y_2 = 5.797\ in$ $\quad E_2 = .7 \times 10^6\ psi$

$A_3 = 56.25\ in^2$ $\quad y_3 = 2.5\ in$ $\quad E_3 = 2000\ psi$

$A_4 = 8.25\ in^2$ $\quad y_4 = 2.75\ in$ $\quad E_4 = .7 \times 10^6\ psi$

$A_5 = 56.25\ in^2$ $\quad y_5 = 2.5\ in$ $\quad E_5 = 2000\ psi$

$I_1 = \frac{1}{12}(24")(1")^3 = 2\ in^4$

$I_2 = \frac{1}{12}(24")(19/32")^3 = .418\ in^4$

$I_3 = 1/12(11.25")(5")^3 = 117.18\ in^4$

$I_4 = \frac{1}{12}(1.5")(5.5")^3 = 20.8\ in^4$

$I_5 = I_3 = 117.18\ in^4$

$$\bar{Y} = \frac{316512 + 5.78e^7 + 281250 + 1.59e^7 + 281250}{48000 + 9.98e^6 + 112500 + 5.78e^6 + 112500} = \frac{7.458e^7}{1.6078e^7} = 4.65\ in$$

$d_1 = 1.944\ in$

$d_2 = 1.147\ in$

$d_3 = 2.151\ in$

$d_4 = 1.900\ in$

$d_5 = 2.151\ in$

8' Span | Roof | SD 2009 | 2

$$EI = \sum_{i=1}^{5} E(I_i + A_i d_i^2)$$

$$= 2000\left[2 + (24)(1.944)^2\right] + .7e^6\left[.418 + (14.25)(1.147)^2\right]$$

$$+ 2000\left[117.18 + (56.25)(2.15)^2\right](2) + .7e^6\left[20.8 + (8.25)(1.9)^2\right]$$

$$= 185399 + 1.34e^7 + 1.51e^6 + 3.54e^7$$

$$= 5.05e^7 \text{ lb}\cdot\text{in}^2$$

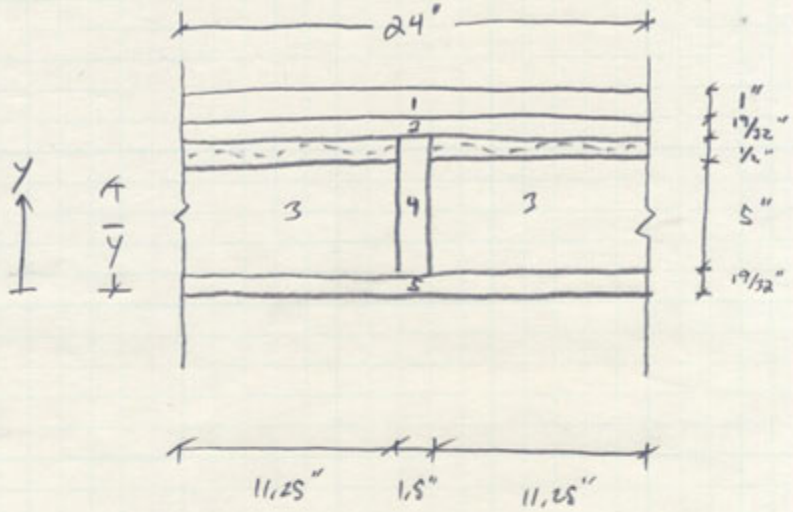
$$w = 70 \text{ psf} = 140 \text{ plf} = 11.67 \text{ lb/in}$$

$$l = 96 \text{ in} \Rightarrow l/360 = .267 \text{ in}$$

$$\Delta = \frac{5wl^4}{384EI} = \frac{5(11.67 \text{ lb/in})(96 \text{ in})^4}{384(5.05e^7 \text{ lb}\cdot\text{in}^2)} = .256 \text{ in} < .267 \text{ in}$$

ok

12' Span | Roof | SD 2009 | 1



$A_1 = 24\ in^2$ $\quad y_1 = 7.188\ in$ $\quad E_1 = 2000\ psi$

$A_2 = 14.25\ in^2$ $\quad y_2 = 6.391\ in$ $\quad E_2 = .7 \times 10^6\ psi$

$A_3 = 112.5\ in^2$ $\quad y_3 = 3.094\ in$ $\quad E_3 = 2000\ psi$

$A_4 = 8.25\ in^2$ $\quad y_4 = 3.344\ in$ $\quad E_4 = .7 \times 10^6\ psi$

$A_5 = 14.25\ in^2$ $\quad y_5 = .297\ in$ $\quad E_5 = .7 \times 10^6\ psi$

$I_1 = 2\ in^4$

$I_2 = .418\ in^4$

$I_3 = 234.36\ in^4$

$I_4 = 20.8\ in^4$

$I_5 = .418\ in^4$

$$\bar{y} = \frac{345024 + 6.38e^7 + 696150 + 1.93e^7 + 2.76e^6}{48000 + 9.98e^6 + 225000 + 5.78e^6 + 9.98e^6}$$

$$= \frac{8.71e^7\ lb \cdot in}{2.6e^7\ lb}$$

$$= 3.35\ in$$

12' Span | Roof | SD2009 | 2

$d_1 = 3.838$ in

$d_2 = 3.041$ in

$d_3 = .256$ in

$d_4 = .006$ in

$d_5 = 3.053$ in

$$EI = 2000\left[2 + (24)(3.838)^2\right] + .7e^6\left[.418 + (14.25)(3.041)^2\right]$$

$$+ 2000\left[234.36 + (14.25)(.256)^2\right] + .7e^6\left[20.18 + (8.25)(.006)^2\right]$$

$$+ .7e^6\left[.418 + (14.25)(3.053)^2\right]$$

$$= 711052 + 9.25e^7 + 470588 + 1.46e^7 + 9.33e^7$$

$$= 2.02e^8 \text{ lb}\cdot\text{in}^2$$

$$l = 144 \text{ in} \Rightarrow l/360 = .4 \text{ in}$$

$$\Delta = \frac{5(11.67 \text{ lb/in})(144 \text{ in})^4}{384(2.02e^8 \text{ lb}\cdot\text{in}^2)} = .323 \text{ in} < .4 \text{ in}$$

okay

E. Decks and Ramps

E.1 Decking Selection

Computer Program:

Decking Analysis

Overview:

Acceptance verification for decking subjected to uniform dead and live loads. The program is based on wood design principles using NDS 2005. The program analyzes ability of member to resist shear forces and bending moments. The continuous, multi-span decking experiences maximum positive moments at mid span and maximum negative moments over the supports. The maximum magnitude (absolute value) of the bending moments will be used for design/analysis. For decking, it is assumed that the magnitude of midspan moments control. A conservative idealization of continuous beams as simply supported spans will be used for simplicity and design speed.

Assumptions:

Sawn lumber
Exterior use (Moisture Content > 19%)
Flat use
Boards butted

Input:

Nominal Depth, in
Nominal Width, in
Tributary Width, ft
Span, ft
Species/Grade and associated reference design values

Output:

Acceptance cells must read “okay.” If any cells display “NG”, either geometric or strength properties must be revised until they read “okay.”

Table 4–3a. Strength properties of some commercially important woods grown in the United States (metric)[a]—con.

Common species names	Moisture content	Specific gravity[b]	Static bending: Modulus of rupture (kPa)	Static bending: Modulus of elasticity[c] (MPa)	Static bending: Work to maximum load (kJ/m^3)	Impact bending (mm)	Compression parallel to grain (kPa)	Compression perpendicular to grain (kPa)	Shear parallel to grain (kPa)	Tension perpendicular to grain (kPa)	Side hardness (N)
Hickory, pecan											
Bitternut	Green	0.60	71,000	9,700	138	1,680	31,500	5,500	8,500	—	—
	12%	0.66	118,000	12,300	125	1,680	62,300	11,600	—	—	—
Nutmeg	Green	0.56	63,000	8,900	157	1,370	27,400	5,200	7,100	—	—
	12%	0.60	114,000	11,700	173	—	47,600	10,800	—	—	—
Pecan	Green	0.60	68,000	9,400	101	1,350	27,500	5,400	10,200	4,700	5,800
	12%	0.66	94,000	11,900	95	1,120	54,100	11,900	14,300	—	8,100
Water	Green	0.61	74,000	10,800	130	1,420	32,100	6,100	9,900	—	—
	12%	0.62	123,000	13,900	133	1,350	59,300	10,700	—	—	—
Hickory, true											
Mockernut	Green	0.64	77,000	10,800	180	2,240	30,900	5,600	8,800	—	—
	12%	0.72	132,000	15,300	156	1,960	61,600	11,900	12,000	—	—
Pignut	Green	0.66	81,000	11,400	219	2,260	33,200	6,300	9,400	—	—
	12%	0.75	139,000	15,600	210	1,880	63,400	13,700	14,800	—	—
Shagbark	Green	0.64	76,000	10,800	163	1,880	31,600	5,800	10,500	—	—
	12%	0.72	139,000	14,900	178	1,700	63,500	12,100	16,800	—	—
Shellbark	Green	0.62	72,000	9,200	206	2,640	27,000	5,600	8,200	—	—
	12%	0.69	125,000	13,000	163	2,240	55,200	12,400	14,500	—	—
Honeylocust	Green	0.60	70,000	8,900	87	1,190	30,500	7,900	11,400	6,400	6,200
	12%	—	101,000	11,200	92	1,190	51,700	12,700	15,500	6,200	7,000
Locust, black	Green	0.66	95,000	12,800	106	1,120	46,900	8,000	12,100	5,300	7,000
	12%	0.69	134,000	14,100	127	1,450	70,200	12,600	17,100	4,400	7,600
Magnolia											
Cucumber tree	Green	0.44	51,000	10,800	69	760	21,600	2,300	6,800	3,000	2,300
	12%	0.48	85,000	12,500	84	890	43,500	3,900	9,200	4,600	3,100
Southern	Green	0.46	47,000	7,700	106	1,370	18,600	3,200	7,200	4,200	3,300
	12%	0.50	77,000	9,700	88	740	37,600	5,900	10,500	5,100	4,500
Maple											
Bigleaf	Green	0.44	51,000	7,600	60	580	22,300	3,100	7,700	4,100	2,800
	12%	0.48	74,000	10,000	54	710	41,000	5,200	11,900	3,700	3,800
Black	Green	0.52	54,000	9,200	88	1,220	22,500	4,100	7,800	5,000	3,700
	12%	0.57	92,000	11,200	86	1,020	46,100	7,000	12,500	4,600	5,200
Red	Green	0.49	53,000	9,600	79	810	22,600	2,800	7,900	—	3,100
	12%	0.54	92,000	11,300	86	810	45,100	6,900	12,800	—	4,200
Silver	Green	0.44	40,000	6,500	76	740	17,200	2,600	7,200	3,900	2,600
	12%	0.47	61,000	7,900	57	640	36,000	5,100	10,200	3,400	3,100
Sugar	Green	0.56	65,000	10,700	92	1,020	27,700	4,400	10,100	—	4,300
	12%	0.63	109,000	12,600	114	990	54,000	10,100	16,100	—	6,400
Oak, red											
Black	Green	0.56	57,000	8,100	84	1,020	23,900	4,900	8,400	—	4,700
	12%	0.61	96,000	11,300	94	1,040	45,000	6,400	13,200	—	5,400
Cherrybark	Green	0.61	74,000	12,300	101	1,370	31,900	5,200	9,100	5,500	5,500
	12%	0.68	125,000	15,700	126	1,240	60,300	8,600	13,800	5,800	6,600
Laurel	Green	0.56	54,000	9,600	77	990	21,900	3,900	8,100	5,300	4,400
	12%	0.63	87,000	11,700	81	990	48,100	7,300	12,600	5,400	5,400
Northern red	Green	0.56	57,000	9,300	91	1,120	23,700	4,200	8,300	5,200	4,400
	12%	0.63	99,000	12,500	100	1,090	46,600	7,000	12,300	5,500	5,700
Pin	Green	0.58	57,000	9,100	97	1,220	25,400	5,000	8,900	5,500	4,800
	12%	0.63	97,000	11,900	102	1,140	47,000	7,000	14,300	7,200	6,700
Scarlet	Green	0.60	72,000	10,200	103	1,370	28,200	5,700	9,700	4,800	5,300
	12%	0.67	120,000	13,200	141	1,350	57,400	7,700	13,000	6,000	6,200
Southern red	Green	0.52	48,000	7,900	55	740	20,900	3,800	6,400	3,300	3,800
	12%	0.59	75,000	10,300	65	660	42,000	6,000	9,600	3,500	4,700
Water	Green	0.56	61,000	10,700	77	990	25,800	4,300	8,500	5,700	4,500
	12%	0.63	106,000	13,900	148	1,120	46,700	7,000	13,900	6,300	5,300

Black Locust Design Values for the analysis of decking:

Values taken from Wood Hanbook (see appendix) and converted to english units.

					Compression		Shear	Tension
			Modulus of Rupture	Modulus of Elasticity	Parallel	Perp	Parallel	Perp
	Moisture	Specific Gravity	kPa	Mpa	kPa	kPa	kPa	kPa
Black Locust	12%	0.69	134000	14100	70200	12600	17100	4400
			psi	psi	psi	psi	psi	psi
			19435	2045032	10182	1827	2480	638

Lumber

Species	Black Locust	
Commercial Grade		

Load

Dead Load	3.588	psf
Live Load	50	psf
Load	53.588	psf
Spacing	12	in *look at 1 ft width
Distr. Dead Load	3.588	plf
Distr. Live Load	50	plf
Distr. Load	53.588	plf

Dimensions

Nominal Depth	1 1/4	in
Actual Depth	1.00	in
Nomial Width	6	in
Actual Width	12	in *look at 1 ft width
Span	1.333333333	ft
Unbraced Length	0	ft

Factors

CD	1.00	Occupancy Live Load
CM	0.85	Outdoor Use
Ct	1.00	T < 100 deg F
CL	1.00	
CF	1.00	
Cfu	1.15	
Ci	1.00	Not incised
Cr	1.15	Floor Joist
Cp	1.00	
CT	1.00	
Cb	1.00	bearing factor (not in)

Properties

Moment of Inertia	1	in^4
Section Modulus	2	in^3
Max Moment	142.9013333	lb-in

Design Values		Wood Handbook
Fb	19435	psi
Ft	638	psi
Fv	2480	psi
Fcperp	1827	psi
Fc	10182	psi
E	2045032	psi
Emin		psi

Adjusted Design Values

Fb'	21847.36938	psi
Ft'	542.3	psi
Fv'	2108	psi
Fcperp'	1552.95	psi
Fc'	8654.7	psi
E'	1738277.2	psi
Emin'	0	psi

Stresses

Max Bending Stress	71.45066667	psi	okay
Max Shear Stress	4.465666667	psi	okay

Deflection

Short Term	0.024545376	in
Long Term	0.001761376	in
Total	0.02718744	in

Deflection Ratio, L/Total	588.507051	okay Limit = 240

E.1.1 Egress Check

Lumber		
Species	Black Locust	
Commercial Grade		
Load		
Dead Load	3.588	psf
Live Load	100	psf
Load	103.588	psf
Spacing	12	in *look at 1 ft width
Distr. Dead Load	3.588	plf
Distr. Live Load	100	plf
Distr. Load	103.588	plf
Dimensions		
Nominal Depth	1 1/4	in
Actual Depth	1	in
Nomial Width	6	in
Actual Width	12	in *look at 1 ft width
Span	1.333333333	ft
Unbraced Length	0	ft
Factors		
CD	1.00	Occupancy Live Load
CM	0.85	Outdoor Use
Ct	1.00	T < 100 deg F
CL	1.00	
CF	1.00	
Cfu	1.15	
Ci	1.00	Not incised
Cr	1.15	Floor Joist
Cp	1.00	
CT	1.00	
Cb	1.00	bearing factor (not in)
Properties		
Moment of Inertia	1	in^4
Section Modulus	2	in^3
Max Moment	276.2346667	lb-in
Design Values		Wood Handbook
Fb	19435	psi
Ft	638	psi
Fv	2480	psi
Fcperp	1827	psi
Fc	10182	psi
E	2045032	psi
Emin		psi

Adjusted Design Values

Fb'	21847.36938	psi
Ft'	542.3	psi
Fv'	2108	psi
Fcperp'	1552.95	psi
Fc'	8654.7	psi
E'	1738277.2	psi
Emin'	0	psi

Stresses

Max Bending Stress	138.1173333	psi	okay
Max Shear Stress	8.632333333	psi	okay

E.2 Joist Selection

Computer Program:

Exterior Deck Joist Analysis

Overview:

Acceptance verification for exterior deck joists subjected to uniform dead and live loads. The program is based on wood design principles using NDS 2005. The program analyzes ability of member to resist shear forces and bending moments.

Assumptions:

Sawn lumber
Exterior use (Moisture Content > 19%)
Pressure treated

Input:

O.C. spacing, in
Nominal Depth, in
Nominal Width, in
Span, ft
Species/Grade and associated reference design values

Output:

Acceptance cells must read "okay." If any cells display "NG", either geometric or strength properties must be revised until they read "okay."

