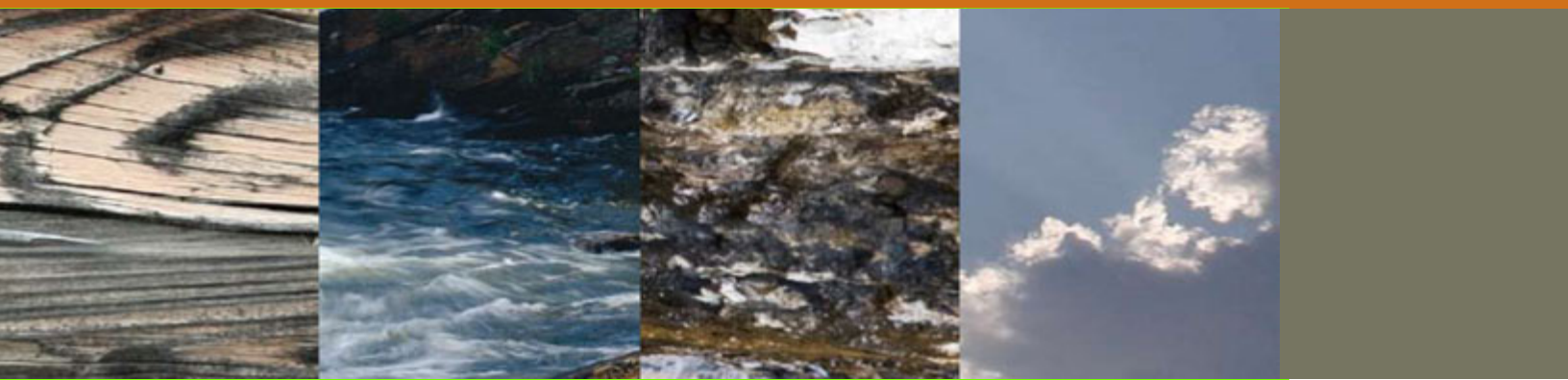
Alberta Solar Decathlon Team



SUMMARY OF CHANGES

THIS SUBMITTAL REPRESENTS A FULL UPDATE OF TEAM ALBERTA'S PROJECT MANUAL. EVERY SECTION NEEDS REVIEW.

Rules Compliance Checklist

4-2	Construction Equipment	Drawing(s) showing the assembly and disassembly sequences and the movement of heavy machinery on the competition site	
4-2	Construction Equipment	Specs for heavy machinery	
4-3	Ground Penetration	Drawing(s) showing the locations and depths of all ground penetrations on the competition site	
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	
4-5	Generators	Specifications for generators	
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-101 through P-104, P-107, final site/deck/tank plan
4-6	Spill Containment	Specifications for all equipment, tanks, and pipes that will contain fluids at any point during the event	221010, 221230, 221316, 223313, 230516, 232113, 232123, 232300, 235600, 235700, 238100
4-7	Lot Conditions	Calculations showing that structural design remains compliant even if 18 in. (45.7 cm) of vertical elevation change exists	
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	
5-2	Solar Envelope Dimensions	Drawing(s) showing the location of all house and site components relative to the solar envelope	
5-2	Solar Envelope Dimensions	List of solar envelope exemption requests accompanied by justifications and drawing references	
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	

6-2	Maximum Architectural Footprint	Drawing(s) showing all information needed by the Rules Officials to measure the architectural footprint electronically	
6-2	Maximum Architectural Footprint	Drawing(s) showing all movable components that may increase the footprint if operated during contest week	
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)	
6-3	Minimum Conditioned Space	Drawing(s) showing space conditioning means in primary living spaces	
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	
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	
7-2	Watering Restrictions	Drawings showing the layout and operation of greywater irrigation systems	
8-1	PV Technology Limitations	Specifications for photovoltaic components	E-___, Sections?????
8-1	PV Technology Limitations	Retail price quote for photovoltaic components	include quote from Sedmek and Enphase
8-3	Thermal Energy Storage	Drawing(s) showing the location of thermal energy storage components	P-107, final site/ deck/tank plan
8-3	Thermal Energy Storage	Specifications for thermal energy storage components	M-002, 231230, 235700
8-3	Thermal Energy Storage	Shading calculations and/or diagrams for thermal energy storage components (if necessary)	Daan
8-4	Batteries	Drawing(s) showing the location(s) and quantity of stand-alone, PV-powered devices	
8-4	Batteries	Specifications for all stand-alone, PV-powered devices	
8-5	Desiccant Systems	Drawing(s) describing the operation of the desiccant system	
8-5	Desiccant Systems	Specifications for desiccant system components	
8-6	Village Grid	Completed Interconnection Application form.	
8-6	Village Grid	Drawing(s) showing the locations of the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	
8-6	Village Grid	Specifications for the photovoltaics, inverter(s), terminal box, meter housing, service equipment, and grounding means	

8-6	Village Grid	One-line electrical diagram
8-6	Village Grid	Calculation of service/feeder net computed load per NEC 220
8-6	Village Grid	Site plan showing the house, decks, ramps, tour paths, and terminal box
8-6	Village Grid	Elevation(s) showing the terminal box, meter housing, main utility disconnect, and other service equipment
9-4	Rainwater Collection	Drawing(s) showing the layout and operation of rainwater collection systems
9-6	Thermal Mass	Drawing(s) showing the locations of water-based thermal mass systems
9-6	Thermal Mass	Specifications for components of water-based thermal mass systems
10-2	Event Sponsor Recognition	Drawing(s) showing the dimensions, materials, artwork, and content of all communications materials, including signage
10-3	Team Sponsor Recognition	Drawing(s) showing the dimensions, materials, artwork, and content of all communications materials, including signage
11-4	Public Exhibit	Interior and exterior plans showing entire accessible tour route
11-4	Public Exhibit	Drawing(s) showing the dimensions, materials, artwork, and content of the handout
11-4	Public Exhibit	Drawing(s) showing the artwork and content of the team uniform

Section Number	Section Name	No. of Pages
DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS		
00 31 00	Available Project Information	1
DIVISION 01 - GENERAL REQUIREMENTS		
01 41 00	Regulatory Requirements	1
01 50 00	Temporary Facilities and Controls	2
01 53 50	Temporary Foundation	1
01 73 29	Cutting and Patching	1
DIVISION 02 - EXISTING CONDITIONS		
	No Sections this Division	
DIVISION 03 - CONCRETE		
03 30 01	Concrete	2
DIVISION 04 - MASONRY		
04 43 00	Stone Masonry	2
DIVISION 05 - METALS		
05 50 00	Metal Fabrications	2
05 73 13	Glazed Metal Railings	1
DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES		
06 10 00	Rough Carpentry	3
06 12 00	Structural Panels	3
06 61 20	Stone-Resin Surfacing Fabrications	2
DIVISION 07 - THERMAL AND MOISTURE PROTECTION		
07 21 16	Blanket Insulation	1
07 21 19	Foamed-In-Place Insulation	2
07 21 29	Sprayed Insulation	3
07 27 01	Air Barrier / Vapour Retarder Membrane	4
07 42 13	Steel Siding	2
07 46 23	Wood Siding	1
07 54 23	Thermoplastic-Polyolefin Roofing (TPO)	5
07 62 00	Sheet Metal Flashing and Trim	2
07 92 00	Sealants	3
DIVISION 08 - OPENINGS		
08 11 13	Hollow Metal Doors	2
08 14 00	Wood Doors	3
08 54 13	Fibreglass Windows	5
08 70 00	Hardware	1
08 80 00	Glazing	2

Section Number	Section Name	No. of Pages
DIVISION 09 - FINISHES		
09 29 00	Gypsum Board	4
09 30 33	Stone Tiling	4
09 31 00	Thin-Set Tiling	4
09 65 00	Resilient Flooring	2
09 90 00	Painting	3
DIVISION 10 - SPECIALTIES		
10 22 19	Demountable Partitions	2
10 28 00	Toilet, Bath, and Laundry Accessories	1
10 44 16	Hand Held Fire Extinguishers	1
10 71 13	Exterior Sun Control Devices	3
DIVISION 11 - EQUIPMENT		
11 31 00	Residential Appliances	1
11 33 00	Retractable Stair	1
DIVISION 12 - FURNISHINGS		
12 10 00	Art	1
12 20 00	Window Treatments	1
12 32 00	Manufactured Casework	3
12 40 00	Furnishings and Accessories	1
12 48 00	Rugs and Mats	1
12 58 00	Residential Furniture	1
DIVISION 13 - SPECIAL CONSTRUCTION		
	No Sections this Division	
DIVISION 14 - CONVEYING EQUIPMENT		
	No Sections this Division	
DIVISION 21 - FIRE SUPPRESSION		
	No Sections this Division	
DIVISION 22 - PLUMBING		
22 05 00	Common Work Results for Plumbing	2
22 05 23	General-Duty Valves for Plumbing Piping	1
22 07 00	Plumbing Insulation	1
22 11 10	Piping	2
22 11 13	Domestic Water Piping	3
22 12 30	Water Tanks	1
22 34 13	Instantaneous, Tankless, Electric Domestic Water Heater	1
22 41 00	Residential Plumbing Fixtures	1

Section Number	Section Name	No. of Pages
DIVISION 26 - ELECTRICAL		
26 05 00	General Electrical Provisions	3
26 05 05	Basic Electrical Materials and Methods	3
DIVISION 32 - EXTERIOR IMPROVEMENTS		
32 91 00	Planting	5
DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND STORAGE EQUIPMENT		
43 32 75	Ion Exchange Purification Equipment	1
DIVISION 48 - ELECTRICAL POWER GENERATION		
48 19 16	Invertors	1

END OF TABLE OF CONTENTS

1 General

1.1 Data sheets and installation notes for materials and equipment used in the construction of this house are filed electronically by MasterFormat Divisions and available at www.solabode.ca/specifications.

END OF SECTION

1 JURISDICTIONAL AUTHORITIES

1.1 This house is designed and constructed to meet the building codes of the following locations:

.1 The display location: The Mall, Washington. D.C., building code: Solar Decathlon 2009 Building Code and Solar Decathlon 2009 Rules.

.2 Permanent location: Calgary, Alberta, Canada, Alberta Building Code 2006 edition.

1.2 Where reference is made to Authority having Jurisdiction, it shall mean all authorities who have within their constituted powers the right to enforce the laws of the current location of the building.

1.3 Authority having Jurisdiction governing the permanent location shall include, but shall not be restricted to the City of Calgary.

2 REFERENCE STANDARDS

2.1 Where edition date is not specified, consider that references to manufacturer's and, published codes, standards and specifications are made to the latest edition (revision) approved by the issuing organization, current at the date of the Specifications.

2.2 Reference standard and specifications are quoted in the Specifications to establish minimum standards. Work of quality or of performance characteristics that exceeds these minimum standards will be considered to conform.

2.3 Should the Contract Documents conflict with specified reference standards or specifications, the most stringent requirements comply with the most stringent requirements.

3 MATERIAL SAFETY DATA SHEETS

3.1 Comply with legislated requirements and provide, on site at an identified central location, MSDS for all products on site.

END OF SECTION

1 COMPLIANCE

1.1 Comply with the requirements of this section when constructing the house at permanent location in Calgary, Alberta, Canada.

2 FIRES

2.1 Fires and burning of rubbish on site are not permitted.

3 DISPOSAL OF WASTE

3.1 Do not bury rubbish and waste materials on site.

3.2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

3.3 Provide bins for separation of recyclables from other waste material. Clearly identify each bin.

3.4 Dispose of all waste legally.

4 DRAINAGE

4.1 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.

4.2 Do not pump water containing suspended materials into waterways, sewer or drainage systems.

4.3 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with all applicable municipal, provincial and federal regulations.

5 SITE CLEARING AND PLANT PROTECTION

5.1 Protect from damage existing trees and plants on site as identified to remain.

5.2 Protect all trees and plants on adjacent properties.

5.3 Comply with all requirements of City of Calgary Tree Protection Bylaw and protect trees on City property.

5.4 All trees to be protected or requiring protection to have fencing installed at or beyongd the drip line. Fencing shall comply with City of Calgary Tree Protection Bylaw, and at a minimum shall be T-bar stake posts with orange vinyl snow fencing. Fence locations to be as per tree protection plan.

5.5 Protect roots of trees to tree dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones.

5.6 Protect vegetation to be preserved from the following damage:

.1 Compaction of the root area by equipment or material. No construction activity is to occur within protection zones.
.2 Trunk damage by moving equipment, material storage, nailing or bolting.
.3 Strangling by typing ropes or guy wires to trunks or large branches.
.4 Poisoning by pouring solvents, gas, paint, etc., within the canopy spread of the plant.
.5 Cutting of roots by excavating, ditching, etc.
.6 Damage of branches by improper pruning.

.7 Drought from failing to water, or by cutting or changing normal drainage pattern past roots.
.8 Changes in pH factor by disposal of lime base materials such as concrete and plaster.
.9 Do not cut roots 40 mm in diameter or over, without the Consultant's approval.

5.7 If major branches or roots are damaged Contractor shall contact Consultant immediately.

5.8 Replacements:

.1 When trees other than those approved for removal are damaged or killed as a result of the construction operations, the Contractor will supply and install replacement plant materials.
.2 Replacement values shall be based on International Arboriculture Standards-Alberta Standards.
.3 Pay penalties required by City of Calgary Tree Protection Bylaw.

6 POLLUTION CONTROL

6.1 Maintain temporary pollution control features installed under this contract.

6.2 Control emissions from equipment and plant to local authority's emission requirements.

6.3 Prevent sandblasting and other extraneous materials from contaminating air beyond application area, by providing temporary enclosures.

6.4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control in construction areas.

7 SIGNAGE

7.1 Supply and install base/ground mounted explanatory signs per drawing details. Verify font, sign message, and colours prior to fabricating sign. Sign shall be anodized, extruded aluminum posts and message board per drawing details.

8 GENERATOR

8.1 Portable Generator: Honda, cat # EP2500CX generator, noise level 69 dB (A) at 7 m at rated load. Generator shall be equipped with 20 L secondary spill containment.

9 HEAVY EQUIPMENT

9.1 Telescopic Handler for material handling: 26000 lb capacity, maximum boom lift height: 31.75 ft.

END OF SECTION

1 TEMPORARY FOUNDATION

1.1 Provide the following adjustable foundation at the Mall, Washington, D.C.:

.1 Holland Binkley Modular Roll Off System, Model # MM0007-03.

.2 Cribbing: see drawing details.

END OF SECTION

1 GENERAL

1.1 Execute cutting, fitting, and patching as required to complete the work.

1.2 Fit the various parts together, to integrate with other work.

1.3 Uncover work as required to install work not installed at the appropriate time.

1.4 Remove and replace defective and non-conforming work.

1.5 Remove samples of installed work for testing as required.

2 INSPECTION

2.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

2.2 After uncovering, inspect conditions affecting performance of work.

3 PREPARATION

3.1 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.

3.2 Provide protection from elements for areas which may be exposed by uncovering work; maintain interior of building free of rain water.

4 PERFORMANCE

4.1 Execute work by methods to avoid damage to other work, and which will provide proper surfaces to receive patching and finishing.

4.2 Cut rigid materials using saw or core drill. Do not use pneumatic or impact tools without prior approval.

4.3 Where existing exposed finishing materials such as brick masonry must be carefully removed for re-installation, work of this nature shall only be performed by journeyman tradesmen of the applicable trade, who shall carefully remove, clean, stack and store material and perform reinstallation.

4.4 Restore work with new products in accordance with requirements of Contract Documents.

4.5 Fit work air-tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

4.6 At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with fire-rated or fire-resistant material, full thickness of the construction element in accordance with the requirements of Section 07 84 00.

4.7 Refinish surfaces to match adjacent finishes: For continuous surfaces refinish to nearest change in plane or material; for an assembly, refinish entire unit.

4.8 At all penetrations through acoustically treated wall and partition assemblies, completely seal all penetrations with acoustic sealant, tape and insulation as required to prevent sound transfer and to maintain the required STC rating of the wall.

END OF SECTION

1 General

1.1 SCOPE

.1 This Section applied to permanent foundation to be constructed in Calgary, Alberta, Canada in accordance with requirements of the Alberta Building Code, 2006 edition.

1.2 REFERENCES

.1 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction

.2 CAN/CSA-A3000-03, Cementitious Materials Compendium.

.3 CAN/CSA-A23.1-04, Concrete Materials and Methods of Concrete Construction.

.4 CAN/CSA-A23.2-04, Methods of Test and standard practices for concrete.

.5 CAN/CSA-A438-00, Concrete Construction for Houses and Small Buildings.

1.3 PROTECTION

.1 Protect forms from ice, snow, excessive moisture, dirt and debris before placement of concrete.

.2 Protect concrete from freezing after placement and for minimum 28 days thereafter.

2 Products

2.1 MATERIALS

.1 Cement shall meet the requirements of CAN/CSA-A3001, “Cementitious Materials for Use in Concrete, type “HS” cement.

.2 Aggregates shall consist of sand, gravel crushed rock conforming to CAN/CSA-A23.1.

.3 Water shall be clean, potable and free of deleterious material.

.4 Concrete mix shall be minimum 15 MPa at 28 days.

.5 Dampproof Membrane: 150 micrometre polyethylene film to CAN/CGSB51.34.

.6 Form release agents: Ecologo certified under the Environmental Choice Program (ECP).

3 Execution

3.1 FORMWORK

.1 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CAN/CSA-A23.1.

.2 Formwork to remain in place until concrete has attained sufficient strength to support its own weight adequately, together with the construction loads likely to be imposed.

3.2 PLACING CONCRETE

.1 Perform concrete work in accordance with CAN/CSA-A23.1.

.2 Place concrete as a continuous operation.

3.3 CURING

.1 Keep concrete moist in compliance with the requirements of CAN/CSA-A23.1

3.4 GROUND COVER

.1 Place dampproof membrane on prepared subgrade under slabs on grade. Lap each sheet minimum 150mm. Seal laps and penetrations using materials recommended by membrane manufacturer.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Mortar set stone veneer to building exterior.

1.2 RELATED SECTIONS

.1 Section 06 10 00 for building paper.

.2 Section 09 30 33 for interior adhesive set stone.

1.3 REFERENCE STANDARDS

.1 CSA-A371-04, "Masonry Construction for Buildings".

2 Products

2.1 MATERIALS

.1 Stone: Thunderstone Quarries “Rundle stone”, gauged stone.

.2 Mortar: to CSA-A179-04, Type “N”. Use proportion mix using cement, lime, aggregates and potable water or pre-approved pre-mixed mortar. Sand used in mortar shall not contain any carbon.