Typical Deck Joist Selection 1 - 2x8:

Lumber

Species	Southern Pine	
Commercial Grade	No. 2	

Load

Dead Load	5	psf
Live Load	50	psf
Load	55	psf
Joist Spacing	16	in
Distr. Dead Load	6.666666667	plf
Distr. Live Load	66.66666667	plf
Distr. Load	73.33333333	plf

Dimensions

Nominal Depth	8	in
Actual Depth	7.25	in
Nomial Width	2	in
Actual Width	1.5	in
Span	5	ft
Unbraced Length	0	ft

Factors

CD	1.00	Occupancy Live Load
CM (Fb)	0.85	outdoor use
CM (Ft)	1.00	outdoor use
CM (Fv)	0.97	outdoor use
CM (Fcperp)	0.67	outdoor use
CM (fc)	0.80	outdoor use
CM (E,Emin)	0.90	outdoor use
Ct	1.00	T < 100 deg F
CL	1.00	
CF	1.00	
Cfu	1.00	Loaded on Narrow Edge
Ci	1.00	Not incised
Cr	1.15	Floor Joist
Cp	1.00	
CT	1.00	
Cb	1.00	bearing factor (not in)

Properties

Moment of Inertia	47.63476563	in^4
Section Modulus	13.140625	in^3
Max Moment	2750	lb-in

Design Values NDS Table 5A

Fb	1500	psi
Ft	825	psi
Fv	175	psi

Fcperp	565	psi
Fc	1650	psi
E	1600000	psi
Emin	580000	psi

Adjusted Design Values

Fb'	1466.25	psi
Ft'	825	psi
Fv'	169.75	psi
Fcperp'	378.55	psi
Fc'	1320	psi
E'	1440000	psi
Emin'	522000	psi

Stresses

Max Bending Stress	209.274673	psi	okay
Max Shear Stress	25.28735632	psi	okay

Deflection

Short Term	0.164008364	in	L/	366
Long Term	0.016400836	in	L/	3658
Total	0.188609619	in	L/	318

Deflection Ratio, L/Total	318.1173913	okay
		Limit = 240

Typical Deck Joist Selection 2 - 2x10:

Lumber

Species	Southern Pine	
Commercial Grade	No. 2	

Load

Dead Load	5	psf
Live Load	50	psf
Load	55	psf
Joist Spacing	16	in
Distr. Dead Load	6.666666667	plf
Distr. Live Load	66.66666667	plf
Distr. Load	73.33333333	plf

Dimensions

Nominal Depth	10	in
Actual Depth	9.25	in
Nomial Width	2	in
Actual Width	1.5	in
Span	7	ft
Unbraced Length	0	ft

Factors

CD	1.00	Occupancy Live Load
CM (Fb)	0.85	outdoor use
CM (Ft)	1.00	outdoor use
CM (Fv)	0.97	outdoor use
CM (Fcperp)	0.67	outdoor use
CM (fc)	0.80	outdoor use
CM (E,Emin)	0.90	outdoor use
Ct	1.00	T < 100 deg F
CL	1.00	
CF	1.00	
Cfu	1.00	Loaded on Narrow Edge
Ci	1.00	Not incised
Cr	1.15	Floor Joist
Cp	1.00	
CT	1.00	
Cb	1.00	bearing factor (not in)

Properties

Moment of Inertia	98.93164063	in^4
Section Modulus	21.390625	in^3
Max Moment	5390	lb-in

Design Values NDS Table 5A

Fb	1500	psi
Ft	825	psi
Fv	175	psi

Fcperp	565	psi
Fc	1650	psi
E	1600000	psi
Emin	580000	psi

Adjusted Design Values

Fb'	1466.25	psi
Ft'	825	psi
Fv'	169.75	psi
Fcperp'	378.55	psi
Fc'	1320	psi
E'	1440000	psi
Emin'	522000	psi

Stresses

Max Bending Stress	251.9795471	psi	okay
Max Shear Stress	27.74774775	psi	okay

Deflection

Short Term	0.30336604	in	L/	277
Long Term	0.030336604	in	L/	2769
Total	0.348870945	in	L/	241

Deflection Ratio, L/Total	240.7767144	okay
		Limit = 240

Typical Deck Joist Selection 3 - 2x10:

Lumber		
Species	Southern Pine	
Commercial Grade	No. 2	
Load		
Dead Load	100	psf
Live Load	30	psf
Load	130	psf
Joist Spacing	16	in
Distr. Dead Load	133.3333333	plf
Distr. Live Load	40	plf
Distr. Load	173.3333333	plf
Dimensions		
Nominal Depth	10	in
Actual Depth	9.25	in
Nomial Width	2	in
Actual Width	1.5	in
Span	5	ft
Unbraced Length	0	ft
Factors		
CD	1.00	Occupancy Live Load
CM (Fb)	0.85	outdoor use
CM (Ft)	1.00	outdoor use
CM (Fv)	0.97	outdoor use
CM (Fcperp)	0.67	outdoor use
CM (fc)	0.80	outdoor use
CM (E,Emin)	0.90	outdoor use
Ct	1.00	T < 100 deg F
CL	1.00	
CF	1.00	
Cfu	1.00	Loaded on Narrow Edge
Ci	1.00	Not incised
Cr	1.15	Floor Joist
Cp	1.00	
CT	1.00	
Cb	1.00	bearing factor (not in)
Properties		
Moment of Inertia	98.93164063	in^4
Section Modulus	21.390625	in^3
Max Moment	6500	lb-in
Design Values		NDS Table 5A
Fb	1500	psi
Ft	825	psi
Fv	175	psi

Fcperp	565	psi
Fc	1650	psi
E	1600000	psi
Emin	580000	psi

Adjusted Design Values

Fb'	1466.25	psi
Ft'	825	psi
Fv'	169.75	psi
Fcperp'	378.55	psi
Fc'	1320	psi
E'	1440000	psi
Emin'	522000	psi

Stresses

Max Bending Stress	303.871439	psi	okay
Max Shear Stress	46.84684685	psi	okay

E.2.1 Egress Check

Typical Deck Joist Selection 1 - 2x8:

Lumber		
Species	Southern Pine	
Commercial Grade	No. 2	
Load		
Dead Load	5	psf
Live Load	100	psf
Load	105	psf
Joist Spacing	16	in
Distr. Dead Load	6.666666667	plf
Distr. Live Load	133.3333333	plf
Distr. Load	140	plf
Dimensions		
Nominal Depth	8	in
Actual Depth	7.25	in
Nomial Width	2	in
Actual Width	1.5	in
Span	8	ft
Unbraced Length	0	ft
Factors		
CD	1.00	Occupancy Live Load
CM (Fb)	0.85	outdoor use
CM (Ft)	1.00	outdoor use
CM (Fv)	0.97	outdoor use
CM (Fcperp)	0.67	outdoor use
CM (fc)	0.80	outdoor use
CM (E,Emin)	0.90	outdoor use
Ct	1.00	T < 100 deg F
CL	1.00	
CF	1.00	
Cfu	1.00	Loaded on Narrow Edge
Ci	1.00	Not incised
Cr	1.15	Floor Joist
Cp	1.00	
CT	1.00	
Cb	1.00	bearing factor (not in)
Properties		
Moment of Inertia	47.63476563	in^4
Section Modulus	13.140625	in^3
Max Moment	13440	lb-in
Design Values		NDS Table 5A
Fb	1500	psi
Ft	825	psi
Fv	175	psi

Fcperp	565	psi
Fc	1650	psi
E	1600000	psi
Emin	580000	psi

Adjusted Design Values

Fb'	1466.25	psi
Ft'	825	psi
Fv'	169.75	psi
Fcperp'	378.55	psi
Fc'	1320	psi
E'	1440000	psi
Emin'	522000	psi

Stresses

Max Bending Stress	1022.782402	psi	okay
Max Shear Stress	77.24137931	psi	okay

Typical Deck Joist Selection 2 - 2x10:

Lumber		
Species	Southern Pine	
Commercial Grade	No. 2	
Load		
Dead Load	5	psf
Live Load	100	psf
Load	105	psf
Joist Spacing	16	in
Distr. Dead Load	6.666666667	plf
Distr. Live Load	133.3333333	plf
Distr. Load	140	plf
Dimensions		
Nominal Depth	10	in
Actual Depth	9.25	in
Nomial Width	2	in
Actual Width	1.5	in
Span	7	ft
Unbraced Length	0	ft
Factors		
CD	1.00	Occupancy Live Load
CM (Fb)	0.85	outdoor use
CM (Ft)	1.00	outdoor use
CM (Fv)	0.97	outdoor use
CM (Fcperp)	0.67	outdoor use
CM (fc)	0.80	outdoor use
CM (E,Emin)	0.90	outdoor use
Ct	1.00	T < 100 deg F
CL	1.00	
CF	1.00	
Cfu	1.00	Loaded on Narrow Edge
Ci	1.00	Not incised
Cr	1.15	Floor Joist
Cp	1.00	
CT	1.00	
Cb	1.00	bearing factor (not in)
Properties		
Moment of Inertia	98.93164063	in^4
Section Modulus	21.390625	in^3
Max Moment	10290	lb-in
Design Values		NDS Table 5A
Fb	1500	psi
Ft	825	psi
Fv	175	psi

Fcperp	565	psi
Fc	1650	psi
E	1600000	psi
Emin	580000	psi

Adjusted Design Values

Fb'	1466.25	psi
Ft'	825	psi
Fv'	169.75	psi
Fcperp'	378.55	psi
Fc'	1320	psi
E'	1440000	psi
Emin'	522000	psi

Stresses

Max Bending Stress	481.0518627	psi	okay
Max Shear Stress	52.97297297	psi	okay

E.3 Girder Selection

Computer Program:

Exterior Girder Analysis

Overview:

Acceptance verification for exterior girder subjected to uniform dead and live loads. The program is based on wood design principles using NDS 2005. The program analyzes ability of member to resist shear forces and bending moments. The continuous, multi-span girder experiences maximum positive moments at mid span and maximum negative moments over the supports. The maximum magnitude (absolute value) of the bending moments will be used for design/analysis. For girders used in exterior decking, it is assumed that the magnitude of midspan moments control. A conservative idealization of continuous beams as simply supported spans will be used for simplicity and design speed.

Assumptions:

Sawn lumber
Exterior use (Moisture Content > 19%)
Pressure Treated

Input:

Nominal Depth, in
Nominal Width, in
Tributary Width, ft
Span, ft
Species/Grade and associated reference design values

Output:

Acceptance cells must read “okay.” If any cells display “NG”, either geometric or strength properties must be revised until they read “okay.”

Girder Selection - 2x10:

Lumber		
Species	Southern Pine	
Commercial Grade	No. 2	
Load		
Dead Load	5	psf
Live Load	50	psf
Load	55	psf
Tributary Width	42	in
Distr. Dead Load	17.5	plf
Distr. Live Load	175	plf
Distr. Load	192.5	plf
Dimensions		
Nominal Depth	10	in
Actual Depth	9.25	in
Nomial Width	2	in
Actual Width	1.5	in
Span	5	ft
Unbraced Length	0	ft
Factors		
CD	1.00	Occupancy Live Load
CM (Fb)	0.85	outdoor use
CM (Ft)	1.00	outdoor use
CM (Fv)	0.97	outdoor use
CM (Fcperp)	0.67	outdoor use
CM (fc)	0.80	outdoor use
CM (E,Emin)	0.90	outdoor use
Ct	1.00	T < 100 deg F
CL	1.00	
CF	1.00	
Cfu	1.00	Loaded on Narrow Edge
Ci	1.00	Not incised
Cr	1.00	Floor Joist
Cp	1.00	
CT	1.00	
Cb	1.00	bearing factor (not in)
Properties		
Moment of Inertia	98.93164063	in^4
Section Modulus	21.390625	in^3
Max Moment	7218.75	lb-in
Design Values		NDS Table 5A
Fb	1500	psi
Ft	825	psi
Fv	175	psi

Fcperp	565	psi
Fc	1650	psi
E	1600000	psi
Emin	580000	psi

Adjusted Design Values

Fb'	1275	psi
Ft'	825	psi
Fv'	169.75	psi
Fcperp'	378.55	psi
Fc'	1320	psi
E'	1440000	psi
Emin'	522000	psi

Stresses

Max Bending Stress	337.4726077	psi	okay
Max Shear Stress	52.02702703	psi	okay

Deflection

Short Term	0.207292757	in	L/	289
Long Term	0.020729276	in	L/	2894
Total	0.23838667	in	L/	252

Deflection Ratio, L/Total	251.6919255	okay
		Limit = 240

E.3.1 Egress Check

Lumber

Species	Southern Pine	
Commercial Grade	No. 2	

Load

Dead Load	5	psf
Live Load	100	psf
Load	105	psf
Tributary Width	42	in
Distr. Dead Load	17.5	plf
Distr. Live Load	350	plf
Distr. Load	367.5	plf

Dimensions

Nominal Depth	10	in
Actual Depth	9.25	in
Nomial Width	2	in
Actual Width	1.5	in
Span	5	ft
Unbraced Length	0	ft

Factors

CD	1.00	Occupancy Live Load
CM (Fb)	0.85	outdoor use
CM (Ft)	1.00	outdoor use
CM (Fv)	0.97	outdoor use
CM (Fcperp)	0.67	outdoor use
CM (fc)	0.80	outdoor use
CM (E,Emin)	0.90	outdoor use
Ct	1.00	T < 100 deg F
CL	1.00	
CF	1.00	
Cfu	1.00	Loaded on Narrow Edge
Ci	1.00	Not incised
Cr	1.00	Floor Joist
Cp	1.00	
CT	1.00	
Cb	1.00	bearing factor (not in)

Properties

Moment of Inertia	98.93164063	in^4
Section Modulus	21.390625	in^3
Max Moment	13781.25	lb-in

Design Values NDS Table 5A

Fb	1500	psi
Ft	825	psi
Fv	175	psi

Fcperp	565	psi
Fc	1650	psi
E	1600000	psi
Emin	580000	psi

Adjusted Design Values

Fb'	1275	psi
Ft'	825	psi
Fv'	169.75	psi
Fcperp'	378.55	psi
Fc'	1320	psi
E'	1440000	psi
Emin'	522000	psi

Stresses

Max Bending Stress	644.2658875	psi	okay
Max Shear Stress	99.32432432	psi	okay

F. Foundations

F.1 Jack Loads

See section F.2 Pad Sizing for calculations.

F.2 Pad Sizing

Foundation Pier Design:

Allowable load on soil:

$$q_all := 1500 \cdot \frac{lb}{ft^2}$$

Maximum point load to jacks/pads:

$$Q_max := 5500 \cdot lb$$

Factor of Safety:

Due to previous compensation of unknowns - through evaluation of load combinations and a prescribed allowable soil pressure - a factor of safety will not be applied and taken as 1.

$$FS := 1$$

Footing Area Required:

$$A_req := \frac{Q_max}{q_all \cdot FS}$$

$$A_req = 3.667\,ft^2$$

Square Footing:

$$Side_req := \sqrt{A_req}$$

$$Side_req = 1.915\,ft$$

Circular Footing:

$$d_req := \sqrt{\frac{4 \cdot A_req}{\pi}}$$

$$d_req = 2.161\,ft$$

F.3 Deck Post Sizing

Deck Posts								
Area (ft2)	Live load (psf)	Dead Load (psf)	Comined Load	Load on Column (lbs)	q-all (lbs/ft^2)	Area of footing (in^2)	Length of 6x6 post on its side (in)	Length of (2) 6x6 post on its side (in)
25	100	5	105	2625	1500	252	45.82	22.91
16	100	5	105	1680	1500	161.28	29.32	14.66
12.5	100	5	105	1312.5	1500	126	22.91	11.45
6.25	100	5	105	656.25	1500	63	11.45	5.73

	Length of 6x6 post on its side (in)	Length of (2) 6x6 post on their side (in)
Actual Dimensions Used	48	**24**
	30	**15**
	24	**12**
	12	6

5.0 Water Budget

Total Water Use

Contests		
Contest 7 - Hot Water	300	gal
Contest 8-3 - Clothes Washer	102	gal
Contest 8-5 - Dishwasher	60	gal
Contest 9-1 - Cooking	3	gal
Total	465	gal
Other		
Cold Water (approx. 1/2 DHW)	230	gal
Landscape Water	150	gal
Thermal Mass Bladder Water*	400	gal
HVAC System Charge	20	gal
Total	800	gal
Overall		
Total	1265	gal
Without Thermal Mass Bladder	865	gal

*Extra 750 gallon temporary tank will be located on construction site to allow temporary storage of water for the thermal mass bladder.

Total Contest Water Use

Total Water Use	465	gal
Max. Daily Water Use	78	gal
Total Hot Water Use	414	gal
Max. Daily Hot Water Use	68	gal

Contest 7 - Hot Water

Contest Criteria

Target Min. Temperature	110	F
Draw Time	10	min
Volume	15	gal
Total Tasks	20	tasks
Max. Tasks/day	3	tasks/day
Average Flow Rate	1.5	gal/min

Calculated Contest Water Use

Total Water Use	300	gal
Max. Daily Water Use	45	gal
Total Hot Water Use	300	gal
Max. Daily Hot Water Use	45	gal

Contest 8-3 - Clothes Washer

Contest Criteria

Target Min. Temperature	110	F
Yearly Water Use	4000	gal
# Loads/Year	392	loads
Hot Water Use/Load (%50)	5.10	gal/load
Total Tasks	10	tasks
Max. Tasks/day	2	tasks/day

Calculated Contest Water Use

Total Water Use	102	gal
Max. Daily Water Use	20	gal
Total Hot Water Use	51	gal
Max. Daily Hot Water Use	10	gal

Contest 8-5 - Dishwasher

Contest Criteria

Target Min. Temperature	120	F
Hot Water Use/Load	6	gal/load
Total Tasks	10	tasks
Max. Tasks/day	2	tasks/day

Calculated Contest Water Use

Total Water Use	60	gal
Max. Daily Water Use	12	gal
Total Hot Water Use	60	gal
Max. Daily Hot Water Use	12	gal

Contest 9-1 - Cooking

Contest Criteria

Hot Water Mass/Task	6.25	lb
Volume (Starting)	0.75	gal
Total Tasks	4	tasks
Max. Tasks/day	1	tasks/day

Calculated Contest Water Use

Total Water Use	3	gal
Max. Daily Water Use	0.75	gal
Total Hot Water Use	3	gal
Max. Daily Hot Water Use	0.75	gal

6.0 Unlisted Electrical Components

The Natural Fusion home contains one unlisted electrical component.

Solar Power Industries photovoltaic module:
Composed of three series connected SPI-C156-365M2 multicrystalline silicon photovoltaic cells integrated with Bayer MaterialScience thermoplastic polyurethane encapsulation material. Used in on the Solar Awning over the movable glass wall on the south side of the home.