.3 Metal lath: 18 gauge galvanized, woven wire mesh or 2.5 lb. flat galvanized diamond mesh. Metal lath shall be self-furring type.

.4 Sealant: General construction sealant as specified in Section 07 92 00.

3 Execution

3.1 PREPARATION

.1 Sheathed Surfaces: Install building paper as specified in Section 06 10 00. Apply metal lath attached with glavanized nails or screws penetrating panel substrate or studs 25 mm and spaced at 150 mm on centres vertically and 400 mm on centres horizontally. Fasteners shall penetrate studs.

3.2 APPLICATION

.1 Apply 13 mm to 19 mm thick bed of mortar to lath or dampened masonry or concrete substrate, covering a maximum of $1m^2$ at a time. Firmly embed units into position on soft mortar bed, twist units slightly to ensure full bond and that mortar is slightly extruded around edges.

.2 Place units with uniform mortar joints, joint width as applicable to stone product selected. Confirm other joint treatment including filling and pointing as required with the Consultant prior to fabrication of mock-up.

.3 Remove excess mortar. Do not allow mortar to set up on face of units. Clean and finish joints.

3.3 FLASHINGS

.1 Install flashings at heads and sills of all openings in stone. Install behind (under) building paper to direct water to the exterior.

END OF SECTION

1 General

1.1 QUALITY ASSURANCE

.1 Design, materials and fabrication are to conform to the Alberta Building Code and CAN/CSA-S16. The fabricator is to be certified to CSA W47.1, Division 1 or 2.1.

.2 Comply with the requirements of the Alberta Building Code for the loads and design required for steel ladders, stairs and hand rails and guardrails.

2 Products

2.1 MATERIALS

.1 Use only materials which are new, free from defects that would impair the strength, durability or appearance, and of the best commercial quality for the intended use.

.2 Steel: Structural quality, to CAN3-G40.20-04.

.3 Rolled Structural Steel Sections: to CAN3-G40.21-04, grade 300W unless noted otherwise on the drawings.

.4 Hollow Structural Steel Sections: to CAN-G40.21-04, grade 300W unless noted otherwise on the drawings.

2.2 FABRICATION

.1 Shop fabricate all components where possible. Fabricate components square, straight, true, free from warping and other defects. Accurately cut, machine, file and fit joints, corners, copes and miters.

2.3 FINISHES

.1 Preparation: prepare all miscellaneous steel scheduled to receive primer (all steel with the exception of galvanized components) in accordance with master Painters Institute (MPI) Surface Preparation Guidelines, 5.1" Structural Steel and Metal Fabrications - Shop Coated Steel". Use SSPC SP-1 Solvent Cleaning, followed by SSPC SP-6 Commercial Blast Cleaning", refer to SPC manual "Guide to Good Painting Practices", Volumes 1 and 2 for additional details.

.2 Apply shop primer to a dry film thickness of 50 to 75 micrometers. Avoid primer runs. Correct any primer defects to Consultant's satisfaction. Site touch-up shop applied primer with primer and preparation procedures equal to those noted herein. Do not prime items to be embedded in concrete.

3 Execution

3.1 FASTENINGS

.1 Provide fastenings, including anchor bolts, bolts, lag screws, expansion bolts, straps, brackets, etc. required for the fabrication and erection of work of this Section.

.2 Use only permanent type fastenings; do not use wood or organic plugs.

3.2 INSTALLATION

.1 Apply an isolation coating to contact surfaces of components in contact with cementitious materials or dissimilar metals except stainless steel.

.2 Install components square, straight, true, plumb and in plane.

.3 Securely anchor components in place.

3.3 SCHEDULE OF COMPONENTS

.1 Steel railings: All welded steel construction, exterior and interior railings prime painted for final site painting. Design and fabricate to meet loads, clearances and dimensions specified in the Alberta Building Code, 2006 edition.

.2 In addition to the above provide all other steel fabrications shown on the drawings.

END OF SECTION

1 General

1.1 SUMMARY

.1 Supply and installation of prefinished manufactured hand rail system with glass balusters as per drawing details, for installation to locations as noted.

1.2 DESIGN

.1 Design railing system, attachments and connections, to resist all loads as noted in the Building Code.

2 Products

2.1 MANUFACTURERS/SYSTEMS

.1 Proprietary, prefinished extruded aluminum system of brackets, balusters, top and bottom rails and ancillary items, assembled to configurations detailed. Glass balusters shall be tempered, clear glass.

.2 Acceptable manufacturer and product: Wagner “Glasswedge” dry mount system or pre-approved similar product.

2.2 FABRICATION

.1 Bolt or screw all connections. Lock all connections to ensure they remain tight.

.2 Accurately form connections with exposed faces flush, mitres and joints tight.

.3 Cut and assemble units to site obtained dimensions and reviewed shop drawings.

2.3 FINISHING

.1 Clean and treat aluminum and factory apply primer and top coat of acrylic paint system. Paint colour custom colour as selected by the Consultant. Paint system shall be guaranteed against fading, chalking, peeling or any other defect for minimum 10 years. All exposed fasteners shall be finished in colour to match.

3 Execution

3.1 INSTALLATION

.1 Install railings plumb and true in exact locations, to provide a rigid structure. Use vandal resistant plated or stainless steel fasteners and lock in place after installation.

.2 Provide all necessary anchors, bolts and plates as required for connecting railings to the structure.

.3 Ensure alignment with adjacent construction. Coordinate with related work to ensure no interruption in installation.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Framing, blocking, sheathing, heavy timber construction.

1.2 QUALITY ASSURANCE

.1 Do all work in accordance with the Alberta Building Code, and Solar Decathlon Rules and Building Code.

2 Products

2.1 LUMBER

.1 Lumber: Dressed Yard Lumber meeting the following requirements:

- .1 Maximum moisture content at time of installation; 19%.
- .2 Maximum moisture content when used for attachment of drywall; 12%.
- .3 Conforming to CAN/CSA-O141-M91 & NLGA Rules.
- .4 Consisting of species group D (SPF); #2 grade or better.

2.2 HEAVY TIMBER CONSTRUCTION

.1 Engineered package: Supplier: Canadian Timberframes Ltd., Golden, B.C., phone (250) 348-2231.

.2 Timber construction: Douglas Fir, Forest Stewardship Council (FSC) certified, #1 grade or better, moisture content at time of installation 19%.

.3 Tension rod assemblies, powder coat finish, as engineered.

2.3 PANEL PRODUCTS

.1 Plywood: Douglas Fir or Western Softwood, Sheathing Grade, to CSA O121 or O151.

.2 Plywood used in subfloor assembly shall be tongue and groove edge finish, as per structural specifications and drawing notes.

.3 Roof sheathing: as per structural specifications and drawing notes.

.4 Kiln dried Oak pegs, miscellaneous fasteners and GRK screws.

2.4 MISCELLANEOUS MATERIALS

.1 Nails: To CSA B111, Galvanized for exterior and roofing work.

.2 Fasteners for underlayment:

- .1 Galvanized, annular ringed, length to provide minimum 85% penetration into sub-floor, but not enough to anchor underlayment to joists.
- .2 Staples: chisel point, non-divergent, double coated, length ensuring minimum 85% penetration into subfloor but not penetrating through.

.3 Bolt, nut, washer screw and pin type fasteners: Hot dipped galvanized finish to CSA G164-M92.

.4 Building paper: Wall sheathing paper conforming to CAN/CGSB-51.32-M77 (30 minute paper).

.5 Subfloor adhesive: to CAN/CGSB 71.26-M88.

.6 Bedding Sealant: Butyl non-hardening, conforming to CGSB 19-GP-14M; Chemtron Butylin.

3 Execution

3.1 ROUGH CARPENTRY WORK

.1 Accurately frame and properly assemble rough carpentry work. Erect plumb and true. Include all necessary nails and other connectors.

3.2 BLOCKING, FURRING, ETC.

.1 Install and secure wood blocking between studs where required for fixing items to walls.

3.3 JOISTS AND JOIST HANGERS

.1 All wood joists supported in joist hangers shall be fully nailed.

3.4 PANEL-TYPE SUB-FLOORING

.1 Install sub-flooring with panel end-joints located on solid bearing, staggered at least 800 mm.

.2 Apply subflooring adhesive to all wood joists under panels. Place continuous single-bead on each joist and double-bead on joists where panel ends butt. Comply with adhesive manufacturer's additional installation instructions.

.3 Fasten panels using common-spiral or annular grooved nails spaced 150 mm O.C. along edges and 150 mm O.C. along intermediate supports.

3.5 FASTENINGS

.1 Unless indicated otherwise, fasten to concrete surfaces with expansion shields and bolts.

3.6 WOOD FRAME AND HEAVY TIMBER CONSTRUCTION

.1 Minimize cutting of framing members for pipes, etc. by prior consultation with other trades.

.2 Bed bottom plate of stud walls in double bead of Bedding Sealant. Ensure vapour barrier is installed under plates as indicated.

.3 Fabricate wood frame and heavy timber construction to the requirements of the Building Code, part 9, ULC assemblies as noted, and as detailed on the drawings.

.4 Minimum sizes and spacing of members, thickness of materials, allowable species and lumber grades, shall meet the requirements of the above noted standards, unless indicated or specified otherwise.

.5 Minimize cutting of framing members for pipes, etc. by prior consultation with other trades. Cutting limitations per part 9 of the Building Code.

.6 Construct framing as necessary to accommodate the work of other trades.

.7 Install at least one row of solid blocking to wood stud walls not more than 2400 mm high, two rows if over 2400 mm high.

.8 Install blocking behind all sheathing and wallboard joints in wood frame construction, and where required for items to be fixed to walls.

.9 Erect heavy timber framing to shop drawings.

3.7 BUILDING PAPER

.1 Use staples to install building paper over sheathing.

.2 Overlap building paper so there are two (2) layers of paper throughout. Overlap all edges of building paper minimum 100 mm. Comply with requirements of Building Code for installation to provide “shingled” water-shedding installation.

3.8 EQUIPMENT BACKBOARDS

.1 Provide backboards for mounting equipment as indicated. Use 19 mm thick Canadian Softwood Plywood/S1S or Douglas Fir Plywood/G1S.

END OF SECTION

1 General

1.1 SYSTEM DESCRIPTION

.1 Structural Insulated Panels (SIPs) of performance-rated oriented strand board (OSB) structurally laminated to polyurethane rigid insulation core. The SIP system incorporates proprietary spline connectors, sealants and fasteners.

1.2 REFERENCES

.1 American Society of Civil Engineers (ASCE) ASCE 7 – Minimum Loads for Buildings and Other Structures.

.2 ASTM E1803 – Standard Test Method for Determining Structural Capacities of Insulated Panels.

.3 Underwriters' Laboratories of Canada (ULC) CAN/ULC-S101 - Standard Methods of Fire Endurance Tests of Building Construction and Materials

.4 Canadian Construction Materials Centre (CCMC) CCMC Technical Guide – Stressed Skin Panels (with structural ribs) for Walls and Roofs.

1.3 DESIGN REQUIREMENTS

.1 Comply with manufacturer's installation guide and design manual.

.2 Provide SIPs which have been manufactured, fabricated and installed to withstand specified loads as determined by design in accordance with the local building codes and to maintain performance criteria without defects, damage or product failure.

1.4 SUBMITTALS

.1 Fire Resistant Assemblies: Intertek Testing Services or equal assembly listing for testing per ASTM E119/CAN/CSA-S101 to required fire resistance rating.

1.5 QUALITY ASSURANCE

.1 Installer Qualifications: Installer to have demonstrated experience acceptable to SIP Manufacturer in installation work similar in scope and size to this project.

.2 Source limitations: Obtain all SIPs through one source. All accessories to be furnished or recommended by the SIP manufacturer.

1.6 REGULATORY REQUIREMENTS:

.1 SIPs shall be recognized for compliance with the applicable building code with an ICC-ES evaluation report for the International Building Code or the International Residential Code and with a CCMC evaluation report for the National Building Code of Canada.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Unloading: Off-load SIPs from delivery truck and handle using fork lift, crane or other means to prevent damage to SIPs.

.2 Storage: SIPs shall be fully supported in level storage and prevented from contact with the ground. Stack SIPs with a minimum of three supports for every eight feet of SIP length.

.3 Protection: SIPs shall be fully protected from the weather. Protect against exposure to rain, water, dirt, mud, and other residue that may affect SIP performance. Cover stored SIPs with breathable protective wraps. Sips shall be stored in a protected area.

2 Products

2.1 MATERIALS

.1 Structural Insulated Panels: Structural Insulated Panels as manufactured by EMERCOR Ltd. Factory manufactured panels shall be shot mold injected polyurethane foam core composite panels, compromising of an exterior skin of OSB a polyurethane foam core and an interior skin of OSB with connecting splines and fasteners.

.2 Core: Polyurethane Rigid Foam insulation.

.3 Splines: OSB, dimensional lumber, engineered wood or I-beam for use in joining SIPs shall be supplied by the SIP manufacturer.

.4 Fasteners for Roof, Corners and Attachment of panels to Frames: “Olympic” Screw SIP006 or SIP008 or “Roof-grip” screw No. 12 or comparable corrosion resistant screws; as approved by SIPs manufacturer.

.5 Fasteners for spline and plate Attachments: Zinc galvanized screws, nails, or staples min. 1¼” (32 mm) long; as approved by SIPs manufacturing.

.6 Adhesive/Sealant: for installing splines and dimensional lumber: “PL-400” or comparable wood construction adhesive as approved by SIPs manufacturer.

.7 Foam Sealant: “Hilti” CF-128 or comparable low to medium rise polyurethane expanding foam as approved by panel manufacturer.

.8 Dimensional Lumber: Spruce-Pine-Fir No. 2 or better or pre-engineered equivalent; as specified in Section 06 10 00.

.9 SIP Panel Seal Tape: Tape with an adhesive suitable for indoor use, minimum 150 mm wide for use on flat SIP joints and minimum 300 mm wide for use on opposing angled surfaces including ridge and roof-to-wall connections. SIP tape supplied by SIP manufacturer.

.10 SIPs panels contain no formaldehyde, CFC’s, or any other harmful gases.

3 Execution

3.1 INSTALLATION

.1 Comply with manufacturer’s installation instructions.

.2 Provide level and square foundation/structural system/substrate that support wall and/or roof SIPs. Provide full bearing of both OSB skins. Provide adequate bracing of SIPs during panel erection. Remove debris from plate area prior to application on sealant and SIP placement.

.3 Connect SIPs using screws or nails as shown on approved shop drawings. Where manufacturer supplied SIP Screws are used, a minimum of 38 mm of penetration is required into support.

.4 Install sealant in a continuous bead into all connections.

.5 Apply SIP tape at joints between roof SIPs, at the roof-to-wall connection and at the ridge. Tape shall only be installed after all spline connections are completed as per Manufacturer installation instructions.

.6 Provide vapor retarders as required by applicable building code.

.7 Restrictions: Do not install SIPs directly or in contact with concrete/dirt. Do not over-cut panel skins for approved field-cut openings. Do not cut skins to install electrical chases. Do not expose EPS core of SIPs to any solvents or solvent-based adhesives.

.8 Remove and replace any SIP wall or roof panels which have become wet or damaged before proceeding with the installation of additional SIPs or other work that may cover a compromised SIP.

3.2 PROTECTION

.1 Protection: Protect installed product from exposure and damage during construction.

.2 Protect SIPs from weather with temporary protection at the end of each day or when rain or snow is imminent. Apply wall or roof sheathing membrane to exposed panel faces as soon as practical after installation.

.3 After installation is complete, cover SIPs to prevent contact with excessive water on all exposed SIP edges and faces.

.4 Roofing material must only be installed on a dry SIP roof with a moisture content of 17% or less.

END OF SECTION

1 General

1.1 SYSTEM DESCRIPTION

.1 Fabrication, supply and installation of solid cast acrylic counter tops, completely cut, trimmed and milled, drilled to receive mechanical fixtures, installed in place.

1.2 QUALITY ASSURANCE

.1 Work of this Section shall be fabricated and installed entirely by one subcontractor. Workers shall be trained and experienced in work of this Section.

1.3 SUBMITTALS

.1 Maintenance Data: Provide 2 copies of maintenance data covering care, cleaning and maintenance of installed units.

1.4 JOB CONDITIONS

.1 All finishing of room or areas scheduled to receive work of this Section shall be completed and approved before commencing installation of work of this Section.

.2 Protect all work and finishes of other Sections from damage, marring or scratching.

2 Products

2.1 PRODUCT / MANUFACTURER

.1 Kitchen counter tops: “Icestone”, colour “Snow Flurry. Lavatory counter tops: Squak Mountain Stone, colour Thunder, suppliers: Jadestone, Calgary and Reva’s the Eco Store.

.2 Sealants: as supplied by counter top manufacturer, compatible with counter top.

2.2 FABRICATION

.1 Fabricate to shapes, profiles shown, in strict accordance with manufacturer's printed instructions and approved drawings.

.2 Obtain all dimensions affecting fabrication and installation from job site.

.3 Cut, drill, shape as required to receive mechanical fittings and services, including under-mounted sinks and all accessories to be mounted or built-in.

.4 All exposed edges and surfaces to be true, level and finished.

.5 All cut-outs shall have radiused corners, to prevent stress-cracking.

.6 Fabricate units to maximum size capable of being safely transported and handled to place of final installation.

.7 Match-number components to be assembled on site. Number items to show proper location on site. Number on back using material which will not show or telegraph through.

.8 Provide anchors to receive work of other Sections to be installed.

3 Execution

3.1 INSPECTION/PREPARATION

.1 Ensure that all built-in anchors and reinforcing is properly located and secure.

.2 Do not precede if there are deficiencies in the work of others which would affect the proper installation of the work of this Section.

3.2 INSTALLATION

.1 Install fabrications in locations scheduled in accordance with approved drawings.

.2 Installation shall be by skilled applicators, experienced in this specific material.

.3 Install on reinforcing, framing and anchors required, setting level and true, aligning properly to building lines and other units.

.4 Assemble units, fasten together to a tight, rigid and secure system, using special adhesives compatible with the plastic. Anchor securely to framing.

.5 Apply trim and accessories.

.6 Smooth joints and finish to match the adjacent surface.

3.3 CLEANING, ADJUSTING

.1 Continuously, as installation proceeds, clean units of dirt and debris which may scratch, discolour or marr the finish.

.2 Adjust and correct any sags, twists, warps or any other discrepancies which may develop.

.3 Remove and replace any disfigured or discoloured units, and replace at no cost to the Owner.

.4 At completion, clean units. Remove any labels, markings.