Approximate Panel Parameters:

V_{oc} = 1.8VDC I_{sc} = 7.6A
V_{mp} = 1.5VDC I_{mp} = 6.9A

Multicrystalline Silicon Solar Cells – 2 Bus:

Size: 156 mm x 156 mm ± 0.5 mm
Thickness: 220 µm ± 40 µm
Front Appearance: Blue Silicon Nitride Antireflective Coating
2 mm Wide Silver Contact on Silicon Nitride
Back Appearance: Aluminum
5 mm Wide Full Length Silver Contact Pads
Electrical: Narrow current range classification

Product ID	**SPI-C156-365M2**
Efficiency (%)	15.24-15.00
Power (W_P)	3.71-3.65
Max Power Current (typ)	7.19
Max Power Current (min)	6.92
Max Power Voltage (typ)	0.512
I_{SC} (A)	7.69
V_{OC} (V)	0.612

7.0 Retail PV Price Quote(s)

The Natural Fusion home will be using Solyndra Panels and Solar Power Industries multi crystalline cells as specified in the Project Manual; Division 26; 26 31 00 Photovoltaic Collectors. We are currently working with three major industry companies including Carlisle SynTec, Solar Power Industries, C/S Group, and Bayer MaterialScience to compile an overall retail quote for photovoltaics. Though it is not entirely complete, information from companies has come in separately and exists as follows:

Carlisle SynTec Incorporated: PV Panels SL-001-191-Universal, 316736; 36 panels priced at $704.70 per unit and extended total of $25, 369.20.

Solar Power Industries: 6” square multi crystalline cell; 6 cells per awning louver with 40 louvers total; 120 cells priced at $8.81 per cell or approximately $1057.08 total at highest efficiency.

Carlisle SynTec Incorporatec

INVOICE

Ship To: PENN STATE UNIVERSITY
ATTN BRIAN GOODYKOONTZ
3127 REASEARCH DRIVE
STATE COLLEGE PA 16801
USA

Order Date: May 27, 2009
Order Number: 9297148
Purchase Order: NA

Customer Contact: BRIAN GOODYKOONTZ
Customer Account: NA

Bill To: CARLISLE SYNTEC
ACCOUNTS PAYABLE
PO BOX 7000
CARLISLE PA 17013
USA

Product	Description	Schedule B	Qty	Unit Price	Extended
316736	PV PANELS SL-001-191-UNIVERSAL	8541406020	36	$704.70	$25,369.20
	Panel installation accessories included in unit pricing				
	FOR RECORDKEEPING PURPOSES ONLY - DO NOT REMIT				
		Total:	**36**	**$704.70**	**$25,369.20**

Please contact Customer Service @ 717-245-7158 with questions

8.0 Reconfigurable Features

Several key components that allow the homeowner to adapt and create their own space include the following key features:

DETACHABLE DINING ROOM TABLE FOR EIGHT

The dining room table is a feature designed to be housed over the center island. The simplistic form, made from reclaimed and sustainably harvested wood, has several key features that extend from just seating for eight, but includes an option to divide into separate units, one for casual dining and another for a work top. Also, the table has the ability to move to any location inside or outside of the house. The last feature of the table is the ability to go above the stove top directly after cooking which enables it to be used as both an eating surface as well as a food prep surface. Overall, the dining room table was designed to be as simplistic as possible while carrying out as many possibilities one would want for a surface top.

SOUTHERN DOOR SYSTEM

This 7'-6" x 32'-0" area on the south façade enables a dissolve between interior and exterior spaces, dividing into four equal sections. Each door consists of three connected sections, allowing one to open individually, much like a regular man door, and the other two to pivot and slide open together. When the doors are open, they rest under the shade of the awning and back against the columns. The design of this wall system allows for blending of the interior and exterior spaces when desired.

SLIDING COMPUTER DESK AND ENTERTAINMENT UNIT

In order to focus on the simplicity of our home, we wanted to minimize the location of paperwork and a workspace. With the understanding that our 'clients' were to be modern and live in a more wireless world, the desk is set up to retract away from the opening and blend into the entertainment unit as a shelf. The simple design relocates the desk top at 30" from above the entertainment console to that of the opening beside the door. This movement allows for a usable workspace, but at the same time one that can be tucked away for a clean look.

PLANT COLLECTION ON THE INTERIOR WALLS

The Lifewell of the home is another means of blending the indoors with the outdoors. The Lifewell bisects the kitchen and bathroom spaces with plants to stimulate the senses. These planter boxes attach to the wall which is made up of the same exterior thermally modified poplar slats, to provide texture, color, and fragrance throughout these spaces. The innovative feature of Lifewell is that it allows the homeowner the opportunity to grow their own herbs and spices indoors to provide a fresh touch to every meal.

9.0 Interconnection Application Form

01-Jun-2009 Solar Decathlon 2009

INTERCONNECTION APPLICATION FORM

Penn State - Lot #109

team name and lot number

PV SYSTEMS

Module Manufacturer	Short Description of Array	DC Rating of Array (sum of the DC ratings)
Solyndra	Main North Roof Array	319.5VDC
Solyndra	South Roof Array	319.5VDC
Solar Power Industries	Louver Array	27.7VDC

Total DC power of all arrays is 5.8 kW (in tenths).

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INVERTERS

Inverter Manufacturer	Model Number	Voltage	Rating (kVA or kW)	Quantity
Xantrex	GT5.0	240VAC	5.0 kW	1
PV Powered	PVP2000	240VAC	2.0 kW	1
Enphase	M190-72-240-S11	240VAC	0.23 kW	3

Total AC power of all inverters is 8 kVA or kW (in whole numbers).

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

The following information is contained in the Construction Drawings:

1) One-line electrical schematic – the loads do not have to be detailed. (See E-601)
2) Calculations of service/feeder net computed load and neutral load (NEC 220) (See E-701)
3) Plan view of the lot showing the house, decks, ramps, tour paths and the service point. (See E-400, L101)
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). (See E-200, E-604)

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

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.

10.0 Energy Analysis Results and Discussion

To arrive at the final Natural Fusion home design, several factors were studied to find the best energy scenario and subsequent options for the design. Throughout the design process, as energy simulations helped to inform the team, options depicted as sub-optimal were only justified if the cost of the other factors was higher than the cost of the efficiency loss in the suboptimal option.

10.1 Green Roof Integrated Photovoltaics

The Green Roof Integrated Photovoltaic system (GRIPV) integrates the PVs with the roof through the relationship between the roof and the PVs. The solar panels are cooled by the plants through evapotranspiration and the panels, in return, shade the plants.

For the main array, the use of copper indium gallium selenide (CIGS) thin film panels provides a more level production curve that better matches consumption because of the ability of the CIGS material to better absorb diffuse solar radiation. This allows the production to peak quicker than silicon PVs and stay relatively level throughout the day, even in scattered cloud cover and overcast days.

10.1.1 Green Roofs

Green roofs have many benefits including better water runoff control and being thermally cool. Over the lifetime of the roof, green roofs are cooler than white roofs because of the self cleaning nature of the plants (white roofs tend to get dirty, reducing thermal performance). The evapotranspiration from the leaves of the plants provides a latent heat removal method that is not present on other roofs. This ability to keep the roof cooler allows the PVs to perform better. In return, the PVs act as a shading device for the plants, protecting them from scorching or dehydration, extending the time required between rains for sustained plant life. The design of the CIGS panels that have been selected allows for rain, snow, and some sunlight transmission to the plants underneath.

Because white roofs are normally used in conjunction with these PV panels, the green roofs will have a white aggregate top layer to increase the albedo of the roof for greater diffuse reflection. This will increase the PV power production.

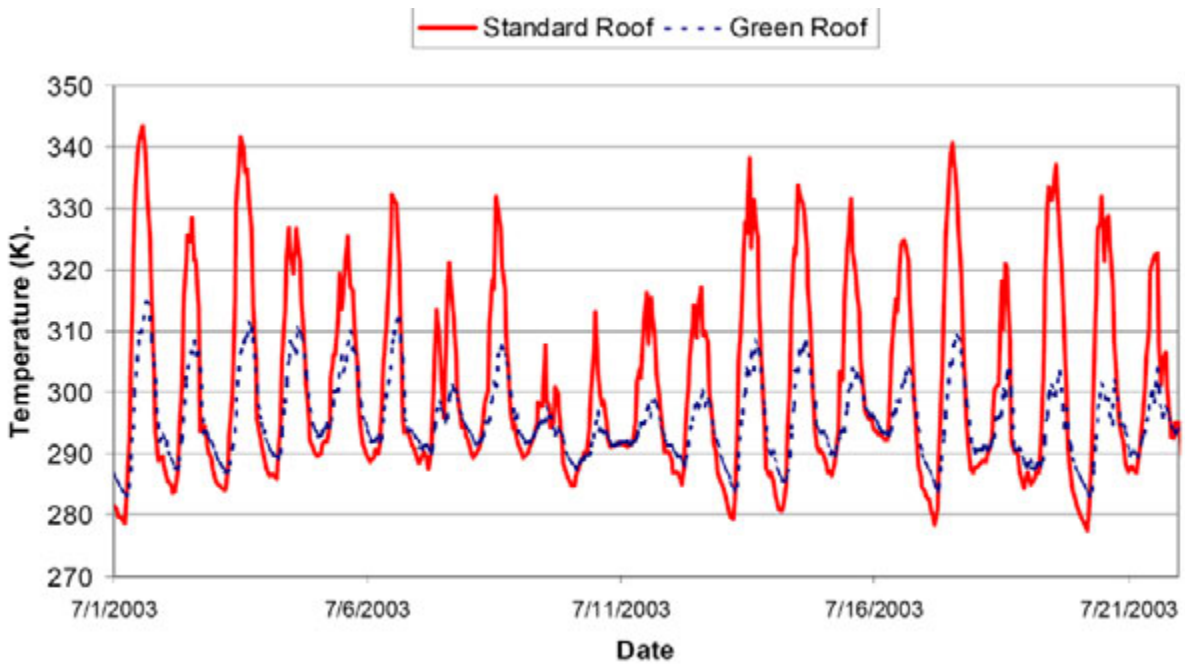


Figure 1: Average control and green rooftop surface temperatures observed on the Penn State University field experiment during July 2003 (Berghage & Beattie, 2004)

10.1.2 Future Studies using CFD

Over the course of this summer, CFD models will be developed to further quantify these benefits. The goal of these models is to determine the ratio of heat removed by simple convection (sensible heat removal) to heat removed by evapotranspiration (latent heat removal). After the capacity of the green roof to remove latent heat through evapotranspiration has been quantized, the plants' passive cooling action can be used for a better evaluation of the benefits of GRIPV systems.

10.1.3 PV performance

CIGS, as a PV material, performs better in a cooler environment. With the unique geometry of the PV panels, models cannot be developed and vetted without experimental studies. This summer, in conjunction with the aforementioned CFD modeling, TRaNsient SYstem Simulation (TRNSYS) models will be vetted against the data collected during the commissioning of the home as well as during the competition.

TRNSYS is also used to study the power production to study the power production of the PVs that have been selected for the Natural Fusion home. Because of their ability to produce more power from the diffuse radiation, the overall power production curve throughout a given day is more level, rising steeply in the morning and remaining level throughout the day. A similar result is obtained by orienting standard PV panels in new configurations; for example, half of the panels tilted slightly east and half of the panels tilted slightly west. As seen in Figure 2, this better matches the energy consumption curve of the average U.S. citizen.

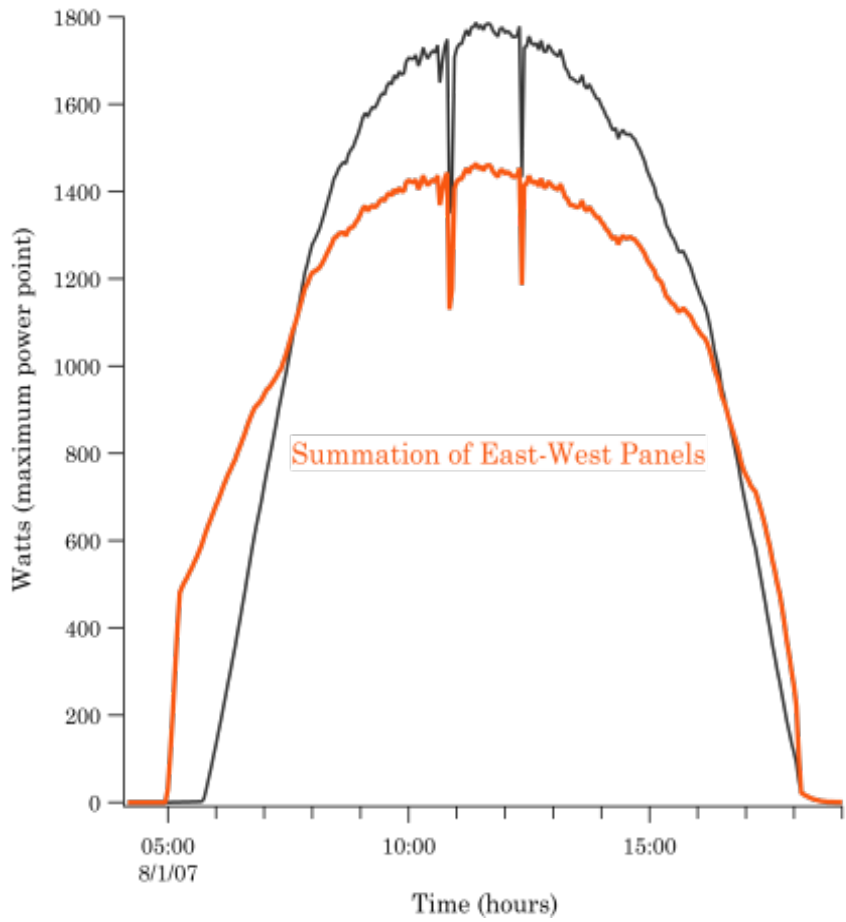


Figure 2: Solar Power Ouput for South Azimuth and East-West Azimuth Orientation (Stewart & Witmer, 2009)

10.2 Solar Water Heaters

A study of thermal water heaters aided in the selection and placement of those heaters. The options for orientation were either horizontal or vertical on the south façade, as angled toward the south was deemed out of context with the overall home design. After some basic solar incidence calculations, vertical panels were deemed better than horizontal panels. In addition to this, snow would not cover the panels during the winter if they are hung vertically.

Hot water demand peaks during winter months. In addition, the Sun's altitude (angle above horizon) is on average lower during winter months than summer months. While the solar thermal collectors should ideally be mounted perpendicular to incoming solar rays at all times, if a fixed position must be selected, it is better to mount the panels in a vertical position to maximize solar gains during winter months.

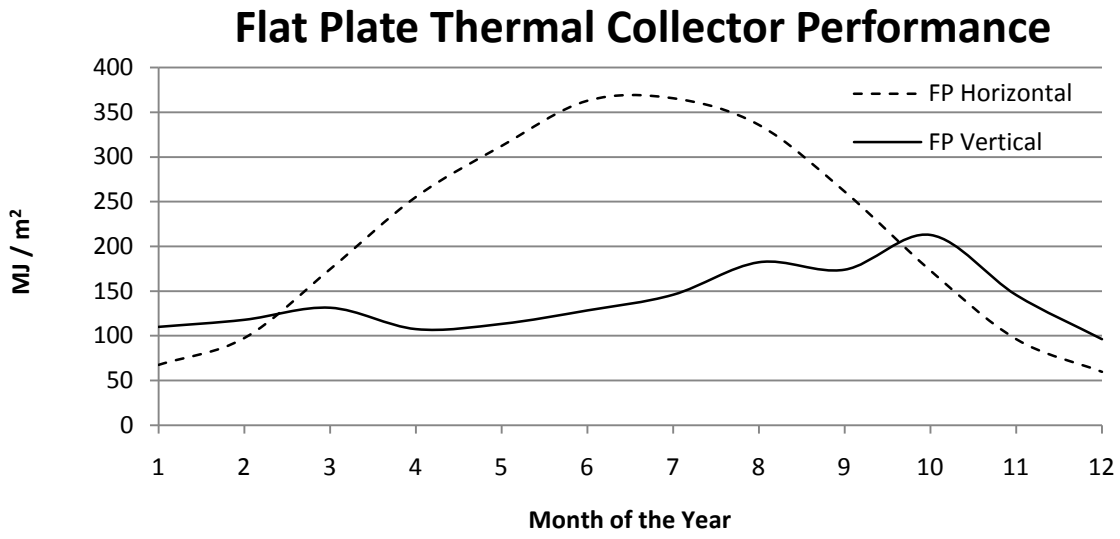


Figure 3: Flat plate thermal collector performance in the target region (Energy Modeling Team)

Table 1 below shows a list of contests that require energy to be used to heat or vaporize water and the estimated amount of electrical energy required to satisfy each contest completely. All energy values were determined based on a starting water temperature of 60F. Typically domestic groundwater enters a residence at approximately 50F; however, during the contest water will be supplied to the home from pillow tanks located outdoors. While water has the highest thermal heat capacity of any common substance, it is assumed that some heat energy from the ambient air will transfer to the water, increasing its temperature.

The estimated electrical energy use assumes that no energy is provided by the flat plate collectors during the competition. While this is unlikely, assuming no energy input from the collectors presents a worst-case scenario that provides an upper limit for the amount of electrical energy required to complete these contests. Since the solar thermal system uses passive technology (zero electrical energy use), any energy provided by the flat plate collectors will simply be less energy required to heat the water to contest requirements.