END OF SECTION

1 General

1.1 PRODUCT DELIVERY AND STORAGE

.1 Deliver insulation and accessories in original unopened packaging or cartons bearing manufacturer's seals and labels.

.2 Store materials under cover on raised platforms, away from moisture. Keep dry at all times.

2 Products

2.1 BATT INSULATION

.1 Fibrous Glass Batts: preformed insulation without a membrane, manufactured to CAN/ULC-S702-97, Type I, sized for friction fit between framing, thermal resistance (RSI) as indicated on the drawings.

2.2 ACCESSORIES

.1 Insulation baffles: Purpose made designed to fit between joists and retain insulation to ensure proper air circulation to attic space.

3 Execution

3.1 PREPARATION

.1 Ensure all in-wall construction is complete before beginning installation.

.2 Install insulation after building substrate materials are dry.

.3 Ensure substrate materials are properly installed and complete before beginning installation.

3.2 INSTALLATION - GENERAL

.1 Install insulation materials in accordance with manufacturer's recommendations.

.2 Install insulation to maintain continuity of thermal protection of building elements and spaces.

.3 Fit insulation tightly around openings and protrusions in plane of insulation.

.4 Install adequate blocking at eaves to ensure proper ventilation of attic space.

3.3 INSTALLATION OF BATT INSULATION

.1 Install batts between framing members, structural components and other items snug and tight.

.2 Cut and trim batts neatly to fit spaces. Use batts free from ripped or damaged back and edges.

.3 Do not compress insulation to fit into spaces.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 This Section includes requirements for a spray applied rigid cellular polyurethane thermal insulation foam product applied where indicated, so as to provide a continuous thermal and air seal.

1.2 REFERENCE STANDARDS

.1 CAN/ULC-S705.1-01 “Standard Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Material - Specification”

.2 CAN/ULC-S705.2-98 “Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Installer’s Responsibilities - Specification”

1.3 ENVIRONMENTAL REQUIREMENTS

.1 Maintain minimum ambient temperature and humidity as per manufacturer’s instructions for specific product being applied for minimum 24 hours before, during and 72 hours after completion of application.

1.4 QUALITY CONTROL

.1 Installer must be qualified, trained applicator of insulation manufacturer. Installation contractor and applicators must be certified and licensed by the Canadian Urethane Foam Contractors Association / National Energy Conservation Association (CUFCA/NECA).

.2 Applicator must use application equipment approved by insulation manufacturer.

.3 Maintain one complete set of manufacturer’s installation and handling instructions at the project site during insulation application.

.4 Perform on-site daily quality control tests as directed by material manufacturer and CUFCA/NECA.

.5 Field inspections shall be performed by a CUFCA certified inspector. Inspections shall be performed at random and unannounced times. Owner will appoint inspector and pay all costs associated with inspections. All inspection reports shall be sent to the Consultant, copy to Contractor.

2 Products

2.1 SPRAY APPLIED POLYURETHANE FOAM

.1 Spray Applied Polyurethane Foam: rigid, 95% closed cell thermal insulation with following properties when applied:

Property	Test Method	Requirement
Density	ASTM D1622-93	30.4 to 39.2 kg/m3
Response to thermal and humid aging	ASTM D2126-94	14% max. volume change

Water absorption	ASTM D2842-94	4% max. by volume
Water vapour permeability	ASTM E96-95	Core: max. 180 ng/(Pa.s.m2) Skins: max. 60 ng/(Pa.s.m2)
RSI	ASTM-C 518	1.05 to 1.13
Flame Spread Classification	CAN/ULC S102	25 - 500

.2 Product shall be suitable for use as an air/thermal barrier in walls in commercial construction.

2.2 ACCESSORIES

.1 Provide all flashings and closures as noted on the drawings and required to provide fire separations and complete the spray applied insulation work. All concealed flashings and closures shall be minimum 22 gauge galvanized sheet steel, exposed flashings to be prefinished steel 22 gauge, colour as selected by the Consultant. Use heavier gauge metal where shown on the drawings or as required by the Authority having Jurisdiction. Use galvanized screw mechanical fasteners to fasten items.

3 Execution

3.1 VERIFICATION OF CONDITIONS

.1 Inspect areas to receive work of this Section and ensure conditions are suitable to commence application. Examine all joint details to ensure proper construction.

.2 Ensure that all work penetrating through air seal is complete.

.3 Ensure that appropriate back-up material has been installed as necessary.

3.2 PROTECTION OF EXISTING WORK

.1 Protect from overspray all finish surfaces which will be exposed to view.

3.3 SUBSTRATE PREPARATION

.1 Ensure no frost is present on substrates to receive spray insulation.

.2 Clean substrates of dirt, dust, grease, oil, loose mortar and other materials which could affect bond of spray applied materials. Ensure all surfaces are dry, sound and clean.

.3 If recommended by manufacturer, prime substrates in accordance with manufacturer's instructions.

3.4 SPRAY APPLIED POLYURETHANE FOAM APPLICATION

.1 Spray apply polyurethane foam in accordance with manufacturer's instructions. Use equipment recommended by manufacturer.

.2 Apply material as indicated and in sufficient thickness to achieve a complete air and thermal seal as detailed. Application tolerance: + 6mm, - 0 mm.

.3 Apply material only when ambient conditions are within acceptable ranges.

.4 Apply material to ensure air sealing at detail locations and junctions.

3.5 CLEANING AND ADJUSTING

.1 Clean off all over-spray. In particular clean ALL over spray from all masonry ties.

.2 Inspect completed installation and replace or repair all areas where material application is deficient in thickness, curing or joint detailing.

END OF SECTION

1 General

1.1 INTENT

.1 Provide and install air barrier / vapour retarder membrane to prevent movement of air and water vapour through building envelope.

.2 Apply membrane to warm side of wall construction to location detailed or noted in wall assembly description.

.3 Provide overlapped joints at roof/wall intersections and at intersection of membrane with door, window and wall air/vapour membranes, as detailed, and as necessary to maintain integrity of air/vapour barrier throughout the building envelope.

.4 Apply sheet membrane to face material of steel stud framing. Extend sheet membrane to beyond framing as necessary to overlap and seal to other membranes and/or roof and wall constructions as detailed.

.5 Apply membrane to other locations as indicated on the drawings.

1.2 STORAGE

.1 Store roll materials on end, one pallet high, and as directed by the material manufacturer.

.2 Prevent exposure of materials to sun.

.3 Protect from damage and disfiguration.

1.3 REFERENCE STANDARDS

.1 Do work in accordance with printed application instructions of the various membranes and these specifications. Where there are conflicting directions consult with Consultant for direction.

1.4 COORDINATION

.1 Coordinate installation of air/vapour barrier with work of other Sections to achieve an air/vapour tight building envelope.

2 Product

2.1 MATERIALS

.1 Acceptable products: Soprema "Sopraseal Stick 1100". or Grace “Perm-A-Barrier”.

.2 Membrane Accessories: Splicing tape, splicing cement, primer, bonding adhesive, lap sealant, waterstop tape and separation sheet as recommended by membrane manufacturer.

.3 Cold temperature primer (solvent based): Soprema “Elastocol Stick”.

.4 Joint sealing tape for sheet air/vapour barrier: air resistant, pressure sensitive acrylic adhesive cloth tape, type recommended by vapour barrier manufacturer, 50 mm wide for lap joints and perimeter seals.

.5 Sealants: Section 07 92 00.

.6 Moulded box vapour barrier: polyethylene box for use with recessed electric switch and outlet device boxes.

.7 Substrate primer for use over Georgia Pacific “Densglas Gold”: Soprema “Elastocol Stick”.

3 Execution

3.1 PREPARATION

.1 Prepare surfaces to receive membrane. Prime surfaces as recommended Air/Vapour Barrier by manufacturer.

.2 For application over “Densglas Gold” apply one coat primer at recommended application rate in accordance with Air/Vapour Barrier membrane manufacturer’s recommendations.

3.2 APPLICATION OF MEMBRANE

.1 Install air and vapour seal membranes to form a continuous air-vapour seal between interior and exterior of building envelope. It is imperative that a complete air-vapour seal be achieved. Be responsible for the completeness of the membrane wherever it is not specifically noted. Advise the Consultant if there is any doubt as to integrity of the membrane, whether detailed or not. Particular attention shall be paid to change in direction bends, such as window head/sill to jamb intersections.

.2 Ensure substrates are clean, smooth, dry, free of fins, sharp edges, loose and foreign materials, oil and grease.

.3 Prime all surfaces using primer suitable for application environmental conditions. Ensure primer has achieved proper cure and has not been contaminated by dust or other contaminants and apply membrane.

.4 Before bonding membrane to substrate in final position, allow the membrane to relax.

.5 Apply membrane fully adhered to substrate in horizontal pattern as practical, commencing at base of wall.

.6 Lap all joints minimum 65 mm.

.7 Press membrane onto surface of substrate, by hand or using a roller.

.8 Roll all membrane using a hand roller and applying sufficient pressure to ensure full bond to substrate.

.9 Form tight seal around all projections in wall surfaces.

.10 Position membranes without stretching, taking care to avoid trapped air bubbles, or "fish mouths".

.11 Splices: clean overlapping areas of membranes and joint with splice cement in accordance with manufacturer's recommendations.

.12 Reinforce all interior and exterior corners with overlay sheet of membrane of sufficient width to ensure proper bond.

.13 Apply membrane using approved mastic in areas where it is difficult to work.

.14 Inspect applied membrane for continuity. Repair punctures, tears or unsealed joints before proceeding or concealing work of this Section. Replace membrane where punctures or tears are extensive, at the direction of the Consultant.

.15 Apply membrane in strict accordance with manufacturers written directions.

.16 At all locations where membrane will be covered with insulation, temporarily protect from puncture or install cover of insulation.

.17 The Consultant will inspect the membrane before covering up. Do not cover up any membrane until this inspection has been carried out and installation has been reviewed by the Consultant.

.18 Cooperate with other trades to ensure continuity of the membrane to achieve a complete air seal. Leave sufficient membrane hanging loose for interface with other building components.

3.3 MEMBRANE FLASHING

.1 Flash and seal perimeter edges and penetrations. Extend wall membrane into window and door frames. Seal all cuts of lap as required to ensure continuity of air/vapour barrier.

3.4 PROTECTION OF COMPLETED WORK

.1 Ensure membrane is undamaged before application of insulation board.

3.5 ELECTRICAL BOXES

.1 Seal electrical switch and outlet device boxes that penetrate vapour barrier as follows:

.1 Install moulded box vapour barrier, lap flange and seal to vapour barrier membrane with sealant or tie in with “Peel and Stick” membrane.

END OF SECTION

1 General

1.1 SCOPE

.1 Work of this section includes supply and installation of oxidizing sheet steel siding with exposed fasteners.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Protect materials from damage and deterioration.

.2 Ensure packaging of prefinished materials permits ventilation.

1.3 QUALITY ASSURANCE

.1 Erection of prefinished steel shall only be performed by trained applicators in the employ of the steel siding supplier.

2 Products

2.1 MATERIALS

.1 Exterior Steel Siding:

.1 sheet steel, minimum base metal nominal thickness: 18 gauge, distressed with vinegar or similar distressing accelerant, cleaned and sealed to locations detailed.

.2 sheet steel, minimum base metal nominal thickness: 18 gauge, cleaned and shop painted with RAL 7043 Traffic Grey B paint to locations detailed.

.2 Sealant: one component silicone or polyurethane General Construction sealant, refer to Section 07 92 00.

.3 Z-Girts: Galvanized steel, to G275, minimum 18 gauge, heavier as required or detailed, size as detailed and as required to accommodate insulation, thickness as shown on the drawings.

.4 Fasteners: Epoxy, surface mounted fastener clips, PC-SM2 to metal and PC-SF1 to other substrates. www.fastmount.com/clip-system/all/

.5 Accessories: exposed trim, closures, cap pieces, etc. of same material and colour as siding.

3 Execution

3.1 INSTALLATION

.1 Confirm acceptability of substrate for soundness, integrity and true to plane and plumb.

.2 All fabrication measurements shall be taken from as-built site conditions.

.3 Install in accordance with manufacturer's installation procedures, drawing details and as specified herein.

.4 Install flashings, starter strips, inside corners, edgings, and soffits.

.5 Install z-girts over air/vapour barrier membrane, use only drilled fasteners specifically designed for substrate.

.6 Install cladding with exposed fasteners, to manufacturer's installation instructions, free of any dents or oilcanning or other defects.

.7 Install exterior corners, fillers and closure strips with carefully formed and profiled work. Install with concealed fasteners except where noted on reviewed shop drawings. Full mitre all exterior corners.

.8 Maintain joints in exterior sheets, true to line, tight fitting.

.9 Caulk joints, seams and junctions with dissimilar materials, with specified sealant.

.10 Provide all components including drip and cap flashings, screws and fasteners as required to complete installation.

END OF SECTION

1 General

1.1 RELATED WORK

.1 Section 06 10 00 Rough Carpentry

2 Products

2.1 SIDING

.1 Vertically oriented, aged “barnboard” siding.

2.2 ACCESSORIES

.1 Fasteners: Nails to CSA B111-1974, screws to CSA B35.3-1962, nails galvanized, screws galvanized.

.2 Flashings: 26 ga. Galvanized steel.

3 Execution

3.1 VERIFICATION OF CONDITIONS

.1 Confirm acceptability of wall substrate for soundness and flatness of plane.

.2 Ensure 30 minute building paper is installed as specified in Section 06 10 00.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Supply and install Thermoplastic Polyolefin (TPO) adhered roofing system including all accessories and polyisocyanurate insulation. Supply and installation of air/vapour barriers in roofing assemblies.

1.2 SUBMITTALS

.1 Upon completion of the work, submit copies of the manufacturer's inspections to the Consultant prior to the issuance of the manufacturer's warranty.

.2 Submit 2 copies of maintenance instructions for roofing system for Owner’s use.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials to the job site in the manufacturer's original, unopened containers or wrappings with the manufacturer's name and brand name intact and legible. Deliver in sufficient quantity to permit work to continue without interruption.

.2 Comply with the manufacturer's written instructions for proper material storage.

.1 Store membrane in original wrapping in a cool, shaded area.
.2 Store curable materials (adhesives and sealants) between 15°C and 26°C in dry areas protected from water and direct sunlight.
.3 Store materials containing solvents in dry, well ventilated spaces with proper fire and safety precautions. Ensure containers are tightly sealed. Use before expiration of their shelf life.

.3 Deliver and store insulation on pallets, off the ground and tightly covered with waterproof coverings.

.4 Remove and replace all damaged materials.

1.4 WORK SEQUENCE

.1 Schedule and execute work to prevent leaks and excessive traffic on completed roof sections. Care should be exercised to provide protection for the interior of the building and to ensure water does not flow beneath any completed sections of the membrane system.

1.5 PROTECTION

.1 Protect the building and site against damage. Be responsible for the correction of any damage incurred as a result of the performance of the contract.

.2 Remove all debris from the job site in a timely manner and dispose if legally. Do not hinder functions of the building.

.3 Take all precautions required to prevent the spread of dust and debris from the construction areas from entering the remainder of the building.

.4 Do not overload any portion of the building, by either use of or placement of equipment, storage of debris, or storage of materials.

.5 Protect against fire and flame spread. Maintain proper and adequate fire extinguishers. Initiate and maintain fire watch patrols during and after use of open flame torches used in roofing application.

.6 Take precautions to prevent drains from clogging during the roofing application. Remove debris at the completion of each day's work and clean drains. At completion of roofing installation, test drains to ensure system is free running and drains are watertight.

1.6 QUALITY ASSURANCE

.1 Unless otherwise noted in this specification, strictly comply with the roofing membrane manufacturer's current specifications and details for installation.

.2 Provide adequate number of experienced workmen regularly engaged in this type of work, skilled in the application techniques of the materials specified including operation of hot air welding equipment.

.3 Keep at least one thoroughly trained and an experienced superintendent on the job at all times roofing work is in progress.

1.7 JOB CONDITIONS, CAUTIONS AND LIMITS

.1 Comply with Carlisle's Sure-Weld Adhered Roofing System specification, Part II - Application, for General Job Site Considerations and all attachments as directed by the membrane manufacturer.

.2 Proceed with roofing work only when weather conditions are in compliance with the manufacturer's recommended limitations.

.3 Surfaces to which the insulation and/or roofing membrane is to be applied shall be clean, smooth, dry, and free of projections or contaminants that would prevent proper application of or be incompatible with the new installation. This includes but is not limited to fins, sharp edges, foreign materials, oil and grease.

.4 New roofing shall be complete and weather tight at the end of each work day.

1.8 WARRANTY

.1 Provide manufacturer's 10 year “No dollar limit” warranty covering labor and material for roof installation with no dollar limitation. The maximum wind speed coverage shall be peak gusts 116 km/hr measured at 4 meters above ground level. Certification is required with bid submittal indicating the manufacturer has reviewed and agreed to such wind coverage.

2 Products

2.1 GENERAL

.1 All components of the specified roofing systems shall be products of Carlisle SynTec Incorporated or accepted by Carlisle SynTec Incorporated as compatible.

2.2 MEMBRANE

.1 Sure-Weld EXTRA 0.072” thick, white reinforced TPO (Thermoplastic Polyolefin) membrane where exposed, Tan in concealed assembly. Membrane thickness over the reinforcing scrim (top-ply thickness) shall be nominal .015” thick (15 mil).

2.3 INSULATION

.1 When applicable, insulation shall be installed in multiple layers. The first and second layers of insulation shall be mechanically fastened to the substrate in accordance with the manufacturer's published specifications.

.2 Insulation shall be Carlisle HPH-P rigid isocyanurate insulation supplied by Carlisle SynTec Incorporated, minimum 100 mm thickness, for flat board insulation, and hot wire cut tapered insulation to create slopes and slopes to drains.

2.4 ROOF MEMBRANE ADHESIVES AND CLEANERS

.1 All products shall be furnished by Carlisle and specifically formulated for the intended purpose.

.2 Membrane Bonding Adhesive: Sure-Weld Bonding Adhesive

.3 Edge Sealant: Cut Edge Sealant

.4 Sealer: Water Cut-Off Mastic and PT 304 Sealant

.5 Pocket Sealant: TPO Molded Pocket Sealant

.6 Cleaner: Carlisle Weathered Membrane Cleaner

2.5 FASTENERS AND PLATES

.1 To be used to provide additional membrane securement. All fasteners are proprietary, supplied by Carlisle:

.1 HP Fasteners: threaded, black epoxy electro-deposition coated fastener used with steel and wood roof decks.