Table 1: Total contest energy use for heating water (Energy Modeling Team)

Total Contest Energy Use for Heating Water

Total Energy Use	75	kWh
Max. Daily Energy Use	11	kWh

Contest 7 - Hot Water

Contest Criteria		
Target Min. Temperature	110	F
Draw Time	10	min
Volume	15	gal
Total Tasks	20	tasks
Max. Tasks/day	3	tasks/day
Average Flow Rate	1.5	gal/min

Calculated Contest Energy Use		
Total Energy Use During Competition	36.6	kWh
Energy Use per Contest	1.8	kWh
Max. Daily Energy Use	5.5	kWh

Contest 8-3 - Clothes Washer

Contest Criteria		
Target Min. Temperature	110	F
Yearly Water Use	4000	gal
# Loads/Year	392	loads
Hot Water Use/Load (%50)	5.10	gal/load
Total Tasks	10	tasks
Max. Tasks/day	2	tasks/day

Calculated Contest Energy Use		
Total Energy Use During Competition	12.0	kWh
Energy Use per Contest	0.6	kWh
Max. Daily Water Use	1.2	kWh

Contest 8-5 - Dishwasher

Contest Criteria		
Target Min. Temperature	120	F
Hot Water Use/Load	6	gal/load
Total Tasks	10	tasks
Max. Tasks/day	2	tasks/day

Calculated Contest Energy Use		
Total Energy Use During Competition	18.0	kWh
Energy Use per Contest	0.9	kWh
Max. Daily Water Use	1.8	kWh

Contest 9-1 - Cooking

Contest Criteria		
Hot Water Mass/Task	6.25	lb
Volume (Starting)	0.75	gal
Total Tasks	4	tasks
Max. Tasks/day	1	tasks/day

Calculated Contest Energy Use		
Total Energy Use During Competition	8.0	kWh
Energy Use per Contest	2.0	kWh
Max. Daily Water Use	2.0	kWh

10.3 Overall Shape

Initially, the floor plan had two main options of a rectangle or an offset of the rectangle. Also, the roof had two main options independent of array style; the flat roof or the southern tilted roof. Both of these two major considerations work differently with each other and offer various pros and cons. Through the development of several models in an energy modeling software package, TRNSYS, the efficiency losses of these various options were calculated. In these models, variables such as the addition of exterior wall surface with the simultaneous reduction of internal walls, the slight increase of window surface area for the offset models with a comparable increase for the tilted roof, and the increase in total volumetric capacitance of the tilted roof models were all studied. Through these studies, the flat roofed rectangle option was found to be the most energy efficient space. A long rectangle with a large southern wall to obtain a large solar gain is beneficial to a home in State College, Pennsylvania as about half of the year requires heating for most spaces and only a quarter of the year requires cooling.

10.4 Windows

Double pane windows are the minimum requirement for all glazing in any structure striving to be energy efficient. Single pane windows are unacceptable on all accounts. Triple pane windows provide a higher insulation value for a slightly higher initial cost and a large increase in overall complexity of the system. Triple pane windows have many disadvantages including additional weight that results in accelerated wear on hardware and casements, a higher risk of glass seal failure causing infiltration and very poor thermal performance, and a loss of visible light transmittance requiring additional use of electric lighting.

In addition to the number of panes, the type of gas between the panes is also crucial. There are several different types of gas that are used in multi-pane windows. These gases include normal air, argon gas, krypton gas, and xenon gas. Krypton and xenon gases, however, are difficult and expensive to obtain. The embodied energy in krypton gas is over 40,000 times that of argon gas while xenon gas is even worse at 375,000 times higher (Harvey, 2006). As such, these two gas options were not considered for the Natural Fusion home.

Table 2: Window cost comparison over 20 year life

Cost per 19sqft window	# of Panes	Gas	U-value	Price/Sqft	Heat Loss $/year/sqft	Capital Cost (429 sqft)	Total Cost (20 years)
$18.75	1	Air	1.04	$1.00	$14.57	$429.00	**$101,759**
$150.00	2	Air	0.29	$8.00	$4.06	$3,432.00	**$31,695**
$174.95	2	Argon	0.24	$9.33	$3.36	$4,002.86	**$27,388**
$214.90	3	Argon	0.19	$11.46	$2.66	$4,916.91	**$27,483**

Argon gas between two panes of glass proved to be the most cost effective choice. This includes a conservative estimated value for the disadvantages associated with triple pane windows. This table portrays the results at an electric price that varies from current rates to 2030 rates, 20 years from now (EIA, 2009). Residential electricity prices are expected to reach $0.17/kWh in the year 2028 (EIA, 2009). At that time the windows will be at the end of their 20-year life. While the 20-year total cost is very close for both the double pane and triple pane windows, the added complexity and issues associated with triple pane windows make them less attractive. Currently, in a Pennsylvania climate, double pane and argon filled windows are the most cost effective solution.

10.5 Thermal Mass

Maximizing themal mass provides energy benefits for every home by passively keeping the house cooler in the summer and warmer in the winter. However, it was necessary to keep the overall home weight to a minimum as the home needed to be transported between multiple locations for the contest.

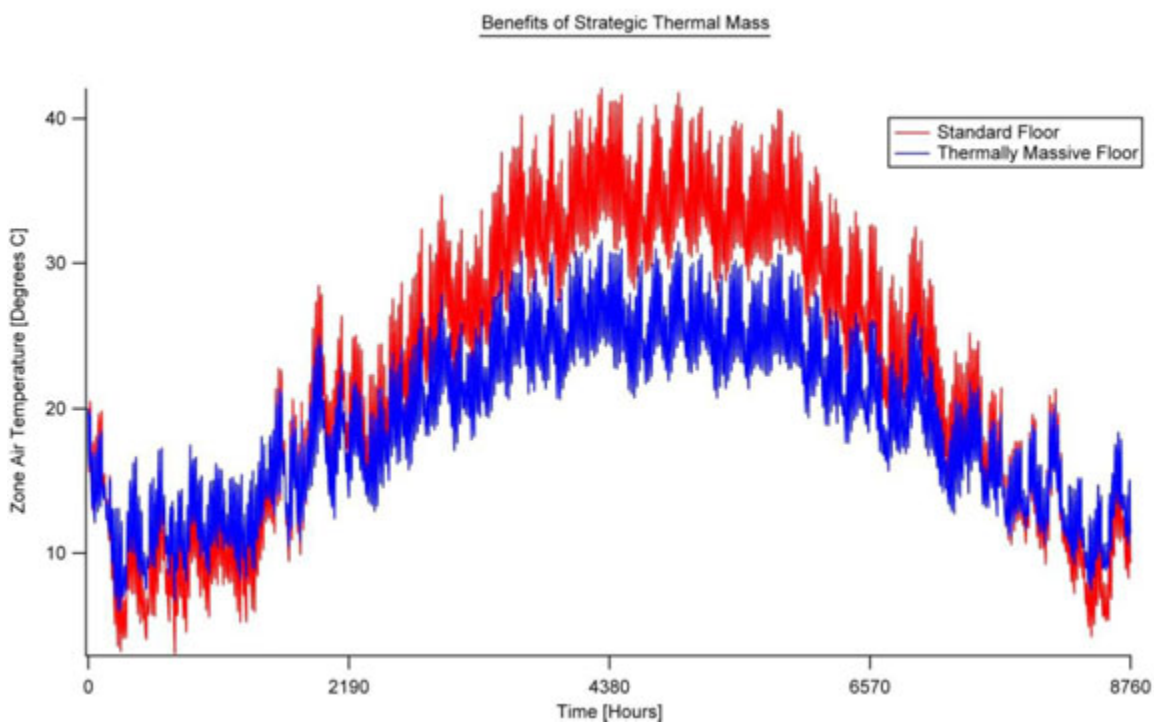


Figure 4: Benefits of strategic thermal mass (Energy Modeling Team)

10.5.1 Floor Water Bladders

A comparative study of water as a thermal mass in a bladder system under the floor was performed against other forms of thermal mass such as stone, concrete and wood. After examination of the design and calculations involving added costs of increasing the floor structure to accommodate larger bladders for more water, it was determined that about 2” of water is the best option for this home. Computer simulation of this scenario shows a positive impact on the thermal envelope of the home.

10.5.2 Phase Change Material

In addition to the water as a thermal mass, there has been an ongoing study of phase change materials. Through substantial research of these systems, it was determined that we should install a simple, passive, phase change system that does not require energy input to function. In the same way that an ice cube in a glass of water maintains the water at a temperature close to its freezing point, the phase change material changes from a solid to a liquid, or vice versa, to maintain the building zone at a comfortable temperature.

10.6 Appliances

A comprehensive study of appliances was performed to reduce the loads of the home. This is a substantial piece of the energy footprint because about 66% of the energy use within a typical home is released as heat into the zone. In general, we studied specific types of one appliance versus each other. This allowed us to narrow down the choices of various appliances to a single type. Then, within that type, it was relatively easy to select the more cost effective choices for our home already within the most efficient category for that type.

10.6.1 Selected Appliance Data

Table 3: Appliance Energy Consumption

Appliance	Energy [kWh/day]	Energy [kWh/year]
Refrigerator-Freezer	1.120	408.8
Induction Range	1.156	422.0
Range Hood	0.640	233.6
Dishwasher	0.521	190.0
Microwave/Convection	0.743	271.3
Washer/Dryer	0.714	260.7
LED HD TV	0.493	180.1
Stereo	0.511	186.3
Computer	0.524	191.2
Smoke Detector	0.010	3.5
Lighting	2.281	832.4

10.6.2 Load Profiles

10.6.2.1 Consumption during Solar Decathlon Contests

A breakdown of each of the contests shows the requirements for each area. During the competition period, from Wednesday, Day 8 through Thursday, Day 15, the Natural Fusion home is expected to require a total of approximately 50kWh. Over this same period it is expected to produce about 20kWh of electricity per day, for a total of about 150kWh. In addition this only accounts for a moderate solar thermal gain for heating the hot water as the hot water system is passive with a backup instant water heater.

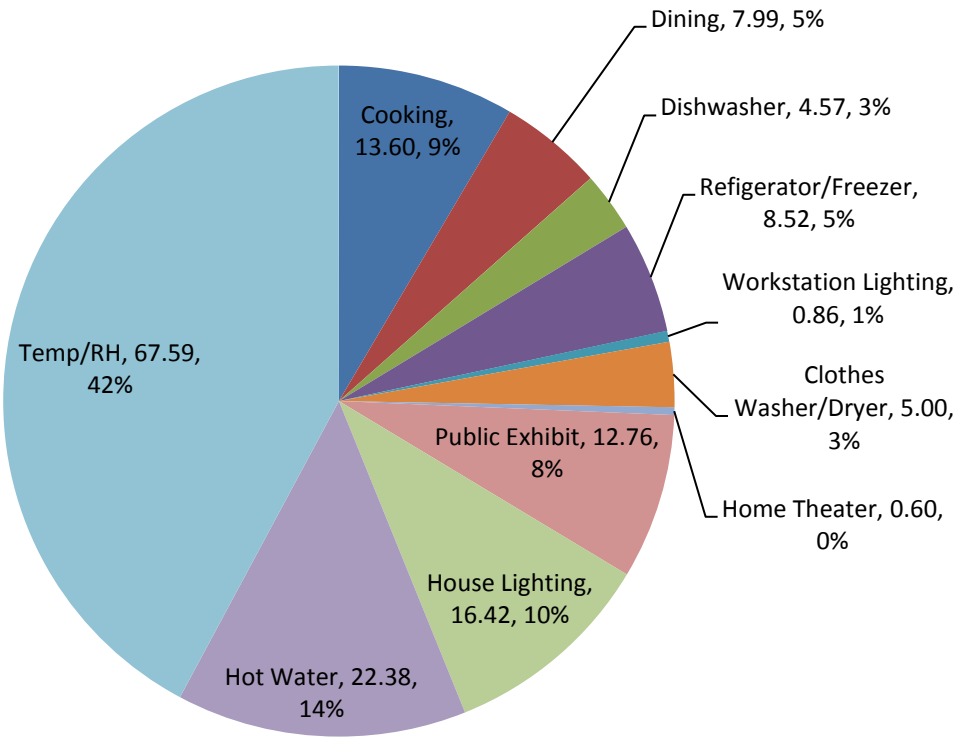


Figure 5: Contests kWh Total (7.6 day period)

10.6.2.2 Annual Average Consumption of Natural Fusion Home

The Natural Fusion home has a large southern glass wall. This wall is adequately shaded in the summer to reduce solar gain when undesirable. During the winter, this southern wall is useful for substantial energy gain. This reduces heating loads during the winter months. Because of the thermal mass of the home, the heat is distributed throughout the home and can be released during the nights. Hence in the following pie chart there is a relatively small heating wedge.

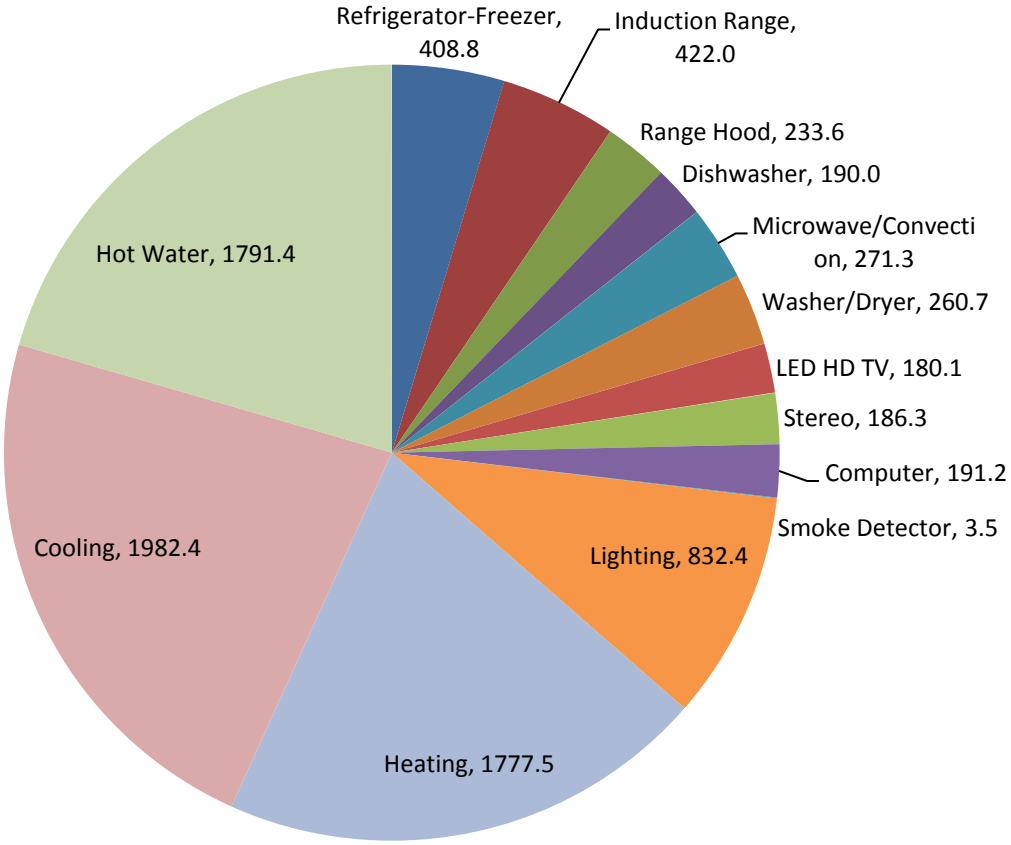


Figure 6: Load Breakdown in kWh/year

10.6.2.3 Annual Average Consumption of Average Home

When compared against other average homes of similar styles in similar target markets, the Natural Fusion home is the most energy conservative, performing the best (EIA, 2009). Because a reduction in energy consumption correlates directly with the cost of living in a home, the Natural Fusion home is extremely desirable.

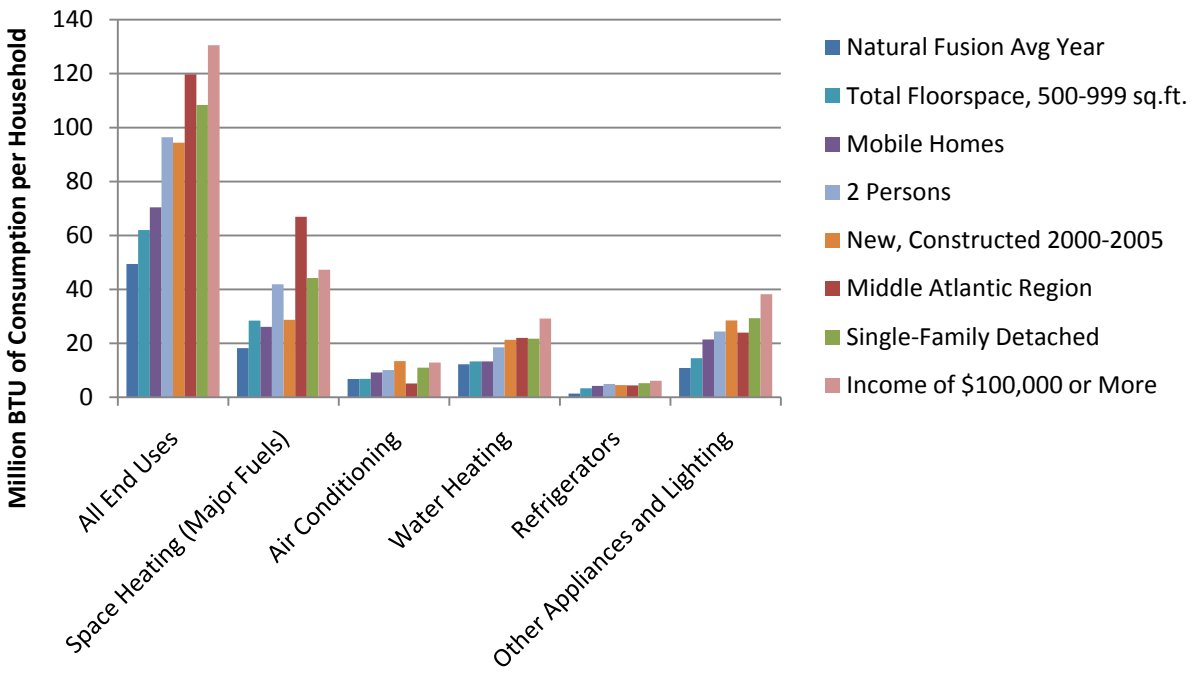


Figure 5: Energy end uses compared in several home types similar to the Target Market (EIA, 2009)

10.7 HVAC

The Heating Ventilation and Air-Conditioning system within the home consists of two 26 SEER ductless mini splits and an energy recovery ventilator. With this extremely high efficiency for cooling in the summer, the large southern glass wall's solar gains can be counter balanced by an extremely efficient system when necessary. For this Energy Analysis, the systems were sized according to the required heating or cooling found through various programs including Energy 10 and TRNSYS.

10.8 Summary

Every aspect of this home has undergone an in depth study of the impact on the overall home energy performance. While the energy footprint of each piece will not be as low as possible, the home's overall footprint is as low as it can be. The study of the overall system is what makes each aspect of the home fit together into Natural Fusion. While there are not many individual pieces of the home that are purely optimized, together, all of the pieces working together create a home that indeed is a wholistic integration of elements.

11.0 Architecture Design Narrative

Focused on the integration between nature and residence, the design of Natural Fusion seamlessly weaves together a balance of the natural and built environments. With a desire to balance nature, function, and technology, the design team for Natural Fusion worked on integrating each element of nature and technology in every function and aspect to the home. Natural Fusion is solely based on the critical balance between how nature and people interact. Based off of this interaction, the design team worked together to fuse the elements of design with the engineers to collaborate on the individual impact one has on another.

In order to begin the process of integrating landscape with the home and the occupant, the simultaneous design of site and structure resulted in a cohesive whole utilizing site lines, sensual experiences and interlocking boundaries between home and site. The fundamentals of embracing site with the home are implemented through the dramatic south façade, where the hope is to extend daily habitation from within the home to the natural landscape. Utilizing opportunities to expand the home in this fashion was a key idea and implemented through other house elements, such as the french doors on the east, which open to a private, more experiential garden. Other bridging site-lines allow for instant connection to the outdoors, most importantly, the main entry. This axis directly makes you look from the front door to nature, anchored by a sculptural autumn brilliance serviceberry tree that provides beauty and dappled lighting throughout the seasons. Additionally, to bring nature into our home, we reversed the site lines and penetrated the envelope of the house with green walls.

The interior green wall divides the house and grounds all integration of landscape, architecture, mechanical and plumbing. Known as the Lifewell, we designed a wall at the heart of the house where one can interact and experience all-important aspects of the Natural Fusion Solar House. Looking above through the skylights, one can see the photovoltaic panels, which are followed by cascading light on a wall of evergreens and herbs. This wall is framed by one of the timber truss' that structurally support our home as well as aesthetically bring the natural character we worked to achieve. These multiple elements give the name Lifewell true meaning for our home. It is truly the life and backbone of the entire structure.

Natural Fusion integrated the important relationship between the natural and the built environments, enabling occupants to not only look towards the earth for sustainable energy but the importance of co-existence.

12.0 Market Viability Justification

12.1 Executive Summary

In their late twenties to early thirties, young professional “DINKs” (Double Income, No Kids) in the greater Philadelphia area are the Target Market for the Natural Fusion competition prototype home. Philadelphia holds all the desired attributes needed to attract and sustain the lives of Double Income No Kids couples. The metropolitan area of Philadelphia continues to grow and evolve constantly. Even through these tough economic times, Philadelphia has stood up against the economy and continues to prosper.

Philadelphia is a suitable city to reside in not only because of its growth, but because of its focus on a greener future. The mayor of Philadelphia has set forth numerous sustainability initiatives to lead the city and all of its residents into a greener future. In addition, Philadelphia maintains the second largest green roof area, and has the tallest green office building in the nation.

Now more than ever, people are becoming more environmentally conscious and willing to conserve, which is why the Natural Fusion competition prototype home is so appealing, specifically to Double Income No kids couples. The systems implemented in the house exemplify the qualities of cost effective, simple to install and maintain, and extremely energy efficient systems for today’s homeowner. The systems also focus on being intuitive in design, and only needing common sense to operate. Every aspect of the Natural Fusion house considers qualities such as simplicity and functionality to prove the design and system choices.

Throughout the home, the features of the Natural Fusion home help to make it efficient and cost effective. Green roof integrated photovoltaics are the home’s main power source. The secondary electrical power system is the solar awning that tracks the sun for greatest power production while blocking out the thermal gains from sunlight penetrating the southern glass wall during the summer. Another unique system included in the Natural Fusion home, the solar water heating system, is a control-less, pump-less, closed-loop, flat plate solar thermal system. Plumbing in the Natural Fusion house is run by a PEX “Home-Run” system that compartmentalizes each fixture separately to minimize the amount of piping that runs through the residence. Heating and cooling in the house is done by the most efficient air source heat pump currently on the market. The ventilation system uses an energy recovery ventilator that allows for fresh air to be brought into the home while energy is transferred from the exhausted air. Under the floor, a bladder system acts as a thermal mass when filled with water to moderate the temperatures of the residence. In addition, a phase change material in the walls and roof absorbs and releases heat depending on the time of day and year.

At the center of all these systems is the energy dashboard. This allows for the homeowner to monitor their energy use, in detail, on a regular basis. Also, this enables the homeowner to plan around cloudy days when sunshine is not abundant enough to concurrently produce energy for intensive activities such as laundry.

The Natural Fusion home is constructed using established modular construction techniques, which embody the philosophy of high quality, energy efficiency, mass customizable production, and low environmental impact. This includes the choice of wooden framed construction over steel framing for

the home's structure.

Double-pane argon filled windows are installed in the home due to their low lifetime cost that is slightly less, but very comparable, to triple-pane windows that are more complex.

Overall the Natural Fusion competition prototype home is of the utmost efficiency relative to the cost of the house. Between the prime Target Market location and simple, cost effective, efficient systems, the house is well suited for Double Income No Kids couples.

12.2 Introduction

In their late twenties to early thirties, young professional "DINKs" (Double Income, No Kids) in the greater Philadelphia area have been chosen as the Target Market for the Natural Fusion competition prototype home. With a combined income of about $100,000 and the need for only a single bedroom, DINKs of the greater Philadelphia area will find great appeal in the precise integration of natural processes, sophisticated systems, and modern design of the Natural Fusion home, providing them the perfect balance for comfortable, sustainable living.

This home would be the couple's primary residence, for sale as a detached single-family house.

Table 1: Target market description

Location of permanent site:	**Greater Philadelphia area**
Housing type:	Single-family detached unit
Number of Occupants:	2
Occupant demographic:	Late-20s to early-30s, Double Income, No Kids ("DINKs")
Homeowner annual income:	$100,000
Number of bedrooms:	1

12.2.1 About the Area

Nestled one hundred miles from New York City and one hundred forty miles from Washington DC, the location for the Natural Fusion Target Market is the greater Philadelphia area, comprised of Philadelphia, Delaware, Chester, Bucks, and Montgomery counties. This area of Pennsylvania is a part of the four-state Philadelphia Metropolitan Area, which is the fifth largest metropolitan area in the nation. Seventy percent of the 5.7 million people of this metropolitan area live within these five counties.

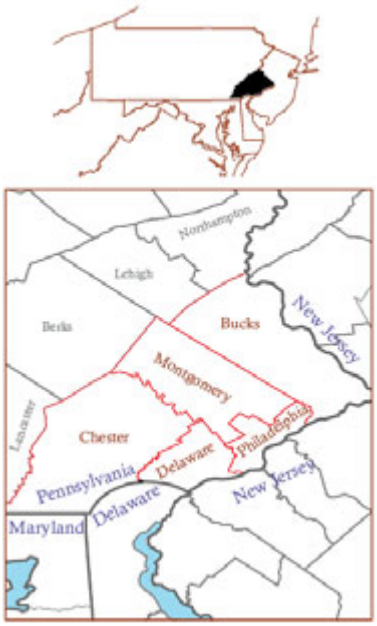
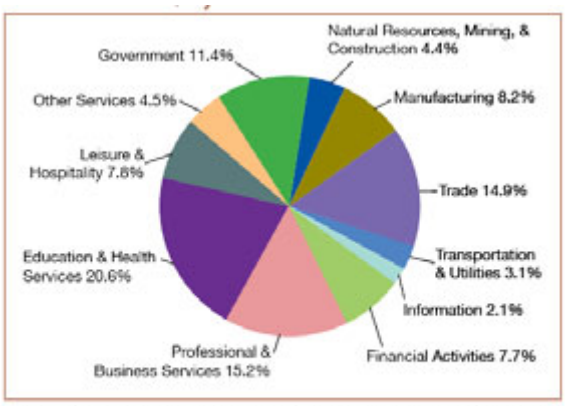


Figure 1: Target Market Area (HUD User)

While the relatively close proximity to two major cultural and governmental hubs of the United States makes the Philadelphia area of particular appeal for residents and businesses, so do the cultural and career opportunities found locally within the City and surrounding areas. Center City Philadelphia is home to historical icons such as Independence Hall and the Liberty Bell, and has strong traditions of fine and performing arts, music, and local cuisine. Located in the surrounding area is a small yet accommodating city called Horsham. Horsham, a suburb within the Target Market area, was ranked fifteenth on CNNMoney's best smaller places to live in 2007, based on the economic opportunities, quality of schools, safety, things to do, and feeling of community (CNN, 2007).

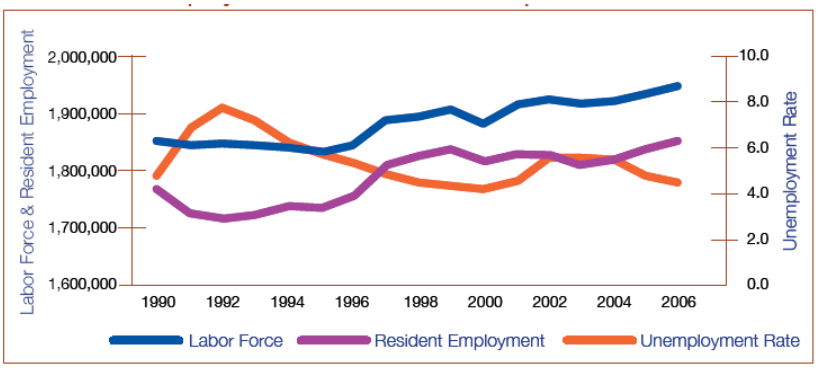
The career opportunities available in the area are also prevalent, with MSNBC naming Philadelphia the top place for college graduates, based on the cost of living and available jobs in 2008 (Hodges, 2008).

This Target Market area has seen the greatest growth in new jobs being in the health care and education industries. Since the 1990s, eighty percent of all news jobs have been in these sectors, and currently account for approximately twenty percent of all the jobs in this area. Architecture, engineering and scientific research companies have made up most of the growth in the Professional & Business Services sector.



Note: Based on 12-month averages through December 2006.
Source: U.S. Bureau of Labor Statistics

Figure 2: Employment by sector in Target Market area, 2006 (HUD User)



Source: U.S. Bureau of Labor Statistics

Figure 3: Trends in the labor force, resident employment, and unemployment rate in the Target Market area, 1990-2006 (HUD User)

12.2.2 Recent Economic Conditions

While the Target Market area and the nation have been hit with the current trends of the economy, Pennsylvania is still seeing a slightly better outcome than the national average. As of March 2009, Pennsylvania is at a 7.8% unemployment rate, with the national average being 8.5% (Federal Reserve Bank of Philadelphia, 2009). It has generally seen less decline of growth than the nation as a whole.

Table 2: 12-month change in employment by sector, Release Date: April 20, 2009 (Regional Economic News, 2009)

Payroll Employment Series	DE	NJ	PA	US
Total Nonfarm	-4.4	-3.2	**-2.3**	**-3.5**
Natural Resources, Mining, and Construction	-14.4	-10.6	**-6.1**	**-11.4**
Manufacturing	-14.7	-10.0	**-9.5**	**-9.8**
Trade-Transportation-Utilities	-6.7	-2.3	**-2.5**	**-4.2**
Information Services	1.4	-5.1	**-7.9**	**-3.8**
Financial Activities	-2.4	-5.8	**-3.0**	**-4.1**
Professional and Business Services	-10.2	-6.9	**-3.8**	**-5.9**
Education and Health Services	3.0	1.9	**2.1**	**2.4**
Leisure and Hospitality Services	-3.4	-2.2	**-1.7**	**-2.4**
Other Services	1.0	-1.3	**0.2**	**-2.0**
Government	1.5	0.2	**0.7**	**0.4**

12.2.3 New Home Growth

New, single family, detached unit homes are continually being built in the Philadelphia metropolitan area, particularly at the Philadelphia Naval Yard revitalization site and on the southern boundary of Center City. These new detached unit homes are geared towards young professionals, and they are located in the city with the third largest residential population in the nation. Over the last few years development has grown beyond center city and has begun in bordering neighborhoods. The beginning of this growth trend started in 1997 when a ten year abatement of taxes on the rehabilitation and conversion of commercial buildings to residential housing was enacted. In the year 2000 this tax abatement was amended to include all new construction which led to further development. Figure 4 shows new home construction over the past twenty five years.

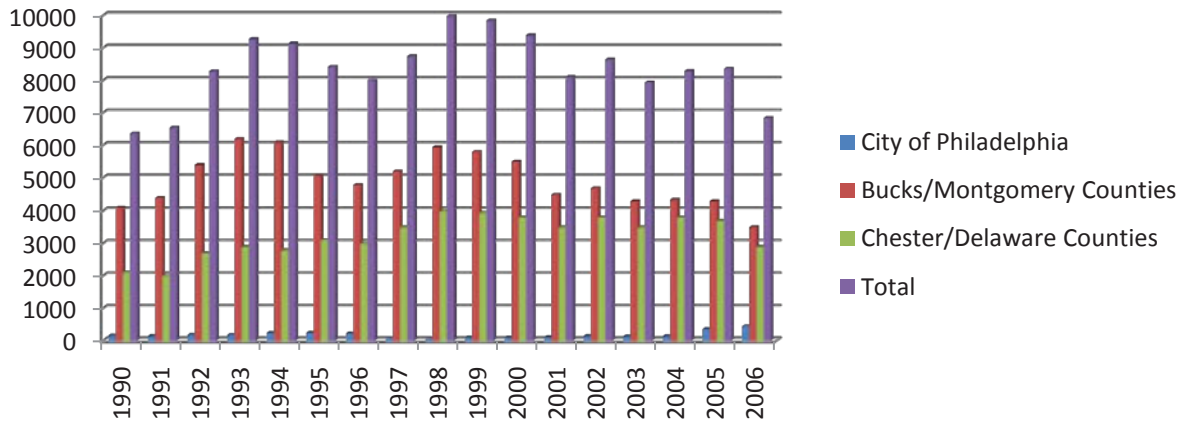


Figure 4: Building permits issued for new single-family home construction units, 1990-2006 (HUD User)

12.2.4 Sustainability Initiatives of Philadelphia

Philadelphia's Mayor Michael Nutter aims to make the city the "greenest city in America" and created the Mayor's Office of Sustainability (MOS) to deal directly with greening the city. Philadelphia is a Solar City as part of the Department of Energy's Energy Initiative with goals of producing 2.3 megawatts of electricity strictly from solar devices by 2011, and 57.7 megawatts by 2021. Currently the Philadelphia Water Department is looking to install three of their facilities with solar rooftops that would have a total production of over one megawatt. In addition, the Philadelphia Industrial Development Corporation is working alongside of Conergy to develop a Solar PV system at the Naval Yard to generate over one megawatt of electricity (Mayor's Office of Sustainability, 2009).

In the residential sector interest in solar power is on the rise according to Paul Macht. Paul Macht of Paul Macht Architects in Rydal, PA (Montgomery County) has been designing environmentally sensitive residences and workspaces out of Rydal since 1990. "Before, people would ask about solar and I used to tell them, install solar panels if you want to help the environment, but the 30 year paybacks were just impractical. Now, with the financial rebates, 30 year mortgage payment options, and utility rates about to increase by 50%, solar is booming. Four out of five of our current projects out to bid all have solar collectors – solar thermal, some solar thin film, some silicon PVs – and contractors have thousands of jobs lined up. We're just trying to keep up with researching all the rebates and tax incentives."

The city of Philadelphia has already reduced electricity use from city-owned buildings by 4.4% since 2003, and has also built a green roof at the Free Library's central branch. Including this green roof Philadelphia is second in the nation with the highest square footage of green roofs. In terms of green buildings, Philadelphia is home to the Comcast Center which is the tallest green office building in the nation (Mayor's Office of Sustainability, 2009).

12.2.5 Local Electric Utility

The Philadelphia Electric Company (PECO), an energy subsidiary of Exelon Corp., is the largest in Pennsylvania. PECO has nearly 2.1 million customers between natural gas and electricity. The electricity that PECO provides to its customers comes from coal, nuclear, natural gas, oil, or hydroelectric. Also, Exelon has committed to a twenty year agreement to buy electricity produced from solar panels by Epuron. Exelon's initiative to go green includes a program called Exelon 2020. This program calls for a reduction, offset, or displacing in excess of 15 million metrics tons of green house gas emissions every year by 2020 (PECO, 2009).

The current electric generation rates for summer months are 4.81 cents per kWh for the first 500kWh and 5.57cents/kWh over 500kWh. Although, rate caps are coming off on December 31, 2010, and rates are expected to rise (PECO, 2009).

PECO does allow for net metering as is required by law in Pennsylvania (PECO, 2009).