.2 HP-X Fasteners: heavy duty #15 threaded fastener with phillips head used for insulation securement into steel, wood plank or minimum 15/32 inch thick plywood.

.3 ASAP Fasteners: pre-assembled 3” diameter Plastic Plate and standard phillips head fastener used for insulation attachment into steel or wood decks. Installed using Olympic Fastening Tools.

.4 InsulFast Fasteners: threaded #12 fastener with #3 phillips head used for insulation attachment into steel or wood decks.

2.6 METAL EDGING AND MEMBRANE TERMINATIONS

.1 Metal edging and membrane terminations shall be proprietary items selected to comply with manufacturer’s installation instructions and details for each termination condition. Systems shall be finished colour as selected by the Consultant, and designed to use concealed clips and fasteners wherever possible. Exposed fasteners shall be finished same colour as exposed metal.

2.7 AIR / VAPOUR MEMBRANE

.1 SBS proprietary, fibreglass reinforced, “peel and stick” membrane.

3 Execution

3.1 GENERAL

.1 Comply with the manufacturer's published instructions for the installation of the membrane roofing systems including proper substrate preparation, job site considerations and weather restrictions.

.2 Position sheets to accommodate contours of the roof deck and shingle splices to ensure shedding water.

3.2 INSULATION PLACEMENT AND ATTACHMENT

.1 Install insulation or membrane underlayment over the substrate with boards butted tightly together with no joints or gaps greater than 4 mm. Stagger joints horizontally and vertically if multiple layers are provided.

.2 Secure insulation to the substrate with the required adhesive and additional Carlisle fasteners and 75 mm diameter Insulation Fastening Plates, spacing and installation in accordance with manufacturer’s specification.

3.3 MEMBRANE PLACEMENT, SEAMING AND ATTACHMENT

.1 Position membrane over substrate. Fold membrane sheet back lengthwise (onto itself) so half the underside of the membrane is exposed.

.2 Apply Sure-Weld Bonding Adhesive in accordance with the manufacturer's published instructions, to the exposed underside of the membrane and the corresponding substrate area. Do not apply Bonding Adhesive along the splice edge of the membrane to be hot air welded over the adjoining sheet. Allow the adhesive to dry until it is tacky but will not string or stick to a dry finger touch.

.3 Roll the coated membrane into the coated substrate while avoiding wrinkles. Brush down the bonded section of the membrane sheet immediately after rolling the membrane into the adhesive with a soft bristle push broom to achieve maximum contact.

.4 Fold back the unbonded half of the sheet lengthwise and repeat the bonding procedures.

.5 Position adjoining sheets to allow a minimum overlap of 50 mm.

.6 Hot air weld the Sure-Weld membrane sheets using proprietary Carlisle Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer's hot air welding procedures. At all splice intersections, roll the seam with a silicone roller to ensure a continuous hot air welded seam. All splice intersections shall be overlaid with Sure-Weld non-reinforced flashing.

.7 Probe all seams once the hot air welds have thoroughly cooled (approximately 30 minutes). Repair all seam deficiencies the same day they are discovered. Apply Cut Edge Sealant on all cut edges of reinforced membrane (where the scrim reinforcement is exposed) after seam probing is complete. Cut Edge Sealant is not required on vertical splices.

.8 Pull the membrane back along the welded splice so the entire underside of the membrane is exposed once the Hot Air Weld has been completed.

.9 Apply Sure-Weld Bonding Adhesive to the exposed underside of the membrane sheet and the substrate.

.10 Allow adhesive to dry until tacky and roll the membrane into the substrate and brush down the bonded section with a bristle broom following the procedure specified above.

.11 Continue to install adjoining membrane sheets in the same manner, overlapping edges a minimum of 50 mm and complete the bonding procedures as specified.

3.4 FLASHING

.1 Flashing of parapets, curbs, expansion joints and other parts of the roof must be performed using Sure-Weld reinforced membrane. Sure-Weld non-reinforced membrane can be used for flashing pipe penetrations, Sealant Pockets, and scuppers, as well as inside and outside corners, when the use of pre-molded accessories is not feasible.

.2 Follow manufacturer's typical flashing procedures for all wall, curb, and penetration flashing including metal edging/coping and roof drain applications.

3.5 DAILY SEAL

.1 On phased roofing, or when the completion of flashings and terminations is not achieved by the end of the work day, install a daily seal to temporarily close the membrane to prevent water infiltration.

.2 Complete an acceptable membrane seal in accordance with the manufacturer's requirements.

3.6 CLEAN UP

.1 Perform daily clean up to collect all wrappings, empty containers, paper, and other debris created by the work of this Section. All debris must be disposed of in a legal and acceptable manner.

END OF SPECIFICATION

1 General

1.1 SYSTEM DESCRIPTION

.1 Sheet metal flashings.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Protect prefinished surfaces from damage.

2 Products

2.1 METAL FLASHING

.1 Metal flashing: Commercial galvanized copper-bearing steel, to ASTM A653, coating designation Z275.

.2 Metal flashing pre-finished: prefinished steel, colour to match adjacent material. Galvanized zinc coating designation Z275.

2.2 MISCELLANEOUS MATERIALS

.1 Flashing nails: Roofing Nails, no. 12 gauge hot dipped zinc coated (not electrogalvanized) with 13 mm diameter heads to CSA B111.

.2 Flashing screws: Hot dipped zinc coated, self-drilling, pan head.

.3 Bituminous paint: To CAN/CGSB-1.108-M89.

.4 Sealants: General Construction sealant, refer to Section 07 92 00.

2.3 FABRICATION

.1 Make flashings of prefinished metal for all cap flashings, for all flashings adjacent to roofing at roof edges and area dividers and where exposed to view from ground. Make flashings for other locations, of plain galvanized metal as follows:

.1 Use 26 gauge except where otherwise indicated.
.2 Use 24 gauge wherever a flat length exceeding 300 mm wide occurs.
.3 Use 24 gauge for fabrication of scuppers.
.4 Use 22 gauge for concealed fastening strips (anchor clips).

.2 All straight run joints shall be S-Lock in roof flashings.

.3 Make joints to allow for thermal movement, space S-Lock joints at 3000 mm maximum centers.

.4 Strengthen free edges of metal flashings by folding to form a 19 mm hem.

.5 Make flashings to curbs, walls and parapets a minimum of 200 mm high, where possible.

.6 Make joints for corners and intersections with standing “S” seams except for exposed pre-finished metal use seams flat locked.

.7 Fabricate scuppers to extend beyond the exterior wall face and to provide 100 mm base and wall flanges at interior (roof side) of opening. Fabricate through-wall scuppers to be 4 sided with the upper scupper opening surface covered with sheet metal.

.8 All bends in flashing shall be machine made; sharp, straight and true to line.

.9 Backpaint all flashings in contact with concrete, masonry, other cementitious materials and dissimilar metals with bituminous paint.

3 Execution

3.1 INSPECTION

.1 Check mounting and counterflashing of mechanical items and report any defect to the Consultant.

.2 Verify that solid wood blocking or sheathing provided to back-up all flashings and that all nails, screws set and wood provides a smooth flat plane.

3.2 METAL FLASHINGS

.1 Do not install metal flashings over membrane roof flashing until the flexible roof flashing has been inspected and approved. This includes curbs for roof mounted items.

.2 Fasten metal base flashing to walls or upstands along top of flashing. Do not secure to cant strip. Form lapped corner joints. Extend rolled edge of base flashing approximately 25 mm on to roof from toe of cant, and rest on top of roof surface.

.3 Allow for thermal expansion and contraction in all exterior sheet metal work.

.4 Fasten flashings at maximum spacing of 600 mm c/c, closer spacing as required for wind conditions.

.5 Do not use exposed fastening unless indicated, or concealed fastening is not possible.

.6 All exposed and pre-finished flashings to provide a smooth flat surface free of indentations, bumps, oil-canning, or twists, all edges, bends hard, sharp and true to line.

END OF SECTION

1 General

1.1 SUBMITTALS

.1 Provide colour samples of the actual sealants for approval; painted or printed colour charts are not acceptable.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Deliver containers labeled and sealed, complete with written application and maintenance instructions.

.2 Store materials in a dry heated enclosure in accordance with manufacturer's instructions.

.3 Comply with all WHMIS and Dangerous Goods Transportation and Handling Act requirements.

2 Products

2.1 SEALANT MATERIALS

.1 Where possible, and maintaining compliance with all other requirements of this specification, select materials with VOC levels less than 250 g/L.

.2 General Construction silicone sealant, conforming to CAN/CGSB-19.13 M87; CGE Silpruf or Dow Corning 790.

.3 Acoustical sealant: Non-hardening, conforming to CAN/CGSB-19.21-M87; Chemtron Metaseal or Tremco “Acoustical Sealant”.

.4 Horizontal joint sealant: Multi-component, self levelling, conforming to ASTM C920-79, Sikaflex 2c SL.

.5 General Construction polyurethane sealant: One component, non-sag, for general construction, conforming to CAN/CGSB-19.13-M87; Sikaflex 1-A.

.6 Sanitary sealant: silicone, GE “Sanitary 1700", Dow Corning “786 Mildew Resistant”.

2.2 ACCESSORIES

.1 Backer Rod: Non-staining, non-absorbent, closed cell polyethylene foam rod, round shape; 30% -50% oversized. Use high density rod in floor joints.

.2 Primer: Non-staining type as recommended by sealant manufacturer.

.3 Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

.4 Joint Cleaner: Non-corrosive solvent type recommended by sealant manufacturer for applicable substrate materials.

2.3 COLOURS

.1 Colours: To match adjacent materials.

.2 Verify all sealant colours prior to ordering materials.

2.4 SELECTION OF SEALANT TYPES

.1 Make sealant selections consistent with manufacturer's recommendations.

.2 Use General Construction silicone sealant or polyurethane sealant for all joints where no other specific sealant type is specified. Do not use on horizontal traffic joints or where immersed in water.

.3 Use Acoustical sealant only where it will be fully concealed and only where no constant or consistent air pressure difference will exist across the joint and where specified.

.4 Use Horizontal joint sealant for floor control joints where no mechanical joint is scheduled.

.5 Use Sanitary sealant in washrooms.

3 Execution

3.1 INSPECTION

.1 Carefully inspect surfaces and materials to receive sealants and verify they are physically capable of retaining sealant bond.

.2 Verify that fillers and backing provided under other Sections are properly installed.

3.2 PREPARATION

.1 Maintain workmanship of highest quality in accordance with best trade practice.

.2 Ensure that joint forming materials are compatible with sealant.

.3 Clean and prepare joints in accordance with manufacturer's recommendation. Clean away loose materials and other foreign matter which might impair adhesion of sealant.

.4 Clean out dirt and water from crevices.

.5 Prime all substrates prior to application of sealants.

.6 Prime other joints when recommended by manufacturer. Use a brush that will reach all parts of the joints. Mask adjoining surfaces prior to priming to prevent staining.

3.3 APPLICATION

.1 Apply sealant in strict accordance with manufacturer's recommendations.

.2 For joints where movement is possible, apply backer rod to achieve a joint depth of one half the joint width but not less than 6 mm; for joints larger than 25 mm use a depth of 13 mm.

.3 Use pressure gun fitted with suitable nozzle. Use sufficient pressure to fill voids and joints solid.

.4 Form surface of sealant smooth, free from ridges, wrinkles, sags, or air pockets and imbedded impurities. Neatly tool surface to a slight concave appearance.

.5 Tool sealants to achieve air tight joints. Use wet tools as required.

.6 Ensure bead is solid, filling entire space between sides and bedding material, exerting sufficient pressure to obtain maximum bond.

.7 Apply sealant within recommended temperature ranges. Consult manufacturer when sealant can not be applied within recommended temperature range.

.8 Seal perimeters of hollow metal door frames on both sides.

.9 Seal control joints in gypsum board and junctions between interior partitions with exterior walls.

.10 Seal control joints in masonry veneer at the outside face.

.11 Seal window and door frames around the inside perimeter, so that an airtight seal is obtained. In addition, apply as indicated on drawings.

.12 Seal control and expansion joints in floors and walls and around service and fixture penetrations.

.13 Install sealant as detailed on the drawings.

.14 Install sealant to all other locations as dictated by good construction practices.

3.4 BOND BREAKER

.1 Use backer rod as specified, to limit depth of sealant and to act as bond breaker at back of joint.

.2 Where depth of joint does not permit the use of backer rod apply paper masking tape to back of joint to act as bond breaker.

.3 Ensure that no joints are formed which are bonded on adjacent sides where there is any possibility of movement.

3.5 HORIZONTAL JOINT SEALANT

.1 Carefully level and accurately place horizontal joint sealant to result in a smooth, level joint, well bonded to the side surfaces.

.2 Prepare and prime surfaces in strict accordance with manufacturer's recommendations.

.3 Keep adjacent surfaces free from spilled materials. Use masking tape if necessary.

3.6 CLEAN UP

.1 Clean adjacent surfaces immediately, leaving Work neat and clean.

.2 Remove excess sealant and droppings using recommended cleaners as Work progresses.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Insulated, flush, hollow metal doors.

.2 Refer to Door Schedule, see drawing A601.

1.2 REFERENCES

.1 Canadian Steel Door & Frame Manufacturer's Association "Manufacturing Specifications for Doors & Frames" and "Canadian Fire Labelling Guide for Steel Doors and Frames".

1.3 QUALITY ASSURANCE

.1 Fabricate all rated doors and frames to the requirements of the above noted references and the Alberta Building Code, 2006.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Store doors and frames vertically in a protected dry area, blocked off the ground and in a manner to prevent sagging, bowing or twisting.

2 Products

2.1 MANUFACTURER

.1 Shanahan's

2.2 MATERIAL

.1 Sheet steel: Cold rolled steel stretcher levelled conforming to ASTM A 527 or A568M, zinc wipe coated ZF001 to ASTM A525.

.2 Insulation: Homogeneous one piece polyurethane or expanded polystyrene core.

.3 Primer: To CAN/CGSB-1.132M-90 for galvanized material.

.4 Foam Insulation: HILTI CF 128-DW, minimal expanding type.

2.3 COMPONENTS

.1 Hollow Metal Doors - Flush Type

- .1 Faces: 18 gauge minimum cold rolled stretcher levelled zinc wipe coated steel, suitable for priming.
- .2 Construction: Full flush lockseam, pan type with vertical and any other edges having lock seams.
- .3 Construct hollow metal insulated doors using polystyrene core bonded to 18 gauge face skins, lock seam.
- .4 Mortise, reinforce and tap for all mortised hardware. Reinforce for closers. Reinforce for panic devices and other surface-applied hardware. Provide conduit and cut-outs for any electrical hardware. Butt reinforcement shall be 3.2 mm thick with 19 mm leg return.
- .5 Make allowances for the specified weatherstripping and threshold as applicable.
- .6 Provide vinyl caps for top edge recesses of exterior doors.

2.4 FINISHES

.1 All metal doors, frames shall have all exposed cut edges shop prime coated. Primer shall be coloured, clear primer is not acceptable.

3 Execution

3.1 INSTALLATION OF DOORS

.1 Hang doors, matching to proper frames, and using hardware scheduled.

.2 Shim butts as required using metal shims to provide correct clearance, fit and operation. Adjust as required for correct and free operation.

.3 Clearance between door and frame and between meeting edges of doors swinging in pairs shall not exceed 3.1 mm.

.4 Clearance under bottom of door shall be no more than 19 mm.

3.2 DOOR AND FRAME TYPES

.1 All exterior hollow metal doors shall be hollow metal insulated type.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Flush, solid core wood doors.

.2 Refer to Door Schedule, see drawing A601.

1.2 QUALITY ASSURANCE

.1 Fabricate and install doors in accordance with AWMAC/AWI “Architectural Quality Standards Illustrated” version 2.0, 2005, for Architectural Woodwork, Section 1300 Architectural Flush Doors and CSA O132.2 Series, as a minimum, or such higher standards as specified herein.

1.3 REFERENCES

.1 AWMAC/AWI, Architectural Woodwork Manufacturers Association of Canada, “Architectural Woodwork Quality Standards Illustrated”, 2005 edition (AWMAC QSI).

.2 CAN/CSA 0132.2 Series 90, "General Requirements for Wood Flush Doors".

1.4 DELIVERY, STORAGE AND HANDLING

.1 Do not deliver items until building is in proper condition for receipt and storage of doors. Store and protect in an approved manner.

.2 Conform to the manufacturer's and the AWMAC recommendations and requirements for shipping, handling and storage environmental conditions.

.3 Polybag doors individually for protection of surface during shipment and handling.

.4 Take particular care to protect doors from water and high humidity conditions.

1.5 WARRANTY

.1 Provide manufacturer's standard door warranty with additional riders if necessary as described herein.

.2 The warranty shall be for two (2) years and will apply to period following 12 months after Substantial Performance of the project.

.3 Warranty shall include for replacement of door should the door warp, cusp, sag, exhibit “telegraphing” of core defects or any other defect which affects appearance or function of door. Limits of allowable tolerances shall be as per AWMAC/AWI QSI version 2.0, 2005 manual, Section 1300-C-1 (warp) page 458, 1300-C-2 (telegraphing) page 459, and 1300-C-3 (squareness) page 459.

2 Products

2.1 MATERIALS

.1 Dry lumber to an average moisture content of between 6 and 12% maximum with a total range from least to greatest moisture content of any individual piece of 4%.

2.2 PAINT GRADE WOOD DOORS

.1 Core material: Particleboard core, “door core”, complying with ANSI A208.1, approximately 33 lbs/cu ft.

.2 Wood veneer face skins: paint grade Birch veneer face skins, 3 ply, not 4 ply, top veneer approximately 0.6 mm thick, rotary cut.

.3 Doors shall be constructed to AWMAC/AWI QSI Custom Grade and these specifications, the most stringent requirements to apply.

.4 Door construction shall be sanded, fully bonded construction (including stiles, rails and hardware reinforcing blocks bonded to core. Entire unit shall be sanded prior to application of door faces. Where materials and construction techniques required to achieve fire rated labelling must be different than as specified herein construct to such requirements and identify such differences on shop drawing submission.

.5 For cross-banding use dense hardwood such as Birch or Maple, either one piece or edge glued. MDF, particle board, and hardboard are NOT acceptable for cross-banding.

.6 For doors constructed with particle board cores provide solid wood blocking top blocks, lock blocks both edges, and bottom block and additional blocking required for all hardware. All blocking shall be fully bonded to core and edges.

.7 For edges of doors, use Birch, 44 mm minimum thickness, solid material, no finger jointing, for paint finish except where restricted by labeling requirements. Fully bond edges to doors.

.8 Construct with #3 AWMAC edge.

.9 Bevel vertical edges of single acting doors 3 mm in 50 mm on lock side and 1.5 mm in 50 mm on hinge side.

.10 Radius vertical edges of double acting doors and doors on center pivots to 55 mm radius.

.11 Seal all edges of all wood doors before shipping from factory. Use clear sanding sealer.

.12 Construct labelled doors in accordance with labelling agency requirements and place label on each door.

.13 Glazing stops shall be White Birch.

.14 Cut outs for glazing shall not encroach within 150 mm of top and sides and 300 mm of bottoms of doors and shall not exceed 40% of the door area of half the door height.

2.3 CLEAR STAIN FINISH WOOD VENEER DOORS

.1 For faces of doors, use wood veneer, 0.6 mm thick, species and cut noted on the drawings.

.2 For cross-banding use dense hardwood such as Birch or Maple, either one piece or edge glued. MDF, particle board, and high performance composite products including HDF and hardboard are NOT acceptable for cross-banding.

.3 For edges of doors, use solid material, finger jointed material is NOT allowed, species to match face veneers, 44 mm minimum thickness, for clear finish except where restricted by labeling requirements.

.4 Construct wood doors to conform to AWMAC/AWI QSI, Premium grade and these specifications, the most stringent requirements to apply.

.5 Construct with AWMAC/AWi QSI No. 2 edge.

.6 Core shall be "Structural Composite Lumber Core", such as Baillargeon "LVL" core, "TimberStrand LSL (Laminated Strand Lumber), uniform density of approx. 32 pcf, or other SCL (Structural Composite Lumber) meeting the requirements of ASTM D5456.

.7 Solid core flush wood doors: shall be 5 ply, sanded bonded, with stiles, rails, and blocking fully bonded to the core.

.8 Adhesive for door construction shall be minimum Type 1, waterproof adhesive. Component moisture content shall be same for all door components and shall be less than 12%. Entire core unit including core and stiles and rails shall be sanded prior to application of cross banding and face veneers. Veneer faces shall be completely glued to substrate, but shall not exhibit glue bleed through veneer. No voids are permitted between layers.

.9 Cut outs for glazing shall not encroach within 150 mm of top and sides and 300 mm of bottoms of doors and shall not exceed 40% of the door area of half the door height.

.10 Bevel vertical edges of single acting doors 3 mm in 50 mm on lock side and 1.5 mm in 50 mm on hinge side.

.11 Radius vertical edges of double acting doors and doors on center pivots to 55 mm radius.

.12 Finish: stain, and post-catalyzed lacquer to requirements of AWMAC/AWI QSI Section 1500, factory applied, site application not acceptable.

3 Execution

3.1 INSTALLATION

.1 Fit doors accurately to the frames, with allowance for finish and possible swelling or shrinking. Provide not more than 3.0 mm clearance at the top and jambs, and not more than 6.0 mm clearance at the bottom, except where undercuts are indicated and allowed by the Building Code.

.2 Hang doors, matching to proper frames, and using hardware scheduled.

.3 Install hinges using minimum 38 mm long, #12 wood screws.

.4 Shim butts as required using metal shims to provide correct clearance, fit and operation. Shims shall be galvanized sheet steel.

.5 Adjust as required for correct and free operation.

.6 Slightly ease sharp arrises.

.7 Seal all cut-outs the same day they are cut.

END OF SECTION

1 General

1.1 DESIGN REQUIREMENTS

.1 Ensure there are no voids between the glass edge and the gaskets and sealants. Glazing gaskets and sealants on the building exterior side of the glass units shall be non-heat conductive.

.2 Windows shall be designated to the requirements of CSA-A440-M00 as follows:

.1 Air Tightness Rating, Fixed windows: Fixed
.2 Air Tightness Rating, Operable windows: A3
.3 Water Tightness Rating: B3
.4 Wind Load Resistance Rating: C5
.5 Resistance to Forced Entry: F2

.3 Design work of this Section to accommodate within the components, expansion and contraction due to cyclic temperature changes, shrinkage, moisture changes, creep in component materials, movement due to differential settlement and any combination thereof, to prevent buckling, twisting, undue stress on fasteners and components and damages.

.4 The work shall accommodate, by means of expansion/contraction provisions, any movement within the work of this Section and between the work of this Section, the building structure. Expansion/contraction provisions shall ensure no damage, distortion, misalignment of work of this section, the building structure, adjacent construction and connections and shall ensure the thermal, vapour barrier, air infiltration/exfiltration and water and weather tightness requirements are maintained.

.5 Design connections for work on this Section to building structure to take into account peculiarities as may be found on the project and wind loads.

.6 Design work of this Section and its connections to the adjacent building structure to ensure no possibility of weakening, loosening or fracturing occurs due to vibrations from any source.

.7 Make provisions to drain to the exterior, any water entering at joints and/or condensation occurring within the window construction, all to "Rain Screen Principle".

.8 All framing components shall be provided with a thermal break of adequate heat resistance to provide a complete and sufficient separation between exterior and interior so that under the specified environmental conditions no condensation will occur on the interior.

.9 It is imperative that a complete air/vapour seal be achieved. Be responsible for the installation of a complete and continuous air/vapour seal membrane between all windows and adjacent surfaces. Consult with the Prime Consultant if there is any doubt as to the functional integrity of the membrane, whether detailed or not. Particular attention shall be paid to change in direction bends.

.10 Cooperate with other trades to ensure continuity of the membrane to achieve air/vapour seal. Confirm compatibility with other air vapour barrier materials.

1.2 MOCK-UP

.1 Install one selected window unit in the construction at a location directed.

.2 Installation shall demonstrate interface/tie-in with Air/Vapour barrier, building structure and interior and exterior building finishes.

.3 Make adjustments as necessary.

.4 Reviewed mock-up will represent minimum acceptable standard for this project.

.5 Reviewed mock-up may be integrated into completed building.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Wrap windows individually at the factory and seal for protection from foreign matter.

.2 Provide blocking between window units and between windows and shipping equipment to prevent damage.

.3 Unload windows where directed by Contractor, provide wood planking under windows and wood blocking between windows. Stack in near-vertical position. Do not remove wrapping.

1.4 OPERATION AND MAINTENANCE DATA

.1 Provide maintenance data for cleaning and maintenance of windows for incorporation into Operations and Maintenance Manual.

.2 Provide a complete As-built schedule of windows including each size and configuration and quantity and glazing details.

1.5 GUARANTEE

.1 Provide a written guarantee, signed and issued in the name of the Owner stating that the windows are guaranteed against leakage, defects and malfunction under normal use for a period of three (3) years from the date of Substantial Performance of the Work.

2 Products

2.1 MANUFACTURER/PRODUCT

.1 Fibreglass pultruded frame windows manufactured by Thermotech Fiberglass Fenestration, Ottawa, Ont., www.thermotechfiberglass.com. Windows shall be triple glazed, 2 low “E” coatings, fixed, casement and slider configurations per window schedule, refer to drawings A601.

2.2 MATERIALS

.1 Frames: Pultruded fibreglass.

.2 Fasteners: Stainless steel, finish to match adjacent material.

.3 Sealants: General Construction silicone as specified in Section 07 92 00, colour to match adjacent finish.

.4 Glass and glazing materials: sealed glazing units manufactured to CAN/CGSB-12.8-M90, “Insulating Glass Units”, triple glazed, 2 low ‘E’ coatings, low “E” coatings selected for shade on east and west facing windows, gain on north and south windows.

.5 Membrane flashing: “Peel and stick” membrane as specified in Section 07 27 01.

2.3 ACCESSORY COMPONENTS

.1 Operating Hardware: Truth dual arm “Entry-Guard”.

.2 Screens: Extruded aluminum frames and aluminum screen fabric held in place with four retaining clips.

.3 Operating pole for high level hopper windows.

2.4 FINISH

.1 Finish: integral white in fibreglass.

2.5 FABRICATION

.1 Work shall be executed in strict accordance with drawing details and the reviewed shop drawings. Where shop fabrication is not possible shop prepare for site assembly and trial fit prior to site delivery.

.2 Miter cut and weld all frame corners.

.3 Apply sealant in accordance with Section 07 92 00. Conceal sealant within work except where exposed as permitted by Consultant.

.4 Manufacturer's nameplates on windows are not acceptable.

2.6 TOLERANCES

.1 Fabricate window units square and true with maximum tolerance of plus or minus 1.6 mm (measured on diagonal) for units with diagonal measurement of 1.8 mm or less, and plus or minus 3.2 mm (measured on diagonal) for units with diagonal measurement over 1.8 mm.

3 Execution

3.1 VERIFICATION OF CONDITIONS

.1 Obtain all dimensions affecting the work of this section from the site. Ensure all adjacent and adjoining materials, flashings, framing, anchors, blocking and fasteners are properly set and in readiness to accept windows.

3.2 PREPARATION

.1 Ensure all Air/Vapour Membranes are properly installed for tieing into windows.

.2 Clean all glass and metal surfaces to be sealed with an oil free solvent. Apply sealant with a caulking gun to provide a regular fillet.

3.3 INSTALLATION - WINDOWS

.1 Perform installation of the work of this section under the direction of a competent representative of the manufacturer and in accordance with reviewed shop drawings and manufacturer’s installation instructions.

.2 Accurately fit frames to provide weather tight installation and still provide clearance required due to expansion and contraction of building structure and frame.

.3 Set all items in their correct location, square, level, plumb, and at proper elevations and alignment with other work.

.4 Do not erect members which are observed to be warped, bowed, deformed or otherwise damaged or defaced to such extent as to impair strength or appearance. Remove and replace members damaged in the process of erection, as directed by the Prime Consultant.

.5 Shim all windows to fit in openings.

.6 Fill voids around window units with non-expanding foam insulation except as required to meet design criteria.

3.4 FLEXIBLE MEMBRANE AIR SEALS

.1 Secure flexible membrane air seals to window frames to close off spaces between frame and adjacent construction in order to maintain the continuity of the air barrier.

3.5 SILL INSTALLATION

.1 Install sill extentions where detailed with uniform slope to exterior, level in length, straight in alignment with plumb upstands and faces. Use one piece lengths at each location.

.2 Cut sills to fit window opening including width of perimeter joints.

.3 Secure sills in place to underside of the sill section securely held in place in the bottom glazing rebate.

3.6 INSTALLATION - ACCESSORY TRIM

.1 Install accessory trims level in length, straight in alignment with plumb upstands and faces. Use one piece lengths at each location.

.2 Cut to fit window opening including width of perimeter joints.

.3 Secure in place with concealed anchoring devices.

3.7 GLAZING

.1 Glaze windows with sealed insulating units employing window manufacturer's standard components.

3.8 ERECTION TOLERANCES

.1 Erect all component parts within the following tolerances:

.1 Variation from plumb: maximum 3 mm plus or minus.
.2 Variation from level: maximum 3 mm plus or minus.
.3 Maximum offset in any end-to-end or edge-to-edge alignment: 2 mm.

3.9 CLEANING

.1 Remove, as work progresses, all corrosive and foreign materials which may set or become difficult to remove at time of final cleaning. All initial cleaning of all windows shall be done by this Contractor.

.2 Clean and remove from the site and premises all rubbish and surplus materials resulting from the work of this section.

END OF SECTION

1 General

1.1 SUBMITTALS - OPERATION AND MAINTENANCE DATA

.1 Provide the following:

.1 Final As-built (as-installed) hardware schedule.
.2 Final As-installed keying schedule.

1.2 QUALITY ASSURANCE

.1 Hardware shall only be installed by trained, experienced hardware installers.

2 Products

2.1 HARDWARE PRODUCTS

.1 Single source: Except where specified in hardware schedule, provide products from only one manufacturer for each item of hardware.

.2 As specified in hardware schedule.

3 Execution

3.1 INSTALLATION - HARDWARE

.1 Install all hardware items to manufacturer's instructions and recommendations.

.2 Where hardware items are required to be installed onto or into surfaces that are to be later painted or finished, install hardware completely to ensure proper fit, remove and store until finishing is complete, and then re-install.

.3 Drill and countersink units which are pre-prepared for anchoring by fasteners. Space fasteners and anchors to manufacturer's recommendations. Use manufacturer supplied fasteners.

.4 Install hardware to heights and centres approved on reviewed hardware schedule.

.5 Protect doors and frames from damage due to installation of hardware.

END OF SECTION

1 General

1.1 REFERENCES

.1 CAN/CGSB-12.1-M90, "Tempered or Laminated Safety Glass".

.2 CAN/CGSB-12.3-M91, "Flat, Clear Float Glass".

.3 CAN/CGSB-12.5-M86, "Mirrors, Silvered".

2 Products

2.1 GLASS

.1 Safety Glass: Tempered to CAN/CGSB-12.1-M90, clear float, 6 mm thick, other thicknesses as noted on the drawings.

.2 Float Glass: Meeting CAN/CGSB-12.3-M91, glazing quality, clear, 6 mm thick unless otherwise noted.

.3 Mirrors: Minimum 6 mm thick, with all exposed edges polished, conforming to CAN/CGSB-12.5-M86, Type 1B, metalic coating. Mirror shall be c/w 2" clear edges, per drawing detail.

.4 Glass shelves: clear tempered glass, 12 mm thick, exposed edges polished.

.5 Glass back-splash: 6 mm clear tempered float with exposed edges polished, factory applied and baked on back-painted.

.6 Door glazing: 6 mm clear, tempered float glass with etched artwork, student created.

.7 Shower glass: 12 mm clear, tempered, exposed edges polished, set in stainless steel “U” channels.

2.2 ACCESSORY MATERIALS

.1 Glazing Tape: 100 percent polybutene vehicle. Extruded in ribbon form with paper separator. Tape shall have an integral shim strip where required.

.2 Setting Blocks: Neoprene, shore "A" hardness 70-90; shims shore "A" hardness 40-50.

.3 Mirror adhesive: Palmer Products Corp. (www.mirror-mastic.com) “Mirro-Mastic”, formulated for adhering mirror on various substrates, composed of petroleum resins, aliphatic solvents and a thickner. Primer for use on gypsum board: Palmer Products “Mirro-Mastic Bond”.

.4 Obscure glazing film: 3M OPL3 polyester film, sand-blast/etched appearance.

.5 Structural silicone sealant: One component silicone sealant, Dow Corning 995 Silicone structural adhesive.

.6 Glazing channel: brushed finish stainless steel, supplier: C.R. Laurence, www.crlaurence.com

2.3 FABRICATION - GENERAL

.1 Cut all glass to field measurement with proper clearances. Cut to produce clean, straight edges with no chips, cracks or flaws.

.2 Make any cut-outs, openings to approved drawings. Polish exposed edges, round-off exposed corners.

.3 Fabricate mirrors to fit measurements of finished spaces, made at the site. Use one piece for mirrors 1200 mm or less in width. Make no horizontal joints except where indicated.

.4 Cut wired glass so that wires are parallel with edges both vertically and horizontally.

.5 Factory apply back-painting to glass. Acceptable manufacturer: Goldray, Calgary.

3 Execution

3.1 INSPECTION/PREPARATION

.1 Ensure all wood backing rebates and stops are properly primed.

.2 Ensure all glazing rebates are smooth and true, free of projections nails, screws, fastenings properly set to prevent contact with glass.

.3 Ensure all stops, splines, glazing accessories provided by others accurately cut to length and proper size and type for specific glazing.

3.2 INSTALLATION

.1 Installation of glass shall be by workmen skilled in this trade in strict accordance with manufacturer's directions, to produce a first-class installation.

.2 Centre and support glass on setting blocks at quarter points, as required shim sides.

.3 Glass shall be free from contact with the frames and stops.

.4 Label each tempered light to show manufacturer's name or trade mark, quality and thickness.

.5 Glaze interior lights in wood frames with foam or cork tape on both sides. Trim tape even with the sight line.

.6 Apply glazing film to clean glass to patterns as detailed. Film must be applied by skilled, trained mechanics using approved tools and techniques.

3.3 INSTALLATION - MIRRORS

.1 Install mirrors to plywood backing with adhesive (“Mirro-Mastic”). Comply with adhesive manufacturer’s written installation instructions.

.1 Prime gypsum board or wood with proprietary primer (“Mirro-Mastic Bond”) and allow to dry.
.2 Apply adhesive to mirror or substrate at minimum one “ping pong ball” size dab per1 sq ft of mirror surface area. Do not place too close to edge to prevent “squeeze-out”.
.3 Press mirror firmly into place. Mastic should spread to about 4 1/2" dia.

END OF SECTION

1 General

1.1 SUMMARY

.1 Pre-finished, fixed vane, extruded aluminum louvers for exterior application c/w frames, mounting brackets and insect screens.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Cover prefinished components to protect surface finishes from damage and deterioration.

.2 Store components off the ground to prevent twisting, bending or delamination. Slope to shed moisture.

2 Products

2.1 LOUVERS

.1 Acceptable manufacturers/products: E.H. Price Limited

.2 Type: Extruded aluminum fixed blade.

.3 Aluminum alloy: 6063-T5.

.4 Frame: 150 mm deep extruded aluminum, 5 degree extruded sloped sill, welded, mitred corners, minimum 3.2 mm thick extrusions.

.5 Blades: 150 mm deep, set at 45 degree angle, 100 mm blade spacing, screwed in place, storm-proof pattern, centre watershed, minimum 3.2 mm thick aluminum extrusions, reinforcing bosses, maximum blade length 3000 mm.

.6 Finish: factory finished, all exposed aluminum shall be PPG “Duranar” fluropolymer paint system finished to match adjacent siding or as otherwise noted on the drawings.

.7 Provide all louvres with insect screens and mounting brackets, welded, galvanized coated, c/w retaining frame and clips.

.8 Mullions: concealed at maximum 1500 mm.

.9 Fasteners: stainless steel, SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, stainless steel washer and aluminum body.

3 Execution

3.1 INSTALLATION

.1 Installation shall comply with manufacturer’s instructions.

.2 Install louvres to locations indicated.

.3 Installation shall be solid, secure, aligned vertically and horizontally. Use stainless steel fasteners as specified above.

.4 Coordinate installation of fixed louvres with installation of adjacent operable louvres.

.5 Isolate aluminum from steel to ensure no galvanic reaction between dissimilar metals takes place.

.6 Seal louvre frames to adjacent construction using General Construction sealants as specified in Section 07 92 00.

.7 Make installation weather tight.

END OF SECTION

1 General

1.1 QUALITY ASSURANCE

.1 Conform to product manufacturer's written instruction and ULC Design Requirements to provide STC and fire ratings as indicated on the drawings.

1.2 REFERENCES

.1 ASTM C36-97, “Gypsum Wallboard”

.2 ASTM C630, “Water Resistant Gypsum Backing Board”

.3 ASTM C840-95: Application and Finishing of Gypsum Board.