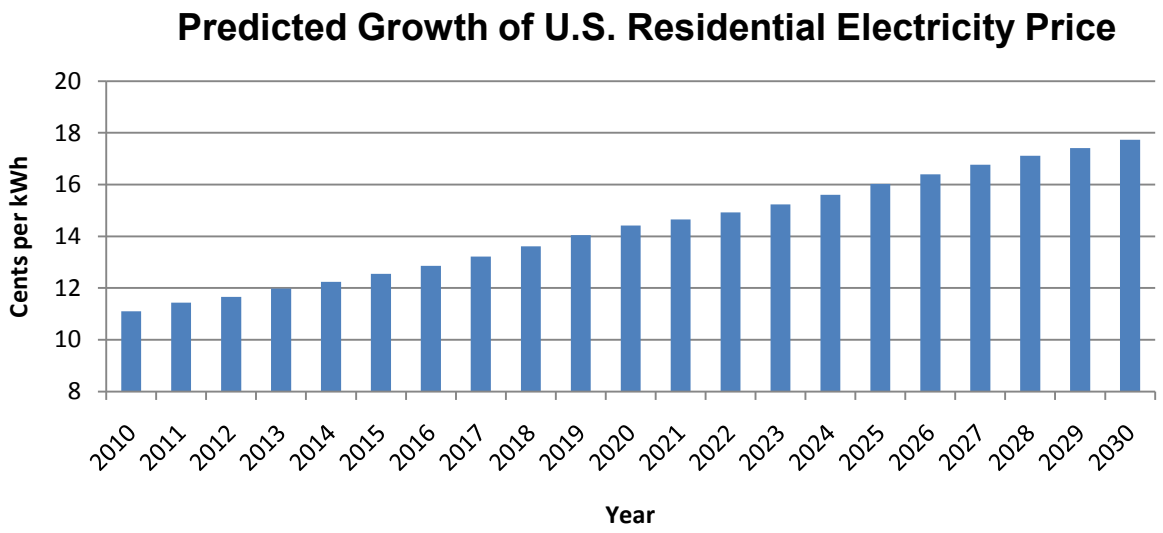


Figure 5: Energy Information Administration's prediction of residential electricity price in the U.S. through 2030 (EIA, 2009)

12.2.6 Pennsylvania Identity

Pennsylvania is more than just a place to reside. It is a place to live, grow, and prosper. According to Paul Macht, Pennsylvania is the top state at retaining its residents because it has the fewest number that leave. In addition, it is only second to California in having the greatest number of green buildings. On the other hand Philadelphia is the fifth ranked top sports city in the nation (Staff, 2008). All of these reasons together give each and every Pennsylvanian a sense of identity and place. This is what attracts people to not only come to Pennsylvania, but to stay permanently.

The Natural Fusion home has brought together many different Pennsylvania industries through integration of local products into the home.

- Bayer MS – Pittsburgh, PA
- Carlisle SynTec – Carlisle, PA
- Professional Building Systems – Middleburg, PA
- Solar Innovations – Myerstown, PA
- Construction Specialties – Muncy, PA
- Solar Power Industries – Pittsburgh, PA

12.2.7 About the People (DINKs)

The long-standing cultural and economic appeal of the greater Philadelphia area has been attracting young professional couples to settle in its city center and surrounding suburbs. Titled “Double Income, No Kids”, “Double Income, No Kids Yet” or “Double Income, No Kids Yuppies”, DINKs are high income earning couples that currently have no kids.

While the small size of the Natural Fusion competition prototype home can appeal to nearly any DINK couple age group, the simple style, high-tech systems, and sustainable features of the Natural Fusion home are of particular appeal to the late-20 or 30-something DINK couples.

These young professional DINKs generally hold degrees in higher education and earn higher than average incomes. They are attracted to the culture, career opportunities and liveliness of the big city; while not needing to live directly in Center City, having the retreat from a long day at work in a nearby suburb is just as attractive.

Figure 6: Stereotypical double income no kid’s couple (DINK) (men.style.com)

When looking for a home, they seek a design that reflects the balances in their own lives – work, environmental consciousness, finances, and daily life – while being a no-hassle integration into their already established lives. They appreciate a sophisticated style, reflecting their own personal good taste and eye for design, and they expect their home systems to run smoothly and efficiently, with as little maintenance and hassle as possible.

But, while they may make above average incomes, Double Income, No Kids couples know how to spend their money wisely, and do their research for high quality products before settling on the first one they see.

Within the home, they enjoy entertaining their friends and neighbors, whenever their busy schedules allow. They appreciate public space for entertaining and private space as a retreat from their busy

lives. They also enjoy traveling, whenever their work schedules will let them take a few days, or a few weeks, off.

Having lived through the age of technology, information, and energy crises, these DINKs are particularly aware of current events, concerned about protecting the environment and have a growing consciousness and interest in their daily energy use.

12.2.8 Do DINK's Want Sustainable Homes?

According to a study done by McGraw Hill Construction in April 2007, young Double Income, No Kids couples make up a relatively large portion of the interested market for green homes. In the national study, 30% of those who would choose a green home are under the age of 35, and 65% are married couples, with eighteen percent making $100,000 or more per year. Seventy nine percent are college educated.

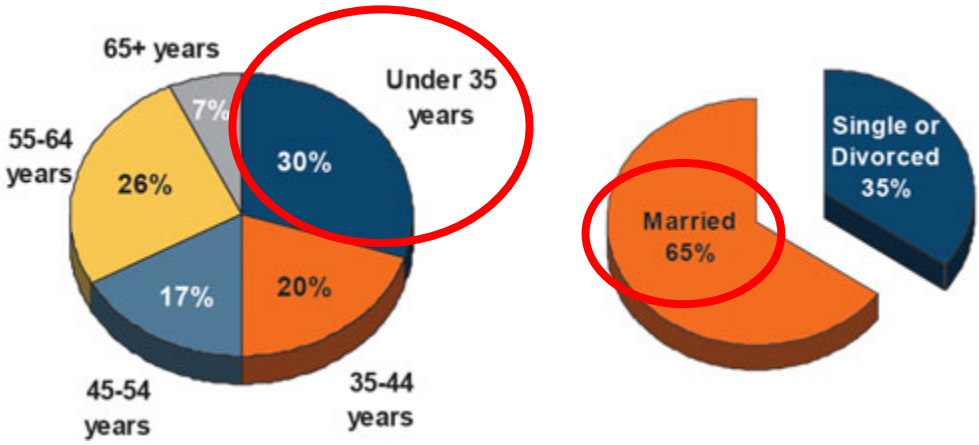


Figure 7: Who's buying green homes? (McGraw Hill Construction, 2007)

12.2.9 Why the Natural Fusion home is appealing to them

The Natural Fusion home is a balanced, no-nonsense, and environmentally responsible retreat for the busy young professional DINKs.

In a similar style of DINKs balancing work, environmental consciousness, finances, and daily life, so does the Natural Fusion home strive to achieve a perfect balance of natural processes, technology, and affordability for modern day professionals. The design is simple, yet sophisticated; high-tech, yet manageable; and, overall, sustainable, yet affordable. Thus the Natural Fusion home offers a realization of affordable, sustainable living for today's Double Income, No Kids couples.

12.3 Livability

Aesthetically, environmentally, and economically, the Natural Fusion competition prototype home is an attractive choice for young professional couples. The precise balance of simple style, high-tech systems, and sustainable features, all at an affordable price, reflects a sense of quality taste and good value, making it particularly appealing for busy young professionals.

12.3.1 Simple, yet Sophisticated Style

Beneath the surface of a seemingly simple layout and single module of a home, it is a precisely-designed fusion of public and private space that particularly suits the needs of two professional, environmentally-conscious adults.

Within the home, the open floor plan for the great room area maximizes the public living and entertaining space, while seamlessly transitioning to the defined private bedroom and bathroom spaces.

But the Natural Fusion home goes steps further with unique design features that allow for transitions and interactions with the public space of nature, while even creating one's own "private" natural space just outside the master bedroom.

The design philosophy was simple; design an energy efficient, solar powered home that does not sacrifice the conventional ideas of a home. The home feels like a blending of aesthetics with simple functionality. People who tour the residence will really feel at home. They will be able to relate to the spaces that have been created while appreciating the energy-efficient, creative aspects that have been implemented.

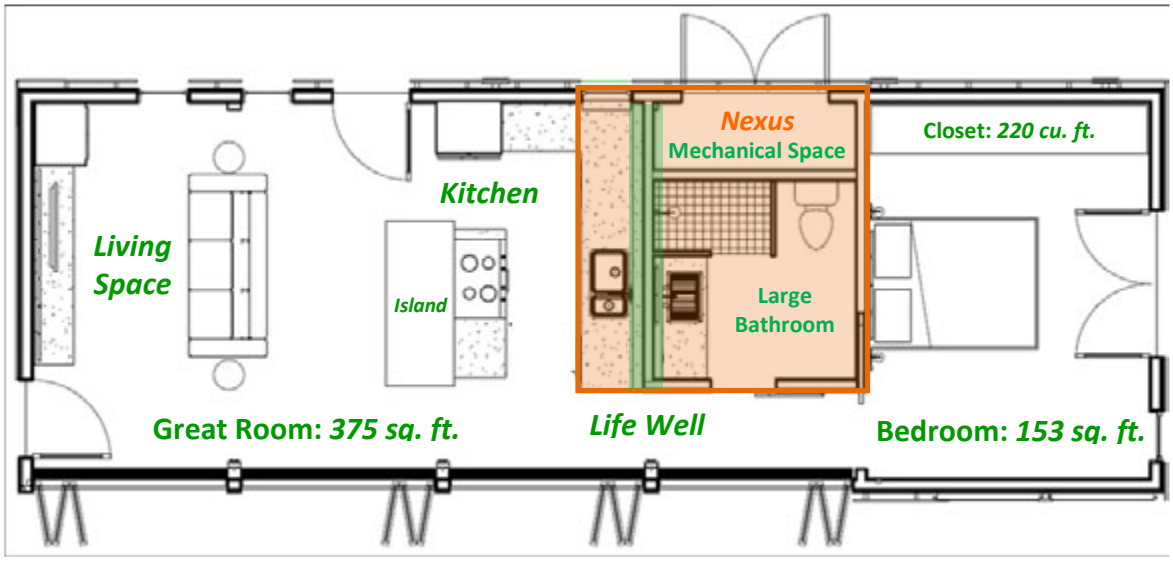


Figure 8: Natural Fusion Floor Plan

12.3.2 Public Space: The Great Room

Ringing in at 375 square feet, the great room area has been carefully designed to maximize the feel of the living space and encourages interactions with an even more public space – the outdoors.

The open floor plan, high ceilings, and plenty of daylight through the southern windows and clerestory make the seemingly small space feel like a large open area, without the added materials or extra energy costs. The space flows to the outdoors when opening the floor to ceiling folding glass wall of the southern façade to the front deck, creating a unique and enjoyable open area for entertaining dinner guests, relaxing after work, or simply reconnecting to the beauty of nature.

Even when closed, the Natural Fusion homeowners can connect and interact with nature through the interior living wall. A year-round garden, the Lifewell, can be used to grow herbs or flowers. This allows year-round fresh ingredients for all occasions.

For those special entertaining events, the kitchen island supports the pullout dining room table with matching stackable seating. When it is just the two homeowners, it conveniently folds back in, and alongside sits the two-seater bar.

12.3.3 Private Space: The Bedroom and Bathroom

A distinct and separate private space, the Bedroom is the ultimate retreat for the busy Double Income, No Kids couple. Coming in at 153 square feet, the high ceilings, unique slate wall mosaic, and patio doors to the outside create a greater feeling of size, unique and personal style, and connection to the outdoors.

Outside awaits their own personal private sense garden, allowing them to relax and refresh after the busy day at work.

Inside, a well-designed, 220 cubic foot closet adds a luxurious feature of a small home, and helps cut down on extra needed furniture.

The large bathroom is a delightful and welcomed surprise to a seemingly small home. The uniquely designed 3Form shower and bathroom living wall add style, value, and a personal touch to this space.

Outside, the Natural Fusion home utilizes a rainwater irrigation system and a bio-intensive vegetable garden for year-round, fresh and sustainable food production, as well as a smart and cost-effective use of water.

12.3.4 High-Tech, yet Manageable Systems

In the age of Blackberries and iPods, the busy Double Income, No Kids couple needs smartly integrated, energy efficient, and user-friendly systems to operate their just as aesthetically sleek home.

The Natural Fusion home systems use common sense and intuitive design concepts to bring the perfect balance of cost effective, simple to install and maintain, and extremely energy efficient systems for today's homeowner. These systems are discussed in detail in the Marketability section.

Each system of the home originates in the nexus, located in and behind the Bathroom. The heart of the Natural Fusion home, the nexus serves as the central organ to seamlessly and efficiently integrate each system of the home. Its central location and close access to the Kitchen and Bathroom allows for the most efficient delivery of energy throughout the home, with less hot water energy lost and less installation and maintenance costs. The exterior entrance also gives the assurance that routine maintenance by professionals can be performed without intrusion into the home while the DINKs are at work.

12.4 Marketability

The systems included in the Natural Fusion home were chosen because their designs are cost effective, high performing and a good overall value for Double Income No kids couples in the Philadelphia area.

12.4.1 Summary of Systems – Simple, Cost Effective, and Efficient

The Natural Fusion home carefully balances cost effectiveness; simple, yet sophisticated design; high-tech, yet manageable systems; and sustainable, yet affordable features. Each feature and system of

the home reflects the perfect balance for the aesthetic, performance, and environmental concerns of the Double Income, No Kids couple. The single modular construction; appealing and practical design features; and simple, cost effective, and efficient systems provide DINKs high value and high appeal.

12.4.1.1 Photovoltaic Systems: GRIPVs

The intelligent integration of technology and natural processes has lead to the innovative and efficient green roof integrated photovoltaics, or GRIPVs, on the Natural Fusion home.

Using the cylinder-shaped, thin film CIGS solar panels, the Sun is passively tracked throughout the day, just by its shape and sitting flat on the slightly sloped roof. The integration with the green roof allows for natural cooling of the panels by the plants, making the panels run even more efficiently, and the white aggregate top layer on the green roof reflects light to provide even more sunlight for the photovoltaics.

The innovative panels are significantly more cost effective than typical crystalline silicon panels. Not only do they cost less per panel ($650 compared to upwards of $1000), they are easier to install, easier to manufacture, and require no penetrations into the roof, meaning less upfront and long-term maintenance costs for the Double Income, No Kids couple.

Finally, the orientation and design of the panels within the Natural Fusion home provides more power during peak DINK couple power usage. As the panels passively track the sun throughout the day, the system provides more power in the morning and evening, the peak energy use times for the young professionals who spend their days at the office.

12.4.1.2 Photovoltaic Systems: Solar Awning

A passive and active solar system in one, the solar awning is the innovative fusion of products from three Pennsylvania industries.

Using a modified operable shading device from Carlisle SynTec as an awning above the southern façade of the home provides passive day lighting and aids significantly in blocking the hot summer Sun from causing overheating in the main living space while allowing the winter sun to penetrate into the living space. The louvers of the awning actively track the Sun to maximize the shading during the summer.

As an added benefit to the tracking system, integrating small Pennsylvania made polycrystalline silicon photovoltaic modules from Solar Power Industries on top of the louvers provides a prefabricated tracking system, considerably increasing amount of energy produced throughout the day. Another addition to the PV modules, and a showcase to the materials of Pennsylvania from Bayer MS, is the thermoplastic polyurethane (TPU) used in place of the typical encapsulation material the non-environmentally friendly ethyl-vinyl acetate (EVA), to increase the cell performance.

A passive and active solar system in one, the solar awning is the innovative fusion of products from three Pennsylvania industries.

12.4.1.3 Solar Thermal System: Hot Water Primarily from the Sun

The control-less, pump-less, closed-loop, flat plate solar thermal system provides an ultra-efficient, extremely cost effective, and very simple-to-maintain way of heating water using the Sun's energy. In case the Energy collected during the day is not enough to adequately provide hot water and supplementary heating for the house, an electric tankless water heater will be included in the system. The system is designed with the plumber in mind, so routine maintenance can be performed by any local plumber, and, due to the inherent simplicity of the system, maintenance will not be required often.

Furthermore, the panels are oriented to capture more Philadelphia winter sun for hot water production in the colder Philadelphia winters. This can be achieved through a vertical orientation of the solar thermal collectors. In the colder months the sun is lower in the sky, meaning that the panels should be closer to vertical to collect the most energy.

12.4.1.4 PEX Manifold: The Simple Way to Run Water

The plumbing requirements of the house are met through the inclusion of a PEX "Home-run" system. This means that each of the plumbing fixtures is connected individually to a supply manifold. This manifold allows each fixture to be switched on and off independently for maintenance. Also, because each run is compartmentalized, the piping can be much smaller, meaning that hot and cold water is practically instantaneous. Additionally, PEX piping has a much better insulation value than a typical copper system, so unused hot water that is left in the supply line will stay warmer for longer.

12.4.1.5 Heating and Cooling: Mini-Split, Ductless Heat Pump

Approaching theoretical limits of energy efficiency, the Fujitsu mini-split, ductless heat pump is the most efficient air source heat pump on the market. Its efficiency is comparable to a ground source heat pump, but requires none of the lengthy installation or high installation cost of a typical ground source heat pump. Furthermore, the system is simple to install, easy to program, and will require no additional ductwork if the DINK couple decides to expand their home in the future. DINKS conveniently find one in both the Great Room and the Bedroom, for custom programmable comfort levels in each space.

12.4.1.6 Ventilation: Energy Recovery Ventilator

Air quality in the home is imperative as the DINK couple will be spending a considerable amount of time in their home. To insure that enough ventilation air is provided to the space, an Energy Recovery Ventilator has been provided for the house. This ERV will allow fresh air to be brought in from outside the home and energy will be transferred from the indoor air that is being exhausted. In this manner ventilation air is provided to the occupants, but energy is not totally lost in the air that is exhausted.