.4 ASTM C1002-83, "Steel Drill Screws for the Application of Gypsum Board".

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials undamaged. Store on site in a dry, weatherproof, heated area.

.2 Store metal furring and accessories flat and protected from moisture and damage.

.3 Store boards flat, in piles, without overhanging boards, protected from moisture and physical damage.

.4 DO NOT ALLOW GYPSUM BOARD PRODUCTS TO BECOME WET DURING DELIVERY, HANDLING, STORAGE, OR INSTALLATION. Promptly remove any wet or damaged board from the site.

1.4 ENVIRONMENTAL CONDITIONS

.1 Maintain room, surface and material between 13o and 21oC for at least 72 hours before and during application and continuously after.

2 Products

2.1 MATERIALS - GYPSUM BOARD

.1 Gypsum board: To ASTM C 36; standard and fire rated (type "C" or "X" as required to meet assembly construction requirements) labelled in accordance with ULC, Warnock-Hersey, or other certification program acceptable to Authority having Jurisdiction; maximum permissible length and width; end square cut, taper edges; paper/paper faces. Thicknesses as indicated.

.2 Moisture resistant gypsum board: To ASTM C 630; maximum practical length and width; ends square cut; paper/paper water repellent face. Thickness 12.7 mm or 15.9 mm as detailed.

2.2 MATERIALS - METAL FRAMING AND FURRING

.1 Fastening devices: Screws to ASTM C1002-83 type S or other approved devices of type and size to suit application and to rigidly secure furring, framing and boards in place, galvanized or stainless steel type for use with “Dens-Glass Gold” or “Dens-shield”. 3.2 mm clips for attaching furring to ceiling carrying channels.

2.3 MATERIALS - ACCESSORIES

.1 Joint tape: To ASTM C475-81, perforated paper with tapered edges as recommended by gypsum board manufacturer.

.2 Joint compound: To ASTM C475-81, bedding and finishing types recommended by gypsum board manufacturer; casein, vinyl or latex base.

.3 Joint tape and joint compound for GP "DensShield", proprietary products specifically approved by board manufacturer for wet locations applications with "DensShield".

.4 Corner and casing beads: To ASTM C645-83, Minimum 0.455 mm metal core thickness (26 gauge) galvanized sheet steel with Z275 zinc finish to ASTM A525M-86, type with perforated steel flanges for screw fastening.

.5 Insulation, acoustic: To ASTM C423-84; fibrous glass semi-rigid batt; width to suit metal stud spacing to tight fit; thickness to match metal stud depth or as specifically noted on drawings, labeled for use in fire rated partitions.

.6 Access doors: 16 ga. cold rolled steel, prime painted, concealed mounting frame, sizes as indicated. Acceptable manufacturers and products: Cendex Inc. “Contour”, Acudor “AT-5020", or Bauco “Plus”.

3 Execution

3.1 INSPECTION

.1 Inspect areas and surfaces and ensure all required blocking for mounting all items is in place before commencing gypsum board application.

.2 Verify stud framing is securely and rigidly erected, all services, lines, outlets, insulation, blocking, vapour retardant membranes are in place, tested and approved.

3.2 FURRING AND FRAMING

.1 Frame openings and around built-in and recessed equipment, cabinets etc., on four sides. Extend furring into reveals. Maintain clearances required by respective equipment suppliers.

.2 Secure furring to concrete or masonry with drilled mechanical fasteners. Maximum spacing 600 mm alternating to opposite flanges.

.3 Install furring level to 3 mm in 3 metres maximum, non-cumulative.

3.3 METAL FRAMED SUSPENDED CEILINGS/SOFFITS/BULKHEADS

.1 Install suspension system after duct work and major above ceiling work is complete. Coordinate location of hangers with other work.

.2 The sizes and spacing of components of suspended ceilings shall be as specified in ASTM C754. Provide additional supports for installations where additional loads, vibrations or features require them. Do not suspend gypsum board ceilings from metal decks. Add structural framing as required to permit hanger spacing in accordance with ASTM C754.

.3 Maintain sufficient clearance under duct and piping work to permit installation of ceiling/soffit materials.

.4 Do not attach hangers to ductwork, piping or conduit or metal deck.

.5 Brace suspension for bulkheads, recesses, coves, formed ceilings, valances and drops to provide a rigid system. Provide bracing as required and shown on the drawings.

3.4 METAL ACCESSORIES

.1 Install corner beads rigidly at all external angle corners vertically and horizontally. Secure rigidly using screw fasteners.

.2 Install casing beads where gypsum board terminates against surface having no trim concealing the junction or where junction is not taped and to locations as noted on the drawings.

.3 Install casing beads where gypsum board butts to window frames or dissimilar wall materials.

.4 Install resilient furring channels to locations noted in partition types on drawings.

3.5 GYPSUM BOARD APPLICATION

.1 Erect gypsum board and tape joints to studs and furring channels to ASTM C840 requirements except where specified otherwise herein.

.2 Install gypsum board vertically, unless noted otherwise for ULC tested assemblies with all joints occurring over firm bearing. Stagger joints on opposite sides of wall. Stagger all vertical joints.

.3 At double layer applications first layer to be square edge sheets, second layer to be tapered side sheets. Stagger all joints of double layers. Fasten outer layer with fasteners of a length to pass through both layers and a minimum of 13 mm into metal framing.

.4 Install fire rated gypsum board at all locations indicated on the drawings.

.5 Install moisture resistant gypsum board in all washrooms.

.6 Construct shower and tub partitions to receive ceramic wall tile of moisture resistant gypsum board only, in strict accordance with manufacturer's current recommended installation procedures.

3.6 INSULATION

.1 Install batt insulation to locations as noted on the drawings.

.2 Install insulation within stud space and above ceilings as indicated for sound and/or fire rating. Extent of insulation is noted on the drawings.

3.7 CEILINGS

.1 Apply board to ceiling suspension system with end joints occurring over supports.

.2 Cut board to fit within 6 mm of fixtures and other surfaces.

.3 Screw attach to furring channels at spacing recommended by gypsum board manufacturer but in no case less than 150 mm o.c.

.4 Coordinate cut-outs, trim and opening details and locations with other subcontractors.

.5 Finish gypsum board to heights and profiles indicated. Trim all corners and edges with proper corner and casing beads.

.6 Install moisture resistant gypsum board ceiling in areas as indicated and all washrooms.

.7 Build bulkheads for drop ceilings as detailed.

.8 Maintain surface flatness and level of ceiling within 3 mm in 3 metres.

3.8 FINISHING

.1 Tape, fill and sand all exposed joint, edges, corners, openings and fixings, to produce an acceptable surface ready to receive surface finishes. Fill with minimum three coats. Feather coats onto adjoining surfaces so that camber is maximum 0.8 mm. (Level 4 finish.)

.2 Make the width of the skim coat not less than 300 mm over joints between tapered edges, and not less than 500 mm over joints between square edges.

.3 Where there are fire rated assemblies which are concealed from view tape all joints and fill with at least 2 coats, unsanded. Provide coverage equivalent to that provided in finished areas, from the standpoint of fire resistance.

.4 Do not tape or fill intersections of interior partitions butting to exterior walls of different materials, finish with “J” trim and sealant.

3.9 ACCESS DOORS

.1 Install flush mounted, recessed cover access doors in locations as indicated on drawings.

.2 Install all access doors provided by other trades. Exact locations of these doors will be verified on site.

3.10 HORIZONTAL DUCT CHASES

.1 Construct, using methods and materials described herein, horizontal fire rated duct chases. Refer to mechanical drawings for locations and fire resistance ratings required.

3.11 CLEANING

.1 All gypsum board debris and dust shall be cleaned up and disposed of daily.

.2 As areas are completed, thoroughly vacuum ceilings, walls and floors of all dust.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Installation of wall stone c/w related accessories.

1.2 REFERENCES

.1 Specification Guide 09 30 00, “Tile Installation Manual 2006-2007” produced by the Terrazzo Tile and Marble Association of Canada (TTMAC).

1.3 QUALITY ASSURANCE

.1 Do tile work in accordance with TTMAC Tile Installation Manual, 2006-2007.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Keep delivered material dry and free from stains and protected from freezing and the elements.

2 Products

2.1 MATERIALS

.1 Stone: Thunderstone Quarries “Rundle stone”, gauged stone.

2.2 MORTAR AND ADHESIVE MATERIALS

.1 Dry Curing Grout: High density, factory prepared, cementitious type grouting compound and latex grout additive, colours as noted or as selected by the Consultant.

.1 Acceptable Products:
- .1 Crest Cements "Superblend".
- .2 Mapei "Keracolour".
- .3 Laticrete "Dryset".

.2 Grout Additive: Performance standard to ANSI A118.6-1985. Latex grout additive.

.1 Acceptable Products:
- .1 Crest Cements "Crestflex".
- .2 Mapei "Plastijoints".
- .3 Laticrete "Laticrete 1776".

.3 Organic adhesive, non-flammable, synthetic resin emulsion-based adhesive for wall tile on gypsum board in dry areas, eg. washroom walls, back splashes, utility rooms, etc.

.1 Crest Cements "Probond".
.2 Laticrete "Latimastic 15".

.4 Water: potable and free of minerals which are detrimental to mortar and grout mixes.

2.3 MISCELLANEOUS MATERIALS

.1 Edge strips and/or expansion control joints: Extruded aluminum, height of profile and type as required for each set of junction conditions between adjacent materials. Schluter Systems Trims.

.2 Sealers: Custom Construction Products “TileLab SurfaceGuard”.

.3 Cement: Normal Portland cement to CAN/CSA-A5-93.

.4 Sand: Clean, washed, sharp and fine silica sand to CSA A179-93.

.5 Multi-component joint sealant for expansion and control joints: as specified in Section 07900.

3 Execution

3.1 INSPECTION/PREPARATION

.1 Verify all surfaces to receive tile and stone work are sound and smooth and free from openings and projections not required.

.2 Repair and make good defective surfaces including levelling, filling.

.3 Ensure all service fittings are completed and to proper levels to receive stone work.

.4 Wash surface with adhesive manufacturer's recommended preparation solution, leaving substrate clean and dry, free from all residue or any other material which may act as bond breaker.

.5 Before laying stone open enough material to cover each area, and mix units to provide a pleasing and even colour range, no obvious all-dark or all-light, or discoloured areas. Reject damaged or marred units.

3.2 APPLICATION - GENERAL

.1 Install units in accordance with current installation handbook of the TTMAC and material manufacturer's directions.

.2 Install units complete with all special units and accessories which are necessary and required to complete the installation.

3.3 LAYOUT

.1 Lay out work and patterns in accordance with drawings and as specified herein.

.2 Lay out work so as to minimize cut units less than one-half in size when located in field of tile. Locate cuts in walls and floors so as to be least conspicuous. Border units to be full unit width unless specifically noted otherwise.

.3 Determine position and location of accessories, equipment and movement joints for Consultant’s review, before beginning tile work.

.4 Coordinate with mechanical equipment and plumbing fittings on floors, walls, and ceilings.

.5 Match units for colour and pattern. Broken, cracked, chipped or deformed units are not acceptable.

3.4 INSTALLATION - GENERAL

.1 Grind and fit stone at intersections against trim and at built-in fixtures and accessories. Fit units around corners, fitments, fixtures, and other built-in objects so that plates, escutcheons, and covers overlap cut. Maintain uniform joint appearance. Cut and drill tile and trim shapes

without damage to exposed faces and edges. Rub cut edges smooth with carborundum stone. Edges resulting from splitting are not acceptable.

.2 Maximum surface tolerance 1:800 between adjacent units.

.3 Make joints between units uniform and width as noted on the drawings, plumb, straight, true, even and flush with adjacent tile. Ensure sheet layout not visible after installation. Align patterns.

.4 Sound units after setting and replace hollow-sounding units to obtain full bond.

.5 Use round or bullnose edged tiles at termination of wall tile panels, except where panel abuts projecting surface or differing plane and as noted on the drawings.

.6 Use round or bullnose tile for base.

.7 Align wall joints to give straight uniform grout lines parallel with floor joints.

.8 Align floor joints to give straight uniform grout lines parallel with the wall joints.

.9 Install trim accessories as detailed.

.10 Install edge strips at all changes in floor material.

3.5 WALL STONE

.1 Install wall stone over gypsum board using organic adhesive.

3.6 EXPANSION AND CONTROL JOINTS

.1 Determine expansion and control joint locations before beginning work.

.2 Provide control joints at the following locations:

.1 At all inner horizontal and vertical corners of the tiled surface.
.2 At all points where stone and dissimilar materials come into contact.
.3 At all locations as indicated on the drawings or at locations as may be determined by examination of substrate prior to installation of tile work.

.3 Make control joints same width as stone joints. Form control joints through tile and setting bed. Keep joints free of mortar and grout, fill with sealant.

.4 Use Multi Component Horizontal joint sealant in all vertical and horizontal joints as specified in Section 07 92 00.

3.7 GROUTING

.1 Allow tile to set for a period of 48 hours prior to grouting.

.2 Force grout into joints, avoiding air traps or voids. Strike or tool joints of cushion edge tile to depth of cushion. Grout to be held flush with cushion edge. Remove all excess grout from face of tile.

3.8 CLEANING/SEALING AND FINISHING

.1 Clean tile in accordance with tile manufacturer's recommendations.

3.9 PROTECTION

.1 Protect the work, make good damage, remove all debris and rubbish and leave the work in a clean and tidy condition.

.2 Prohibit traffic from using newly tiled floors for a minimum of three days.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Supply and installation of porcelain wall and floor tiles c/w related accessories.

.2 Supply and installation of ceramic wall and floor tiles c/w related accessories.

1.2 REFERENCES

.1 Specification Guide 09 30 00, “Tile Installation Manual 2006-2007” produced by the Terrazzo Tile and Marble Association of Canada (TTMAC).

1.3 QUALITY ASSURANCE

.1 Do tile work in accordance with TTMAC Tile Installation Manual, 2006-2007, except as specified herein.

1.4 ENVIRONMENTAL CONDITIONS

.1 Maintain air temperature and structural base temperature at tile installation area above 12°C for 48 h before, during, and 48 h after, installation.

2 Products

2.1 MATERIALS

.1 Tiles: Supplier: Ames Tile, “Metallica” 12" x 24" glazed, rectified tile MEBR1224.

.2 Ensure that all tile of each colour and style are from the same dye lot and are the same caliber.

2.2 MORTAR AND ADHESIVE MATERIALS

.1 All setting materials and adhesives, grout and membrane materials shall be supplied from a single manufacturer for the entire project.

.2 Thinset Mortar:

.1 Acceptable Products for tile up to 305 mm x 305 mm:
- .1 Crest Cements "Tile-Set".
- .2 Mapei "Kerabond".
- .3 Custom Building Products "MasterBlend".
- .4 TEC “Full Set”

.3 Thinset Mortar Additive:

.1 Acceptable Products:
- .1 Crest Cements "Acryl-5000".
- .2 Mapei "Keralastic".
- .3 Custom Building Products "Acrylic Mortar Admix".
- .4 TEC “XtraFlex”

.4 Thinset mortar for tiles 305 mm x 305 mm and larger.

.1 Acceptable Product, (c/w integral polymer modifider):
- .1 Custom Builidng Products"Marble and Granite" white mortar mix.

.2 Mapei “Ultra/Contact”
.3 TEC “3N1" Performance Mortar

.5 Dry Curing Grout: High density, factory prepared, cementitious type grouting compound with integral grout additive, colour to match tile, sanded for floor tile, non-sanded for wall tile.

.1 Acceptable Products:
.1 Mapei "Ultracolour".
.2 Custom Building Products "Polyblend"
.3 TEC “AccuColor”

.6 Organic adhesive, non-flammable, synthetic resin emulsion-based adhesive for ceramic wall tile on washroom walls only.

.1 Mapei “Type 1" mastic.
.2 Custom Building Products "CustomBond" ceramic tile mastic.
.3 TEC “TA101" mastic.

.7 Water: potable and free of minerals which are detrimental to mortar and grout mixes.

2.3 MISCELLANEOUS MATERIALS

.1 Tile cleaner: As recommended by ceramic tile manufacturer, “Aqua Mix” heavy duty tile and grout cleaner..

.2 Sealant for expansion and control joints: “Horizontal Joint Sealant” “Sikaflex-2C SL” as specified in Section 07 92 00.

.3 Cement: Type “GU”, General Use hydraulic cement.

.4 Sand: Clean, washed, sharp and fine silica sand to CSA A179-93.

.5 Waterproofing membrane: Schluter Systems “Kerdi Membrane”.

.6 Tile termination trims: extruded aluminum, anodized finish, colour as selected by the Consultant, acceptable manufacturer: Schluter.

.1 “Schiene” series for top of porcelain tile base
.2 “Rondec” series for vertical outside corners for wall tile and base
.3 “Schiene” or “Jolly” series for top of ceramic wall tile where wall tile does not extend to underside of ceiling

3 Execution

3.1 TILE LAYOUT

.1 Lay out tile work and patterns in accordance with drawings and specified herein.

.2 Lay out tile work so as to minimize cut tiles less than one-half tile in size when located in field of tile. Locate cuts in walls and floors so as to be least conspicuous. Border tiles to be full tile width unless specifically noted otherwise.

.3 Determine position and location of accessories, equipment and movement joints for Consultant’s review, before beginning tile work.

.4 Coordinate with mechanical equipment and plumbing fittings on floors, walls, and ceilings.

.5 Match tiles for colour and pattern by using tile from cartons in the same sequence as manufactured and packaged. Broken, cracked, chipped or deformed tiles are not acceptable.

3.2 TILE INSTALLATION

.1 Install shower tile over waterproof membrane. Install waterproof membrane using materials and techniques as per membrane manufacturer's instructions.

.2 Grind and fit tile at intersections against trim and at built-in fixtures and accessories. Fit tile around corners, fitments, fixtures, and other built-in objects so that plates, escutcheons, and covers overlap cut. Maintain uniform joint appearance. Cut and drill tile and trim shapes without damage to exposed faces and edges. Rub cut edges smooth with carborundum stone. Edges resulting from splitting are not acceptable.

.3 Maximum surface tolerance 1:800.

.4 Make joints between tile uniform and width as directed by the Consultant for each tile type and size, plumb, straight, true, even and flush with adjacent tile. Ensure sheet layout not visible after installation. Align patterns.

.5 Sound tiles after setting and replace hollow-sounding units to obtain full bond.

.6 Use round or bullnose edged tiles at termination of wall tile panels, except where panel abuts projecting surface or differing plane and as noted on the drawings.

.7 Align wall joints to give straight uniform grout lines parallel with floor joints. For porcelain wall and floor tiles in public areas make joints the same width.

.8 Align floor joints to give straight uniform grout lines parallel with the wall joints.

.9 Install trim accessories as detailed.

.10 Install edge strips at all changes in floor material.

3.3 FLOOR TILE

.1 Set floor tile using "thinset" setting bed method. Thinset to be c/w acrylic additive.

3.4 WALL TILE

.1 Install wall tile to substrate using organic adhesive and latex modified dry curing non-sanded wall grout for gypsum board substrate.

.2 Set wall tile to showers over waterproof membrane using "thinset" setting bed method.

3.5 CONTROL JOINTS

.1 Determine control joint locations before beginning tile work.

.2 Provide control joints at the following locations:

.1 Maximum 3.6 m centres in each direction of tiled vertical and horizontal surfaces.
.2 At all inner horizontal and vertical corners of the tiled surface.
.3 At all base tile to floor tile connections.
.4 At all points where tiled and dissimilar materials come into contact.

.5 At all locations as indicated on the drawings or at locations as may be determined by examination of substrate prior to installation of tile work.

.3 Make control and expansion joints same width as tile joints. Form control joints through tile and setting bed. Keep joints free of mortar and grout, fill with sealant.

.1 Use Multi Component Horizontal joint sealant in all vertical and horizontal joints as specified in Section 07 92 00.

3.6 GROUTING

.1 Allow tile to set for a period of 48 hours prior to grouting.

.2 Force grout into joints, avoiding air traps or voids. Strike or tool joints of cushion edge tile to depth of cushion. Grout to be held flush with cushion edge. Remove all excess grout from face of tile.

3.7 EDGE STRIPS

.1 Install edge strip at edges of floor tile where tile butts to other flooring, at edges of thinset floor tile, where required, as shown on drawings.

.2 Install strips flush with finished surface of tile, in accordance with manufacturer's instructions.

3.8 CLEANING/SEALING AND FINISHING

.1 Clean tile in accordance with tile manufacturer's recommendations.

3.9 PROTECTION

.1 Protect the work, make good damage, remove all debris and rubbish and leave the work in a clean and tidy condition.

.2 Prohibit traffic from using newly tiled floors for a minimum of three days.

END OF SECTION

1 General

1.1 SCOPE

.1 Supply and installation of interlocking resilient floor planks to locations noted.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Deliver and store materials without damage, store on end in original wrappings or containers, with manufacturer's labels and seals intact.

1.3 PROJECT CONDITIONS

.1 Ensure that substrate surfaces for installation are clean, level, smooth, dry, and dust free and that conditions with respect to existing hazardous materials are acceptable.

.2 Do not lay flooring until the latest possible period before completion of the project.

.3 Condition flooring and the substrate at not less than 20°C for not less than 48 hours prior to starting installation.

.4 Ensure installation area is properly illuminated and provide portable task lighting as required.

2 Products

2.1 ACCEPTABLE MANUFACTURERS AND PRODUCTS

.1 Ozoloc “Etchings”, catalogue # TM6R654, adhesive free resilient, 4" x 36" x 4.5 mm gauge.

2.2 MATERIALS

.1 Critical Radiant flux ASTM-E-648 - Class 1 - 0.45 Watts cm^2, smoke: ASTM-E-662 - <450.

.2 Transition/reducer strips: purpose made vinyl, thickness and profile of transition/reducer to suit application/location.

.3 Adhesive for transition/reducer strips, cove top strips: contact bond adhesive as approved by accessory manufacturer.

.4 Underlayment: Dura Undercushions Ltd. 6 mm thick, poly backed, 64 oz/sq yd, 22 lbs per cu ft, flammability: Meets CAN/CGSB-4.2,

3 Execution

3.1 PREPARATION

.1 Protect surrounding surfaces from damage due to flooring work.

.2 Carefully inspect floor surfaces for flaws.

.3 Sweep and vacuum floors prior to commencing application to remove all dust, dirt loose materials and items which will cause flaws to the finished floor installation.

.4 Condition material within space for minimum 24 hours prior to ostallation.

.5 Ensure wood substrate is properly fastened at recommended spacing and all edges are filled and sanded.

3.2 INSTALLATION

.1 Install underlayment, use release type adhesive as recommended by underlayment manufacturer.

.2 Install flooring in accordance with details and recommendations in the manufacturer's installation manual.

.3 Lay flooring with joints straight, in true plane and symmetrical. Ensure no variations in shade or pattern to obtain a uniform effect.

.4 Cut flooring and fit neatly around fixed objects. Scribe flooring to vertical surfaces and fixtures in the floor, where no base is to be used, so that tight joints are produced.

.5 Apply flooring to full extent of rooms and spaces, extending under any counters, desks, cabinets and casework, unless indicated otherwise.

.6 Make flooring continuous through doorways for similar patterns. Terminate flooring at centreline of door in door openings where adjacent floor finish is dissimilar.

.7 Install transition strips with adhesive to locations where adjacent floor finishes are at different heights to ensure smooth transitions.

3.3 ADJUSTING AND CLEANING

.1 When installation is complete, scrub the floor lightly using a neutral detergent solution. Do not flood with water. Rinse clean and allow floor to dry.

.2 Promptly as the Work proceeds and on completion, clean up and remove from the premises all rubbish and surplus materials resulting from the work, leaving the work areas broom clean.

END OF SECTION

1 General

1.1 REFERENCES

.1 Master Painters Institute (MPI) "Architectural Painting Specification Manual", 2004 edition.

1.2 PERFORMANCE REQUIREMENTS

.1 Except as specifically specified herein, all painting work and preparation shall be performed in accordance with the requirements specified in the MPI manuals.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Store paint materials to prevent hazards.

.2 Comply with manufacturers storage instructions. Do not allow paint materials to freeze.

1.4 EXTENT OF PAINT APPLICATION

.1 Exterior:

.1 Exposed steel.
.2 New wood, not including “barn-board”.
.3 All items as noted on the drawings or in Finish Schedule.

.2 Interior:

.1 In areas where walls are specified as painted paint all surfaces including doors and frames.
.2 Do not paint stainless or pre-finished steel, or anodized aluminum.
.3 Paint surfaces as noted in Finish Schedule.
.4 Paint all exposed new metal fabrications and wood, doors, frames, railings, etc.
.5 Paint all exposed mechanical and electrical louvres, diffusers, grilles (not prefinished).

2 Products

2.1 MATERIALS

.1 Paints: Top quality as listed in MPI manual, “Approved Products List”, January 2009, for each application.

.2 Use paint from one manufacturer throughout the project.

.3 All paints shall be pre-mixed, site mixing of colours is not acceptable.

.4 Thinners, cleaners, etc.: Type and brand recommended by the paint manufacturer, bearing identifying labels.

.5 For specific applications, use products as scheduled on drawings.

2.2 GLOSS LEVELS

.1 Gloss levels for interior paint finishes shall be as specified Finish Schedule.

2.3 COLOUR SCHEDULE

.1 Colour schedule as specified in Finish Schedule.

3 Execution

3.1 PREPARATION

.1 Prepare surfaces to be painted or finished in accordance with requirements specified in Manual noted in Article 1.1 "References" above.

.2 Thoroughly vacuum clean all surfaces to be painted.

.3 Furnish sufficient drop cloths, shields and protective equipment to prevent spray or dropping from fouling surfaces not being painted.

.4 Place waste, cloths and material which may constitute a fire hazard in metal containers and remove daily from site.

.5 Remove all electrical plates, surface hardware, fittings and fastenings, prior to painting operations. Store and replace in undamaged condition on completion of work in each area.

.6 Mark off and protect finished surfaces and materials to prevent damage due to paint spatter, drips and fouling.

3.2 APPLICATION

.1 All paint applications shall be "premium grade" unless specified otherwise.

.2 Apply paint only when dust-free conditions prevail. Results shall be even, uniform in sheen, colour and texture; free from brush or roller marks, or other defects.

.3 Permit paint to dry before applying succeeding coats. Touch up suction spots after application of first coat.

.4 Sand and fill exposed plywood and particle board edges. Filler shall be compatible with finishing materials.

.5 Reduce materials only when indicated by paint manufacturer. Reduce only with approved thinner.

.6 Do not use paint which has hardened paint or foreign materials present in the container.

.7 Paint all surfaces of wood doors including top and bottom and side edges as well as door faces.

.8 All items which have been prime painted prior to site installation shall receive finish painting.

.9 Paint both sides and all edges of equipment and panel backboards prior to erection. Use intumescent paint system specified below.

.10 Apply paint by brush or roller.

3.3 PAINT CODES

.1 "Code" numbers used are from the MPI Manual.

3.4 EXTERIOR SYSTEMS

.1 Code EXT 5.1D, ALKYD: For structural and miscellaneous steel
Alkyd metal primer, 2 coats alkyd

.2 Code EXT 6.2D, SOLID COLOUR STAIN: For dimension lumber
Oil/alkyd primer, 2 coats solid colour stain

3.5 INTERIOR SYSTEMS

.1 Code INT 5.1E, ALKYD: For structural steel and metal fabrications
Alkyd metal primer, 2 coats alkyd

.2 Code INT 6.2F, FIRE RETARDANT, PIGMENTED: For plywood equipment backboards
Per manufacturer's requirements to obtain ULC rating.

.3 Code INT 6.3B, ALKYD: For dressed lumber
Alkyd primer/sealer, 2 coats alkyd

.4 Code INT 9.2B, HIGH PERFORMANCE ARCHITECTURAL LATEX: For plaster and gypsum board
Latex primer sealer, 2 coats HIPAC latex

3.6 CLEANING

.1 Remove paint marks and spatters, as work proceeds and on completion.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Aluminum framed, glass and MDF panel partition system, c/w accessories, custom extruded aluminum tube wiring channel and all accessories to form a complete proprietary demountable partition system used as “veneer” for decorative purposes and to conceal services.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Prepare pre-assembled units and ship from manufacturer’s manufacturing and assembly facility to site with appropriate packaging to ensure no damage while in transit and handling on the job site.

.2 Do not bring partitions to the site until areas are finished and ready for installation.

1.3 SEQUENCING

.1 Do not install partitions until all electrical and mechanical work is complete, all finished ceilings and flooring materials have been installed.

.2 Where system will but against fixed steel stud and gypsum board partitions ensure that fixed partitions are finished and painted.

.3 Fabricate panels from site measurements.

2 Products

2.1 ACCEPTABLE MANUFACTURER/PRODUCT

.1 DIRTT Environmental Solutions.

2.2 ALUMINUM

.1 Aluminum alloy 6063-T5.

2.3 GLASS

.1 Clear float, 6mm thick, tempered with applied frit finish to pattern noted on drawings. Frit to be baked on and protected to ensure cleaning fluids and finger-prints do not mark glass.

.2 Coloured glass: laminated with coloured interlayer.

2.4 FINISHES

.1 Aluminum: Clear anodized.

.2 MDF: Shop spray painted white.

2.5 MISCELLANEOUS ITEMS

.1 Grippers to hold bottom track in position.

.2 Top track retainer: clip system.

.3 Wire-way tube: proprietary by partition manufacturer, custom aluminum extrusion.

.4 All fasteners and clips required to complete the system and its installation.

3 Execution

3.1 EXAMINATION

.1 Prior to commencing installation, examine areas to receive partitions and ensure that ceilings, flooring are installed and complete. Ensure that gypsum board walls are complete at finished, walls are square, in plane and true, painted.

3.2 INSTALLATION

.1 Install system in accordance with manufacturer's shop drawings and installation instructions.

.2 Install all partitions plumb, level and square.

.3 Install and adjust all doors and hardware.

.4 Install wiring tubes to locations noted.

END OF SECTION

1 General

1.1 PROJECT CONDITIONS

.1 Do not install accessories until all other finishing work has been completed.

.2 Ensure that blocking and mounting plates as required have been properly installed.

2 Products

2.1 FIXTURES

.1 Toilet Paper Dispenser:

.2 Coat hooks:

.3 Soap holder:

.4 Grab Bars: 1-1/4" dia. x 18 gauge tubing of stainless steel, concealed screw attachment, flanges welded to tubular bar, provided with steel back plates and all accessories. Satin finish, peened grip, straight bar, Bobrick #B5806.99.

.5 Mirrors: Flat mirrors, 6 mm mirror with stainless steel frame, corners welded and polished, mirror edges protected with plastic edge filler strips, galvanized steel back, concealed hanging system, water resistant polyethylene rear pad. Bobrick #B-290 2436.

.6 Shower curtain and rod:

3 Execution

3.1 INSTALLATION

.1 Install and secure all accessories rigidly in place following manufacturer's instructions. Install plumb, level and secure.

.2 For stud walls install steel back plate to stud prior to drywall finish. Plate to have threaded studs or plugs provided.

.3 For installation of grab bars provide templates and steel reinforcing plates. Instruct whether shop or field drill and tap technique will be used.

.4 Mounting heights shall be as required for handicap use.

.5 Locate accessories where indicated on drawings.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Supply and installation of hand held fire extinguishers.

1.2 MAINTENANCE MANUALS

.1 Provide instructions for care and maintenance of hand held fire extinguishers.

2 Products

2.1 RATING OF PORTABLE FIRE EXTINGUISHERS

.1 Provide hand portable extinguishers rated in accordance with CAN/ULC S508 and bearing ULC label.

2.2 PORTABLE FIRE EXTINGUISHERS

.1 Multi-Purpose Dry Chemical Pressure Type:

.1 Description:ammonium phosphate, powder type, heavy duty steel cylinder, baked enamel finish, squeeze grip handle with positive on/off valve, hose and nozzle, mounting brackets.
.2 Capacity: kg.
.3 ULC Rating:[ ].
.4 Classification:Class A, B, and C fires.

3 Execution

3.1 INSTALLATION

.1 Install fire extinguishers with top 1.5m above floor.

.2 Provide extinguishers to locations noted on the drawings.

END OF SECTION

1 General

1.1 SUMMARY

.1 Supply and installation of electrically operated roller shades including all tracks, wiring, controls and related hardware to complete the installation.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials in original wrappings or containers with manufacturer's labels and seals intact.

.2 Handle and store materials in accordance with manufacturer's recommendations protecting materials and finishes from damages, marring of finishes or soiling.

2 Products

2.1 ACCEPTABLE MANUFACTURERS

.1 Nysan Shading Systems Ltd., Calgary, Alberta.

2.2 MATERIALS

.1 Shade roller assembly: top roller axle shall be an extruded aluminum one piece tube with a diameter of 50 mm, wall thickness of 1.5 mm designed to suit window span. For spans 3657 mm and over, one piece tube 85 mm diameter, wall thickness 1.5 mm. An integral slotted spline retains the fabric edge, reinforces the tube along its entire length and serves as a locking device for the sprocket clutch assembly.

.2 Electrical operator:

- .1 Electrical components: electric shade motors, master control system (MCS Relays), remote push button switches and other electrical switching to CSA/UR and ULC/UL approval by this Section.
- .2 Control switch: Rocker switch: 3 position - up - down - stop control.
- .3 Mount operator in shade roller assembly with control switches remotely located as shown on the drawings.
- .4 Include all components for proper unit operation.
- .5 Ensure connectivity to main home control system.
- .6 Shade motor: a synchronous capacitor, start and run, single phase type 120 volt - 60 Hz thermally protected, brushless motor, permanently lubricated bearings and gearbox, weatherproof housing.
- .7 Motor speed range: 10 to 64 RPM.
- .8 Limit control: adjustable thumbscrew control setting allowing exact length of travel in both up and down travel.
- .9 Braking: solenoid disc brake locking mechanism to control position if motor current is interrupted.

.3 Housing:

- .1 Satin finished steel, minimum 18 gauge for recess mounting.
- .2 Cover: removable clear anodized finished aluminum, c/w mounting clip.

2.3 ACCESSORIES

.1 Hem bar: to be solid galvanized steel "C" shaped profile 31 mm x 3 mm thick to maintain a straight bottom and flat surface.

.2 Bearings: all bearings for ends shall be self-lubricating nylon (Delrin).

.3 Sealant: General construction sealant, refer to Section 07900, colour black.

.4 Roller end caps: friction fit PVC idler cap with shift axis extension and side slot to lock into roller tube reinforcing spline.

.5 Drive shafts: solid brass drive extensions, square bar shape, for drive transfer for multiple groupings of shade rollers and manual gear box attachment.

2.4 LOUVRES

.1 Pre-finished perforated aluminum louvres.

2.5 FABRICATION

.1 Shading system components to be manufactured and assembled allowing for custom installation techniques to suit project requirements.

.2 Individual items shall be designed and fabricated, assembled and erected in accordance with manufacturer's recommendations.

.3 Finished assemblies shall be complete in every respect, square, true to size and free from distortion, twist or any other defects which could affect their strength, operation or appearance. Factory applied finish shall be uniform, smooth and without blemish.

.4 The fabric shall retain its shape and not be affected by moisture or heat and be non-flammable.

.5 Materials shall be colourfast, cut glare and reverberation from shining surfaces at the exterior. The top of the fabric shall be held in place in the retention spline of the shade roller. The bottom of the fabric shall have a continuous heat welded hem containing a metal hem bar.

2.6 FINISHES

.1 All exposed aluminum to be clear anodized finish in accordance with AA-M12C22A31.

.2 Steel: satin finish..

.3 Unexposed aluminum: mill finish.

3 Execution

3.1 INSPECTION / PREPARATION

.1 Verify that all blocking and framing necessary to carry shade assembly hardware is properly and securely installed.

.2 Verify that conduit and boxes are roughed in for control system wiring (refer to Division 26).

.3 Make accurate measurements at the site before fabrication. Check glazing framing section layout and spans and loading capabilities. Additional supports and track may be required and are to be included in the contract price.

3.2 INSTALLATION

.1 Work shall be installed only by manufacturer's skilled tradesmen and installed in strict accordance with the reviewed shop drawings.

.2 All items shall be installed plumb, square, rigidly coupled and adequately anchored, maintaining uniform clearances and accurate alignment levels and parallel with window plane.

.3 The shade fabric shall be pre-measured and manufactured off-site.

.4 Use only non-corrosive metal fasteners for installation.

3.3 ADJUSTING AND CLEANING

.1 Adjust shades to provide for operation without binding. Replace shades and operating components as required to ensure smooth and trouble free operation.

.2 Perform operation check.

.3 Clean shades and exposed components.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Installation of appliances including mechanical and electrical connections.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Be responsible for movement of appliances from unloading area to floors and final location of each appliance in each suite.