12.4.1.7 Thermal Mass: Innovation and Performance

The Natural Fusion home is designed to be lightweight for transportation. This is the case for all modular homes because substantial savings can be realized with any reduction in shipping weight. However, lightweight homes are more susceptible to temperature changes, causing larger fluctuations in zone temperature, resulting in a higher heating and cooling load. As such, the home has two main

features to add thermal mass at the final location for energy savings, but minimize transportation weight for maximum transportation savings.

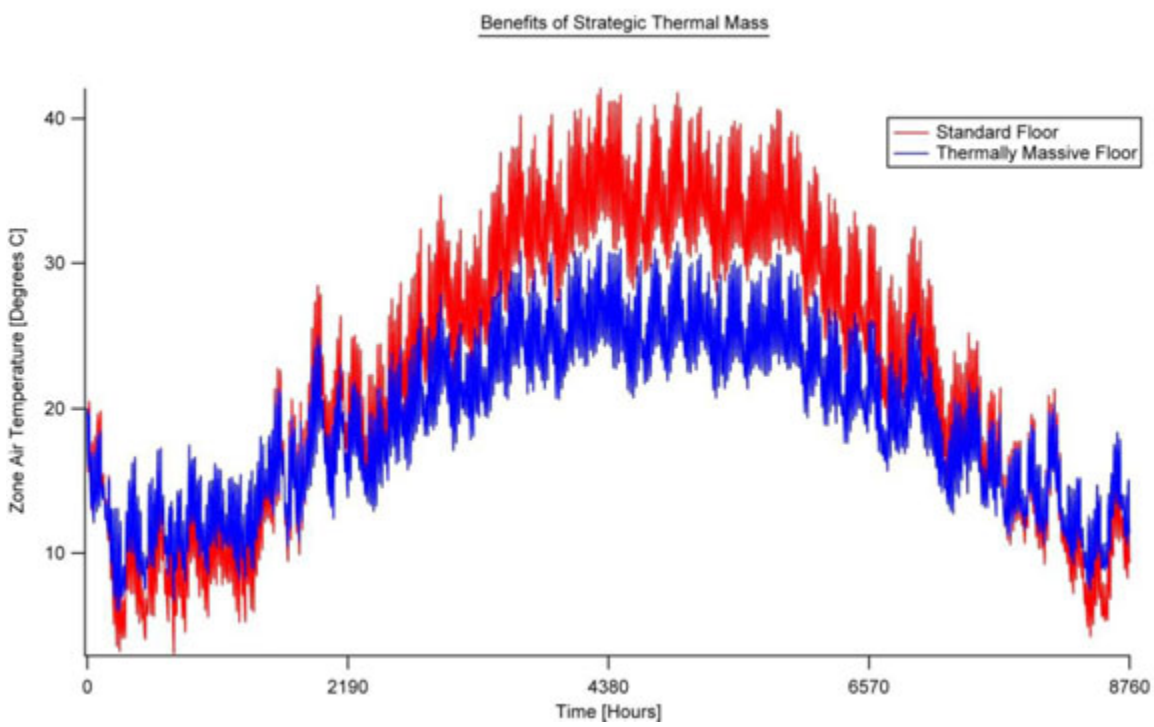


Figure 9: Benefits of strategic thermal mass (Energy Modeling Team)

The first of these features is a bladder system for the area underneath the floor. These bladders, made of thermoplastic polyurethane (TPU), will be filled on-site at the competition to absorb and release energy during the day to level the heating and cooling loads. If desired, the bladders could be connected to an insulated water storage tank and pumped through the system at a low velocity to increase the thermal mass of the house beyond the capacity of the floor area.

Water is also one of the most effective materials for thermal mass storage, outperforming typical thermal mass flooring like concrete or stone. Using concrete or stone would have also required a larger and more supportive framing system, which would further increase both the transportation cost as well as the total cost of materials for the home. This saves about 23,000 lbs of concrete.

The second feature is a phase change material that has been used in all of the walls and the main roof. The cost of this material is $2.81/sq.ft.

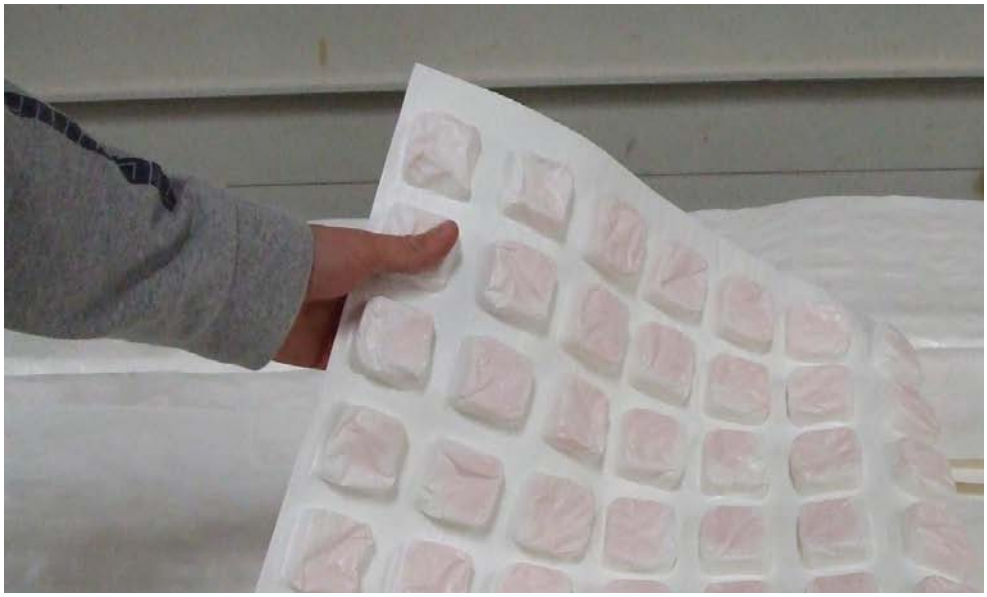


Figure 10: Phase change material installed in walls and ceiling

To help maintain a constant temperature for the house, the material will change its phase from solid to liquid when the temperature rises and vice versa. This change in phase will absorb some of the energy from the air and assist in keeping the temperature in the house within the comfort zone requirements, allowing a gradual transition in temperature that will help to reduce the load that must be met by the heat pump units.

12.4.1.8 Thermal Blinds: Minimizing losses through openings

For the energy conscious DINK couple, it will not always be necessary that the view from the large glass fenestrations be open. For example, at night privacy may be more desirable. Also, at night the windows are not providing any thermal gain or aesthetic benefit. It is during times like these that the DINK couple may wish to utilize the thermal blinds. These insulation devices will allow the windows to be covered with additional insulation to increase the thermal resistance of the entire assembly.

12.4.1.9 Lighting: Naturally and Intelligently

While the Natural Fusion home brings in first and foremost the natural light from the Sun whenever possible, it also incorporates an energy-efficient wireless lighting controls system for ultimate user comfort and appeal. DINKs can easily set “mood lighting” for various tasks throughout the week – dining, movies, or relaxation are just a few of the possibilities. One can also turn off all the lights with just a single button, making it harder to leave a light on – and wasting energy – by accident.

The high tech capabilities of the lighting controls also allows for lighting schedules, so that the vacationing DINK couple can set times for the lighting to go on and off, for an added sense of security and home satisfaction.

12.4.1.10 Appliances: High Performance, Convenience and Aesthetic Appeal

Top of the line EnergyStar and energy-efficient appliances are a perfect fit for the Natural Fusion home. The EnergyStar LG Refrigerator, safer to operate GE Induction Cooktop and convenient LG Washer/Dryer Combination unit provide a cost-effective balance of performance and economics. The combination conventional oven, convection oven, and microwave provide the ultimate in space saving and high-tech appliances.

12.4.1.11 Energy Dashboard: Informing the Energy-Conscious DINK

Education and good information are critical for maximum energy conservation, and in turn, saving money. The energy dashboard system is designed to do both. Primarily, through the supply of good information, the system will display energy use throughout the home in a way that can be broken down to reveal what areas use the most energy. In conjunction with this, energy production will also be displayed. With both of these streams of information, the user can make educated decisions about what course of action should be taken.

For example, let us say that the user is interested in doing a load of laundry. From past experience, the user knows that use of the washer/dryer unit causes a large spike in the energy consumption graph. In addition to this, the user also understands the relationship between power production from the PVs and the weather. The user looks outside and sees that it is raining. Because of the energy dashboard system, the user can make the best decision and wait for a sunny day to do laundry.

12.4.1.12 Single Modular Construction

Constructed using established modular construction specifications; the Natural Fusion home's construction process embodies its philosophy of high quality, energy efficiency, and low environmental impact, ultimately adding value and satisfaction as a high quality product for the sensible Double Income, No Kids couples.

The already high quality standard for a tight building envelope and quality construction of modular was exceeded by the Natural Fusion home with its partner modular building, Professional Building Systems, of Middleburg, PA.

The primary efficiencies of the modular home construction process, in comparison to on-site construction, are material and labor efficiency. Material efficiency within modular production stems from the purchasing power gained when manufacturers procure material in quantities greater than those purchased for single unit, on-site construction, as well as the ability to utilize scrap material for alternate purposes. Labor efficiency is associated with modular home manufacturing because facilities can be sited in regions with favorable labor rates and units shipped to markets in which labor rates are higher. High efficiency is associated with production line construction systems; workers and their primary tools and materials are located in close proximity to the work area and setup/break-down times are minimized.

Using spray foam insulation from Bayer MaterialScience, Walls reached an R-35 insulation value, Roof an R-40 value, and Floor an R-40 value with a wall thickness of only four inches. To obtain these high R-values with standard fiberglass insulation, the walls would have to be at least 2.5 times thicker. In addition to this, the spray foam insulation decreases infiltration, further reducing the heating and

cooling load. Typically walls are not built much thicker, so using spray foam insulation will reduce yearly energy bills. This puts more money in the pockets of the DINKs, adding to their satisfaction of home performance.

Additionally our unique and combined building envelope insulation waterproofing technique adds value and performance. The Natural Fusion home is blanketed with polyisocyanurate (polyiso) board insulation, which double acts as a second layer of insulation and the waterproofing membrane. This smart use of materials thus decreases costs while also decreasing monthly energy bills.

Furthermore, the Natural Fusion single module design saves material, labor, installation and transport costs, over even having just one more module. Thus, the balanced and precise design of the Natural Fusion home is already saving money and energy in its final, integrated form.

12.4.1.13 Double Pane vs. Triple Pane Windows: The Cost Effective Choice

Double pane windows are the minimum requirement for all glazing in any structure striving to be energy efficient. Single pane windows are unacceptable on all accounts. Triple pane windows provide a higher insulation value for a slightly higher initial cost and a large increase in overall complexity of the system. Triple pane windows have many disadvantages including an increased heaviness causing accelerated wear on hardware and casements, a higher risk of glass seal failure causing infiltration and very poor thermal performance, and a loss of visible light transmittance requiring additional use of electric lighting.

In addition to the number of panes, the type of gas between the panes is also crucial. There are several different types of gas that are used in multi pane windows. These gases include normal air, argon gas, krypton gas, and xenon gas. Krypton and xenon gases, however, are difficult and expensive to obtain. The embodied energy in krypton gas is over 40,000 times that of argon gas while xenon gas is even worse at 375,000 times higher (Harvey, 2006). As such, these two gas options were not considered for the Natural Fusion home.

Table 3: Window cost comparison over 20 year life

Cost per 19sqft window	# of Panes	Gas	U-value	Price/Sqft	Heat Loss $/year/sqft	Capital Cost (429 sqft)	Total Cost (20 years)
$18.75	1	Air	1.04	$1.00	$14.57	$429.00	**$101,759**
$150.00	2	Air	0.29	$8.00	$4.06	$3,432.00	**$31,695**
$174.95	2	Argon	0.24	$9.33	$3.36	$4,002.86	**$27,388**
$214.90	3	Argon	0.19	$11.46	$2.66	$4,916.91	**$27,483**

Argon gas between two panes of glass proved to be the most cost effective choice. This includes a conservative estimated value for the disadvantages associated with triple pane windows. This table portrays the results at an electric price that varies from current rates to 2030 rates, 20 years from now (EIA, 2009). Residential electricity prices are expected to reach $0.17/kWh in the year 2028 (EIA, 2009). At that time the windows will be at the end of their 20-year life. While the 20-year total cost is very close for both the double pane and triple pane windows, the added complexity and issues associated with triple pane windows make them less attractive. Currently, in a Pennsylvania climate,

double pane and argon filled windows are the most cost effective solution.

12.4.1.14 Steel vs. Wood: The Environmental and Economic Choice

The Natural Fusion home was designed to have low embodied energy and a big-picture decreased impact to the environment, with the Natural Fusion Materials Team doing Life Cycle Analyses using the National Institute of Standards and Technology's Building for Environmental and Economic Sustainability, or BEES 4.0, of all material choices before choosing specific materials, and also for the home as a whole in its final state.

One of the greatest impacts and values was the use of wood over steel, thus adding environmental satisfaction and a sense of environmental responsibility, as well as embodied cost saving to the Natural Fusion home. Figure 11 illustrates the overall economic and environmental performance of steel framing, treated wood framing, and untreated wood framing. Wood Framing is what the Natural Fusion home uses. The untreated timber framing outperforms steel framing when compared using environmental and economic criteria, mainly due to the energy intensiveness of steel manufacturing.

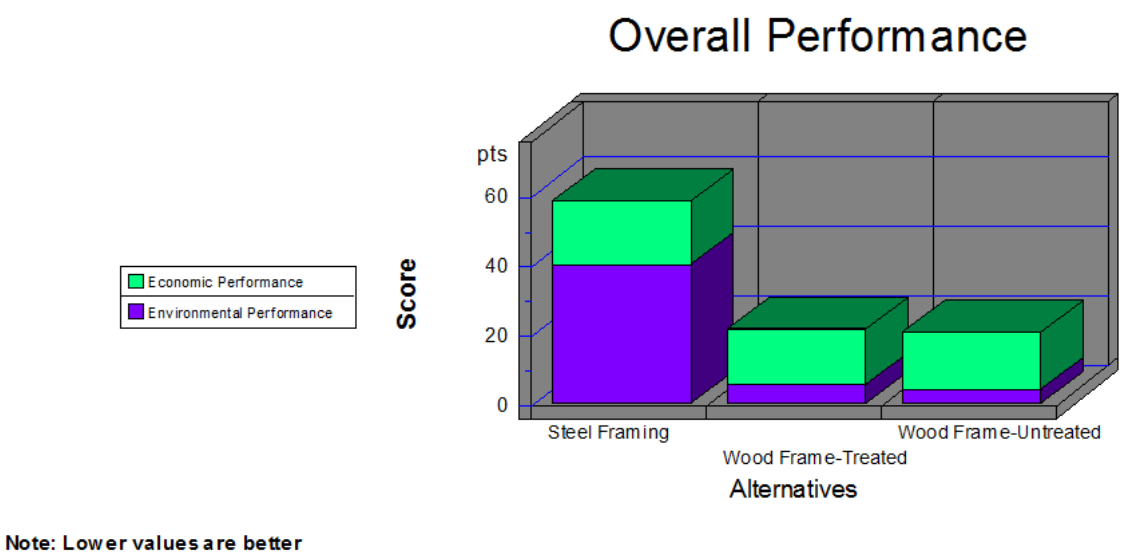


Figure 11: Overall economic and environmental performance of steel vs. wood framing (BEES)

A more specific environmental analysis of the framing types can be seen in Figure 12, also determined through BEES, shows the greenhouse gas emissions associated with each type of framing.

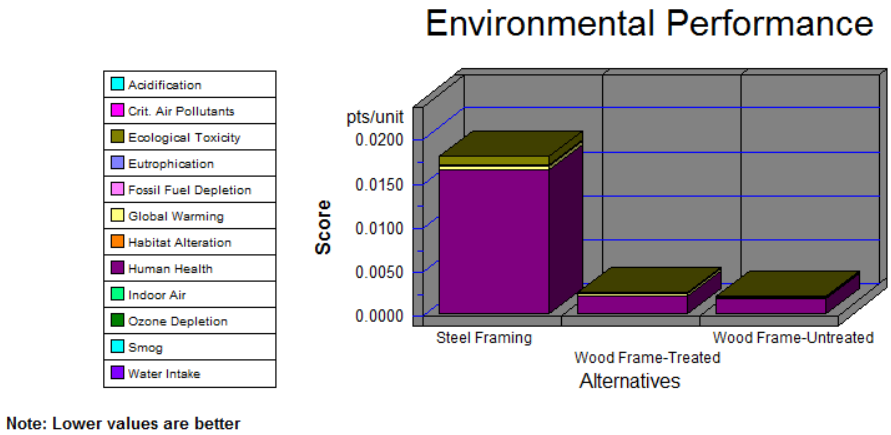


Figure 12: Environmental performance of steel vs. wood framing (BEES)

12.4.1.15 Appliances: Cost Effective, Efficient, and Beautiful

Each appliance was selected after a critical examination of the needs, requirements, aesthetics, energy efficiency and consumption, maintenance, and cost of several alternatives. Because the most critical step in designing a solar powered home is to reduce the loads, the energy consumption of each appliance must be minimized.

Listed below are the energy requirements of the main appliances of the home.

A few key features to point out are as follows:

- The use of a condensing washer/dryer for efficient water removal during the drying process
- A sound system with a D-Class amplifier
- An LCD TV as opposed to a plasma TV. Rear projection can provide larger sizes at similar energy requirements, but cannot be mounted as flush against the wall.
- Use of a laptop as opposed to a desktop computer because it is designed to use energy more conservatively for wireless purposes
- An Induction range is up to 20% more efficient than electric coil ranges
- The refrigerator is one of the largest in its energy consumption class, while meeting the aesthetic needs for the kitchen

12.4.1.16 Life Well: Enjoyable and Environmentally Conscious

The home has a multifunctional wall in the kitchen and living room. The wall is made up of boards that can hang shelves, planters, pots and pans, spice racks, etc. The idea is to use it as a peg board would be used in a workshop. The main purpose in the kitchen is to use it to hang planters, which will contain herbs that the owner could use for cooking.

12.4.1.17 GRIPVs: The Ultimate in Performance and Value

The Natural Fusion solar electric system is a Green Roof Integrated Photovoltaic (GRIPV) system. Green roofs have many benefits, ranging from better water runoff control to being thermally cool. This is due to several factors.

First is the self cleaning nature of the plants. White roofs tend to get dirty, reducing thermal performance. The evapotranspiration from the leaves of the plants provide a latent heat removal method that is not present on other roofs.

Second, a typical roof is dark in nature. Green roof plants reflect certain wavelengths of the light spectrum that a normal roof absorbs. When a green roof is implemented, the roof does not reach the temperature extremes that a typical roof would.

Third, the soil and water that the plants are surrounded by act a thermal mass. Typical roofs reach high temperature extremes in the summer months, and low temperature extremes in the winter months because of their low thermal mass. For Green roofs, because of their higher thermal mass, the actual temperature of the roof throughout a day is moderated and more level when compared to the air temperature.

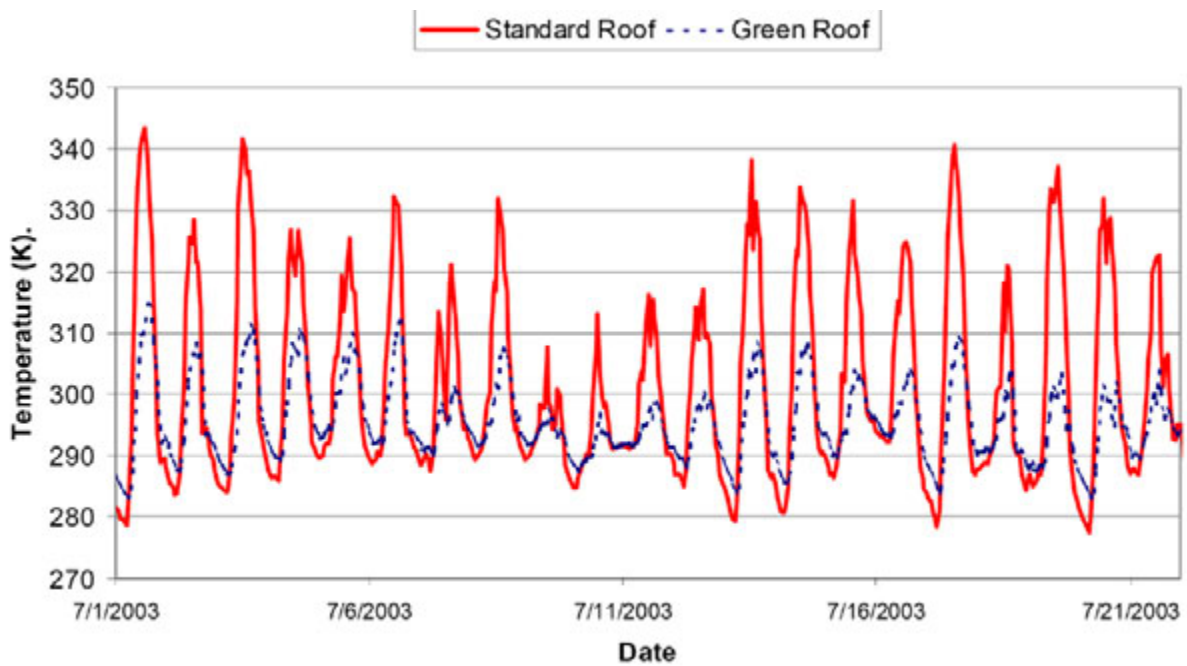


Figure 13: Average control and green rooftop surface temperatures observed on the Penn State University field experiment during July 2003 (Berghage & Beattie, 2004)

This ability to keep the roof cooler allows the PVs to perform better. In return, the PVs act as a shading device for the plants, as the plants are underneath of the PVs. The PVs protect the plants from getting scorched or dehydrated, extending the time required between rains for sustained plant life. The design of the PV panels allows for rain, snow, and some sunlight to reach the plants.

Green roofs are a great way to not only beautify a building, but also to provide energy savings. The temperature of the green roof also benefits the interior temperature of the building because of the thermal mass created from the soil and water. This layer of thermal mass helps keep cut down on heat conduction into and out of the building.

12.4.1.18 Heat Pump: The Ultimate in Efficiency, at an Affordable Cost

The heat pump system in the Natural Fusion home is the best currently available system for this type of home. The Seasonal Energy Efficiency Ratio (SEER) represents the ability to provide cooling to a zone. The Energy Efficiency Ratio (EER) represents the instantaneous energy efficiency of cooling equipment. The Heating Seasonal Performance Factor (HSPF) represents the heat pump's energy efficiency over one heating season.

Table 4: The Fujitsu 9RLS compared to the Energy Star requirements

Unit	Fujitsu 9RLS	EnergyStar Minimum[1]
SEER (Btu/Wh)	26	14.5
EER (Btu/Wh)	17	12
HSPF (Btu/Wh)	12	8.2

All of the values in Table 4 are in terms of energy moved, in the form of heat from or into the space (Btu/hr) per unit of energy input (W) into the system. The EER values can be simply converted into Coefficients of Performance (COPs) by dividing by 3.14 giving a COP of around 5.1 while EnergyStar only requires 3.5. This means that the same amount of energy input into the EnergyStar baseline system achieves much less cooling than the unit specified for the Natural Fusion Home.

12.4.2 Current, and Lasting, Value

The design choices and performance results of the Natural Fusion home are of particular value for those DINKs who are generally interested in green homes. The design of the home along with the included systems allow for many generations of use while holding a higher value than a non-efficient comparable home due to the high tech yet manageable systems that are used.

12.4.2.1 Green Homes: A Quality Investment

From the same report that named DINKs as top buyers of green homes, the top incentives behind purchasing them were given. These included lower utility, maintenance and operating costs; superior performance; preferential mortgage rates, or utility or government incentives; increasing energy costs; better buyer education; government codes, ordinances and regulations; and third party certification.

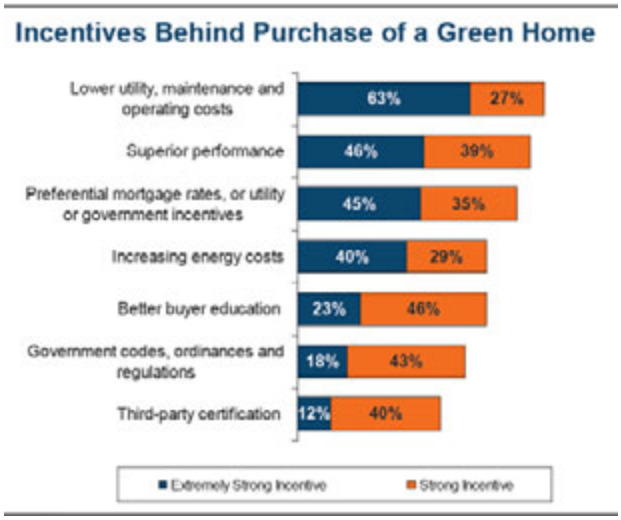


Figure 14: DINK incentives to buying a Green Home (McGraw Hill Construction, 2007)

The Natural Fusion home meets and exceeds each of these criteria, while meeting the particular needs of the Double Income, No Kids young professionals of the greater Philadelphia area.

12.4.2.2 Lower utility, maintenance and operating costs

There's no doubt about it – the ultra efficient systems and high value of daytime solar power will make a huge impact on the DINKs' energy bill.

Furthermore, the engineering systems of the home are designed, not only with ultra-efficiency in mind, but also with particular foresight into maintenance. So not only do they perform better than typical home systems, they are designed to be easy to install, maintain and operate over its lifetime.

For example, the solar thermal system uses no controls, pumps, or other added parts that could potentially break. The Trench Heater uses passive design and natural processes to "operate". These systems are also fixable by the typical plumber, making it easy to get the routine checkups and maintenance when needed.

12.4.2.3 Superior Performance

When compared against other average homes of similar styles in similar target markets, the Natural Fusion home is the most energy conservative, performing the best (EIA, 2009). Because a reduction in energy consumption correlates directly with the cost of living in a home, the Natural Fusion home is extremely desirable.

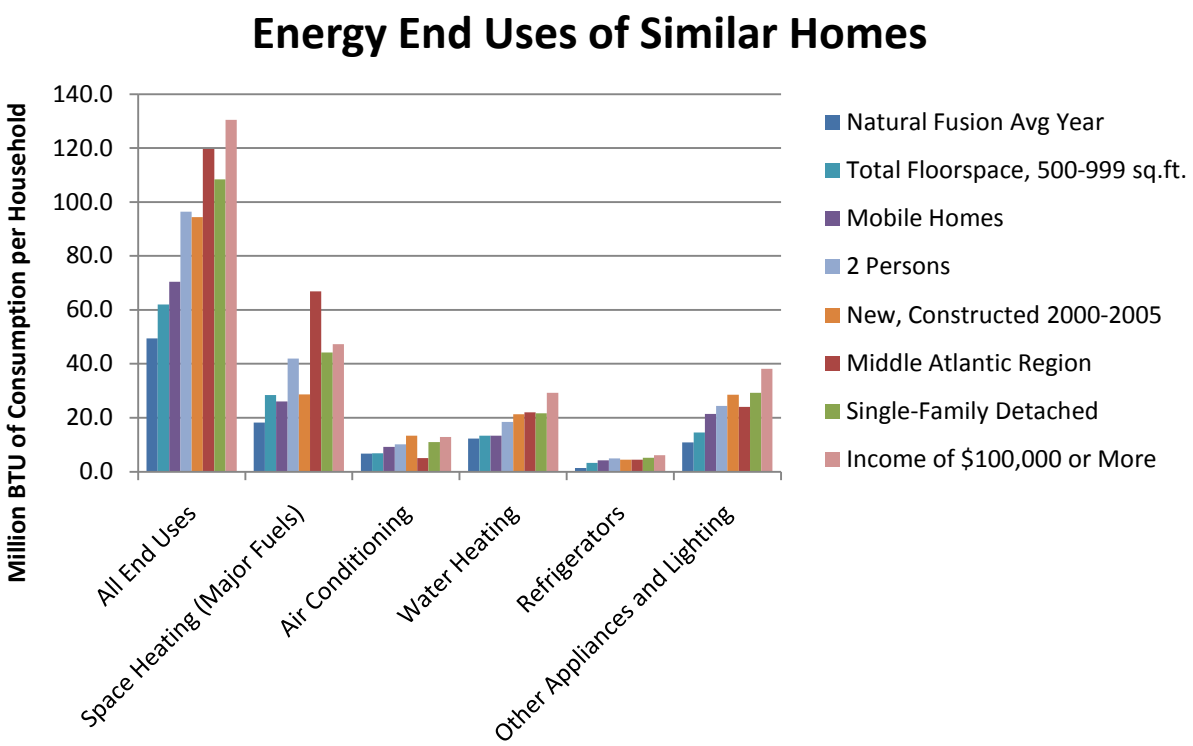


Figure 15: Energy end uses compared in several home types similar to the Target Market (EIA, 2009)

12.5 Conclusion

All in all, the Natural Fusion competition prototype home is a direct match for a Double Income No Kid couple. Between the excellent Target Market location and simple, cost effective, and efficient systems, the house is well suited for Double Income No Kids couples. All systems were chosen with the target market in mind, making them all high tech yet manageable solutions for the specific jobs they were designed to accomplish. The interior layout allows for a roomy, relaxing feel that any home should have whether Green or not. The Natural Fusion home extends a giant leap into a greener future for everyone.

12.6 Works Cited

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13.0 Engineering Design Narrative

The three main areas of engineering design are Mechanical and Plumbing, Electrical and Photovoltaic (PV), and Structural. Each of these sections is described in this section to show how Natural Fusion is implemented in each area.

To arrive at the final Natural Fusion home design, several factors were studied to find the best energy scenario and subsequent options for the design. Throughout the design process, as energy simulations helped to inform the team, options depicted as suboptimal were only justified if the cost of the other factors was higher than the cost of the efficiency loss in the suboptimal option.

13.1 Mechanical and Plumbing

The Mechanical and Plumbing Systems of the Natural Fusion Home are specifically designed to meet three goals. These goals, common to most engineered design, are:

- Provide a comfortable and healthy space for the occupants
- Operate with a high efficiency, reducing electric load
- Allow simplistic operation and maintenance of the systems

While at first glance these goals may seem mutually-exclusive, the implications of each must be considered with respect to the specific application; in this case, a residence.

Most houses are not required to meet any sort of requirement as far as ventilation rates and provide heating and cooling as required by the occupant. In the case of outdoor air ventilation, studies have shown that Indoor Air Quality has a very large effect upon the health of the occupants both long-term and short-term. Also by allowing the occupants to control the temperature the system is typically not operating at its best point for the indoor and exterior conditions.

High efficiency is crucial in a house powered by solar cells as a high electrical load from the heating and cooling equipment will greatly affect the power left for the other functions of the house. Also every home owner would love to pay less on their energy bills for heating and cooling, a more efficient system can significantly reduce these costs.

Finally, the entire process must be relatively simple to take effect in a residence. The reason American homes rely upon conventional systems is that they are simple to operate and maintain. If the outdoor condensing unit breaks, then a call to the local handyman will solve the problem. With solar houses the trend is toward designs for which there are too many components, increasing efficiency but also increasing the difficulty of maintenance. This means that a solar home owner must call a specialist to fix the problem of the house. Also with a very complex system, controls can be very difficult to work out.

The design for the Natural Fusion Home implements super-efficient air-conditioning and heating equipment in a simple layout. Ventilation air is provided through an Energy Recovery Ventilator to minimize energy loss and ensure the respiratory health of the occupants. Through these measures and others, the goals of the design were adequately met.

13.2 Electrical and Photovoltaic

Natural Fusion involves utilizing natural resources as efficiently as possible. This includes energy. The electrical systems are all designed to operate with high energy efficiency while minimizing the overall loads throughout the home. As one of the main concepts of the Solar Decathlon is building integrated photovoltaics (BIPVs), the main goal of the Natural Fusion photovoltaic system is to redefine BIPVs. Since a building is composed of system we are proposing integrating photovoltaics into the systems that make up a building. There are several systems we are integrating with photovoltaics. The main system is the green roof, demonstrating green roof integrated photovoltaics (GRiPV). Green roofs provide many benefits to a home, but usually a decision has to be made between a green roof and photovoltaics. We are using a type of solar panel that allows a large amount of light to pass through them, providing the necessary light to the plant life below. The plants aid the PV system in providing evaporative cooling and a relatively low absorption spectrum to increase the reflective radiation on the panels.

We are also designing an awning PV system that will provide shading from the summer sun and allow winter sun to enter the home aiding the thermal mass and day lighting. The system incorporates a tracking louver system on a North-South axis with PV cells on the louvers. We are still in the designing phase of this system, but we several companies that are working with us on the concept.

13.3 Structural

This project manual provided structural calculations and evaluation of atypical construction methods and loading conditions not covered in applicable building codes.

The objective of the structures group is to create a safe and sensible structural design that maximizes efficiency and minimizes the use of materials that require high energy during production.

A key feature of the home is the frames that transform large span bending moments into isolated axial forces, enabling the use of tensegrity.

Research is being done to minimize the amount of material required by roofing components to increase the roof's R-value.

High performance computer programs were used to evaluate all feasible load combinations to find and design to the critical load scenario. Some programs were commercially available, but when necessary, members of the structures group wrote custom computer programs. The main reason for the use of programs as opposed to hand calculations was to provide the designers with flexibility throughout the process. Alterations are easy to implement and check.

All interior and exterior floor structure components are designed for serviceability at 50 psf and for safety at 100 psf. In other words, means of egress components are permitted to deflect but not rupture in case of an emergency. Pier footings for means of egress components are designed for 100 psf loading.

14.0 Lighting Design Narrative

From the exterior, the lighting design for the Penn State Solar Decathlon home will support the connection between the inside environment and out. Higher brightness inside surfaces will help reinforce the form of interior spaces and create a level of transparency with the exterior.

Lower levels and distinct patterns of light, created from architecturally integrated lighting solutions, will facilitate transition from the outside to the inside. In-grade luminaires will lead pedestrians to the entrance, while general ambient light is provided by integrated LEDs in the awning. The use and view of exterior luminaires will be minimized to emphasize the effect of the light distribution on surfaces. Once inside, custom luminaires will be integrated into columns providing useful light to the corridor while creating visual interest. The same luminaires will incorporate glowing natural patterns that will unite the natural environment with the interior architecture. As one progresses further into the living space, the luminaire aesthetic will reflect a transformation from simple and natural patterns to contemporary and sleek forms and materials.

An inviting environment will be created through the use of localized lighting on key features while creating a warm atmosphere to provide a home-like feeling. Indirect lighting, by the linear cove, will provide general ambient illumination to the living room and kitchen. Through the use of new and efficient technology, energy consumption will be reduced while maintaining the desired quality of light. Adequate light will be provided to work planes in the kitchen, living room, bathroom, and bedroom by flexible localized task lights.

A whole-home control system will facilitate the occupant's usage of lighting equipment through the designation of specific light zones that can be made into different scenes for varying use. Wireless control makes the lighting adjustable from anywhere in the home; even from outside the home. A clock will automatically control lighting when daylight is not present; this will not only save energy but also provide a safe and secure environment.

Passive daylighting systems within our home include the clerestory, which extends the entire length of the house and provides ample light into all living spaces. Daylight control and limitation will also be accomplished by an awning around the south facade.

In summary, the concept of Natural Fusion is supported through the integration of lighting into the architectural forms of the home, varying luminaire aesthetic (from the outside to the inside), daylight abundance, and occupant control. While supporting the overall design concept, the lighting design of The Pennsylvania State University Solar Decathlon Home also provides quality lighting that creates a visually pleasing environment and comfortable living space.

NATURAL FUSION

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