.2 Indicate all information required for rough-in including mechanical and electrical services, sizes, etc.

1.3 MAINTENANCE DATA

.1 Ensure that one copy of manufacturer's instructions covering operation, maintenance and care of each appliance installed in each suite is left in the suite or turned over to the Owner as directed.

2 Products

2.1 APPLIANCES

.1 Refer to Schedule in I series drawings.

3 Execution

3.1 INSTALLATION

.1 Move appliances from loading dock (delivery location) to final locations in building.

.2 Install all appliances, make connections, level, and ensure trouble-free operation.

.3 Remove all packaging crates and materials.

.4 Replace all damaged items.

.5 Turn operating manuals over to Owner.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Folding Stairway including stairway, frame, door handrail.

.2 Stair shall meet requirements for Alberta Building Code for rise, run, and handrail requirements.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Store equipment indoors, protected from weather and as recommended by manufacturer to prevent damage.

2 Products

2.1 ACCEPTABLE MANUFACTURER/PRODUCT

.1 Custom design, see shop drawings, “Z” seriesdrawings.

2.2 ACCESSORIES

.1 Chain hoist, per manufacturer’s specification.

2.3 FINISHES

.1 Clear anodized finis to aluminum stairway components.

.2 Douglas Fir treated.

2.4 SOURCE QUALITY CONTROL

.1 All products tested in factory test jig for proper operation before shipment.

3 Execution

3.1 EXAMINATION

.1 Ensure guide rail is properly positioned prior to installation of stair unit.

3.2 INSTALLATION

.1 Install per shop drawings and structural notes.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Supply and installation of art.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Wrap and protect all artwork to ensure art and mounting are not damaged during shipping.

2 Products

2.1 ARTWORK

.1 Student created art.

3 Execution

3.1 INSTALLATION

.1 Install art to locations as directed using standard heavy-duty hooks and fittings. Ensure anchors are installed into solid backing.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Shop manufactured casework, clear finish wood veneer, lacquer finished.

.2 Shop manufactured casework, proprietary cast resin case panels.

.3 Refer to Section 06 61 20 for counter tops.

.4 Casework hardware.

1.2 QUALIFICATIONS

.1 Perform all work both in plant and on site by skilled journeyman tradesmen.

.2 The Consultant reserves the right to inspect the facilities of the manufacturer and other projects completed by him to verify quality of work and installation.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Do not deliver casework until site conditions are adequate to receive the work of this Section. Protect items from weather while in transit.

.2 Store indoors, in well ventilated areas with a constant but minimum temperature of 16°C and relative humidity of 15 to 50%.

.3 Expose all casework to a conditioning environment of 21°C and relative humidity between 25% and 50% for at least 72 hours prior to installation until they reach moisture and temperature equilibrium.

.4 Protect finished casework during shipment. After installation protect surfaces by suitable means. Do not remove until immediately before final inspection.

.5 Materials to be moved into position shall be properly protected to avoid damage and prevent marring of exposed surfaces.

2 Products

2.1 LUMBER MATERIAL

.1 Hardwood lumber: to National Hardwood Lumber Association (NHLA) requirements, moisture content of maximum 6%, species Birch or as noted on “I” series drawings.

2.2 PANEL MATERIALS

.1 “Agri-board” core board for veneered casework.

.2 Hardwood veneer: Douglas Fir species, cut and match as identified on the “I” series drawings, minimum veneer thickness 0.6 mm, for clear finish.

.3 Cast resin panles: 3-form”Varia Ecoresin”, colours and finishes as noted on the “I” series drawings.

2.3 FASTENERS

.1 Nails and staples: to CSA B111-1974; galvanized.

2.4 CABINET HARDWARE AND ACCESSORIES

.1 Hinges, drawer guides: Blum “Soft close”, finish as noted.

.2 Door and drawer pulls: as noted on the drawings.

2.5 SHOP ASSEMBLY

.1 Shop assemble and finish work for delivery to site in size easily handled and to ensure passage through building openings.

.2 Provide space at rear of casework where required for mechanical and electrical fittings.

.3 Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.

.4 Conceal nails and staples.

.5 Provide concealed anchors for vanities, countertops and splashbacks.

.6 Source quality control: Maintain all phases of shop fabrication and finishing open to inspection.

2.6 CASEWORK CONSTRUCTION AND MATERIALS

.1 Case body construction as a minimum as follows and as detailed:

.1 Frameless, fluted dowel construction.
.2 Nailer strip glued and stapled into the top and bottom of the wall cabinet behind back.
.3 Nailer strip glued and doweled into top of base cabinets behind back.

.2 All shelves shall be adjustable, supported on shelf pins, shelf construction 3/4" thick “melamine”, exposed edges shall be finished with adhesive applied PVC edge tape. Colours as noted on “I” series drawings.

2.7 SHOP/FACTORY FINISHING

.1 All clear finish to be stain, two coats clear catalized lacquer, sand between each coat.

2.8 SHOP FABRICATION, CAST RESIN

.1 General: according to thicknesses and details on the drawings.

.2 Obtain governing dimensions before fabricating items which are to accommodate or abut appliances, equipment and other materials.

.3 Ensure adjacent part of continuous work match in colour and pattern.

3 Execution

3.1 INSTALLATION

.1 Examine areas to receive casework for conditions that will adversely affect installation.

.2 Do not install items before unsatisfactory conditions have been corrected.

.3 Coordinate casework items with partition construction for the placement and installation of items fastening to partitions.

.4 Set and secure all components in place, rigid, plumb and square and sub-assemblies or modules rigidly fastened to each other.

.5 Provide matching flush filler pieces to match drawer/door profiles as required.

.6 At junction of counter back splash and adjacent wall finish, apply small bead of general construction sealant, refer to Section 07 92 00.

.7 After installation, fit and adjust operating hardware.

.8 Do not cut and fit casework items on site.

.9 Permanently fix cabinets and base units using appropriate fasteners and anchors. Scribe bases to floor.

.10 Carefully scribe cabinet work which is against other building materials, leaving gaps of 0.8 mm maximum.

.11 Fit closure strips and scribe to irregularities of adjacent surfaces, maximum gap opening 0.5 mm.

3.2 INTERFACE WITH OTHER PRODUCTS

.1 Review the mechanical and electrical documents and ensure that the vertical channels are properly sized and adequately secured to support all piping, conduit or equipment shown as being fixed to the vertical channels. Coordinate locations of all equipment related to laboratory casework.

.2 Ensure that all fittings and connections, provided under this contract are compatible in both material type and size with the related connections specified in Divisions 15 and 16.

3.3 CLEANING AND ADJUSTING

.1 Wipe down surfaces to remove fingerprints and markings and leave in clean condition. Polish all glass and metal surfaces.

.2 Remove any surfaces that are gouged, scratched or contain any visual disfiguration not acceptable to the Consultant. Remove from the site and replace with new units.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Supply of dishes and utinsels.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Wrap and protect all furnishings and accessories to ensure they are not damaged during shipping.

2 Products

2.1 FURNISHINGS AND ACCESSORIES

.1 Dishes:

3 Execution

3.1 INSTALLATION

.1 Install art to locations indicated.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Supply and installation of rugs and mats.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Wrap and protect all rugs and mats to ensure art and mounting are not damaged during shipping.

2 Products

2.1 RUGS AND MATS

.1 .

3 Execution

3.1 INSTALLATION

.1 Install items to locations as directed.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Supply and installation of residential furniture.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Wrap and protect all residential furniture to ensure art and mounting are not damaged during shipping.

2 Products

2.1 RESIDENTIAL FURNITURE

.1 .

3 Execution

3.1 INSTALLATION

.1 Install items to locations as directed.

END OF SECTION

1 INTENT

1.1 Provide complete, fully tested and operational mechanical systems to meet requirements described herein and in complete accord with applicable codes and ordinances.

1.2 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

1.3 Install equipment generally in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment to satisfaction of the Minister at no extra cost.

1.4 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors. Uncrate equipment, move in place and install complete; startup and test.

2 UTILITY SERVICE CONNECTIONS

2.1 Arrange and pay for utility service connections, water and sewer.

3 MATERIALS

3.1 Materials and equipment installed shall be new, full weight and of quality specified. Use same brand or manufacturer for each specific application.

3.2 Statically and dynamically balance rotating equipment for minimum vibration and low operating noise level.

3.3 Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous location except plumbing fixtures and trim.

4 CUTTING AND PATCHING

4.1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

4.2 Drill for expansion bolts, hanger rods, brackets, and supports.

4.3 Do not cut or burn structural members.

4.4 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

5 EQUIPMENT PROTECTION AND CLEANUP

5.1 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

5.2 Protect equipment with polyethylene covers and crates.

5.3 Operate, drain and flush out bearings and refill with new change of oil, before final acceptance.

5.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

5.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

5.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

6 ELECTRICAL MOTORS

6.1 Supply mechanical equipment complete with electrical motors.

6.2 Provide motors to CEMA and CSAstandards for hard, continuous service, designed to limit temperature rise to 400°C for open housing and 500°C for drip proof housing, and operate at 1200 or 1800 r/min unless otherwise specified.

6.3 Motors shall have ball or roller type bearings.

6.4 Provide grease lubrication fittings on motors with frame sizes 254T and larger.

6.5 Refer to electrical specification for voltage, phase and cycle.

END OF SECTION

1 General

1.1 FLAME/SMOKE DEVELOPMENT RATINGS

.1 Pipe insulations, recovery materials, tapes, vapour barrier facings and adhesives shall have maximum flame spread rating of 25 and maximum smoke developed rating of 100 except in plenum spaces and air handling systems where maximum smoke development rating shall be 50, when tested in accordance with CAN/ULCS1021988, NFPA2551996, or ASTM E8496a.

.2 Insulating materials and accessories shall withstand service temperatures without smoldering, glowing, smoking or flaming when tested in accordance with ASTMC44182.

2 Products

2.1 PIPE INSULATION

.1 3/4" thick, diameter to suit pipe diameter, Totaline “TotalFex”.

.2 Accessories: Proprietary products: adhesives, tapes.

3 Execution

3.1 INSTALLATION

.1 Apply insulation after required piping system tests have been completed.

.2 Ensure insulation is continuous through walls and floor penetrations.

.3 Ensure piping surface is clean and dry before insulating

.4 Comply with manufacturer’s installation instructions.

END OF SECTION

1 General

1.1 REFERENCES

.1 ANSI B16.18-1984 (R1994) Cast Copper Alloy Solder Joint Pressure Fittings

.2 ANSI B16.22-1995 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

.3 ASTM B88-96 Seamless Copper Water Tube

1.2 APPLICABLE REGULATIONS

.1 National Plumbing Code of Canada 2005.

.2 Alberta Regulation 219/97 Plumbing Code Regulation.

2 Products

2.1 COPPER PIPE COMPONENTS

.1 Pipe:

.1 Copper Water Tube:to ASTM B8896.
.2 ACR Copper Tube:to ASTM B28095a.
.3 DWV Copper Tube:to ASTM B30696.

.2 Joint and Fitting Components:

.1 Wrought Copper Fittings:to ANSI B16.221995.
.2 Cast Copper, Brass & Bronze Fittings:to ANSIB16.181984.
.3 Solder Joints:to ASTM B3296.
.4 Brazed Joints:to ASTM B66490.

2.2 ABS PIPE COMPONENTS

.1 Pipe:ABS plastic pipe.

.2 Joint and Fitting Components:

.1 Fittings:ABS fittings.
.2 ABS Solvent Cement.

3 Execution

3.1 INSTALLATION REQUIREMENTS

.1 Install piping systems in accordance with the following:

.1 Plumbing and drainage system: to National Building Code of Canada 2005 and Alberta Regulation 219/97 Plumbing Code Regulation.
.2 Heating and cooling system:to comply with recommendations of ASHRAE Guide.

.2 Install piping to allow for expansion and contraction without exceeding maximum allowable stresses for pipe and equipment flanges.

.3 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.4 Provide all offsets necessary to install piping systems within the physical limitations of the building.

3.2 ROUTES AND GRADES

.1 Route piping in an orderly manner and maintain proper grades.

.2 Install piping to conserve headroom and space.

.3 Where practicable, group piping at common elevations.

.4 Slope hydronic and domestic water system piping at 0.2% and drain at low points.

.5 On closed loop water systems, equip low points with 20mm drain valves and hose nipples. At high points, provide collecting chambers and high capacity float operated automatic air vents.

.6 Grade horizontal sanitary and storm drainage vent piping at 2% minimum.

END OF SECTION

1 General

1.1 SUMMARY

.1 This Section specifies the water distribution piping system, including potable cold, hot and re-circulated hot water piping, and hydronics, including associated fittings, and specialties within the building.

1.2 RELATED SECTIONS

.1 Piping Section 22 11 10

1.3 REFERENCE DOCUMENTS

.1 ASTM F 2389-06 - Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems.
.2 CSA B137.11 - Polypropylene (PP-R) Pipe and Fittings for Pressure Applications.
.3 NSF/ANSI 14 – Plastic Piping System Components and Related Materials.

1.4 QUALITY ASSURANCE

.1 Material shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.

.2 Material shall comply with manufacturers specifications.

.3 Special Engineered products shall be certified by NSF International as complying with NSF 14.

2 Products

2.1 PIPE AND PIPING PRODUCTS

.1 Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in a three layer extrusion process. Domestic hot water and heating piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389. All pipe shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.

.2 Pipe shall be aquatherm® Greenpipe®, Faser®, or Climatherm® available from Aquatherm, Inc. Piping specifications and ordering information are available at www.aquathermpipe.com.

2.2 FITTINGS

.1 Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.

.2 Fittings shall be aquatherm® Greenpipe® available from Aquatherm, Inc.. Fittings specifications and ordering information are available at www.aquathermpipe.com.

2.3 VALVES

.1 Valves with PP-R bodies shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The valves shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.

.2 Valves with brass bodies shall be manufactured in accordance with the manufacturers specifications and shall by certified by NSF International as complying with NSF 61.

.3 Valves shall be aquatherm® Fusiotherm® available from Aquatherm, Inc.. Valve specifications and ordering information are available at www.aquathermpipe.com.

3 Execution

3.1 PIPING APPLICATIONS

.1 Install listed pipe materials and joining methods below in the following applications:

.1 Underground, Service Entrance Piping: Polypropylene (PP-R) piping in SDR 7.4 or heavier.
.2 Aboveground: Polypropylene (PP-R) piping in SDR 6, 7.4 or 11 based on the required minimum pressure rating and use temperature.

3.2 FUSION WELDING OF JOINTS

.1 Install fittings and joints using socket-fusion, elecrofusion, or butt-fusion as applicable for the fitting type. All fusion-well joints shall be made in accordance with the pipe and fitting manufacturer’s specifications and product standards.

.2 Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.

.3 Prior to joining, the pipe and fittings shall be prepared in accordance with F 2389 and the manufacturer’s specifications.

.4 Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer’s specifications.

3.3 VALVE APPLICATIONS

.1 Install gate valves close to main on each branch and riser serving 2 or more equipment connections and where indicated.

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

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

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

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

3.4 PIPING INSTALLATIONS

.1 Install hangers and supports at intervals specified in the applicable Mechanical Code and as recommended by pipe manufacturer.

.2 Support vertical piping at each floor and as specified in the applicable Mechanical Code.

3.5 INSPECTING AND CLEANING

.1 The pipes should be flushed with cold water after finishing the installation. Inspect and test piping systems following procedures of authorities having jurisdiction and as specified by the piping system manufacturer.

END OF SECTION

1 General

1.1 DELIVERY, STORAGE, AND HANDLING

.1 Ship instantaneous, tankless electric domestic water heater and accessories in original, unopened cartons and ensure they are not damaged during shipping or storage.

2 Products

2.1 INSTANTANEOUS, TANKLESS ELECTRIC DOMESTIC WATER HEATER

.1 Instantaneous, Tankless Electric Domestic Water Heater, c/w controls and accessories: Hubbell cat# 110-2

3 Execution

3.1 INSTALLATION

.1 Comply with manufacturer's installation instructions and plumbing codes.

END OF SECTION

1 General

1.1 REGULATORY REQUIREMENTS

.1 Plumbing fixtures shall be approved by the authority having jurisdiction.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Ship plumbing fixtures and trim and accessories in original, unopened cartons and ensure they are not damaged during shipping or storage.

2 Products

2.1 RESIDENTIAL PLUMBING FIXTURES

.1 See schedule drawing I-601.

3 Execution

3.1 INSTALLATION

.1 Comply with manufacturer's installation instructions and plumbing codes.

END OF SECTION

1 General

1.1 SUMMARY

.1 Pre-finished, fixed vane, extruded aluminum louvers for exterior application c/w frames, mounting brackets and insect screens.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Cover prefinished components to protect surface finishes from damage and deterioration.

.2 Store components off the ground to prevent twisting, bending or delamination. Slope to shed moisture.

2 Products

2.1 LOUVERS

.1 Acceptable manufacturers/products: E.H. Price Limited, cat # DE 439

.2 Type: Extruded aluminum fixed blade.

.3 Aluminum alloy: 6063-T5.

.4 Frame: 150 mm deep extruded aluminum, 5 degree extruded sloped sill, welded, mitred corners, minimum 3.2 mm thick extrusions.

.5 Blades: 150 mm deep, set at 45 degree angle, 100 mm blade spacing, screwed in place, storm-proof pattern, centre watershed, minimum 3.2 mm thick aluminum extrusions, reinforcing bosses, maximum blade length 3000 mm.

.6 Finish: factory finished, all exposed aluminum shall be PPG “Duranar” fluropolymer paint system finished to match adjacent siding or as otherwise noted on the drawings.

.7 Provide all louvres with insect screens and mounting brackets, welded, galvanized coated, c/w retaining frame and clips.

.8 Mullions: concealed at maximum 1500 mm.

.9 Fasteners: stainless steel, SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, stainless steel washer and aluminum body.

3 Execution

3.1 INSTALLATION

.1 Installation shall comply with manufacturer’s instructions.

.2 Install louvres to locations indicated.

.3 Installation shall be solid, secure, aligned vertically and horizontally. Use stainless steel fasteners as specified above.

.4 Coordinate installation of fixed louvres with installation of adjacent operable louvres.

.5 Isolate aluminum from steel to ensure no galvanic reaction between dissimilar metals takes place.

.6 Seal louvre frames to adjacent construction using General Construction sealants as specified in Section 07 92 00.

.7 Make installation weather tight.

END OF SECTION

1 REGULATORY REQUIREMENTS

1.1 Comply with Safety Codes Act and rules and regulations made pursuant thereto, including the Canadian Electrical Code.

1.2 Unless otherwise indicated, all references to "Canadian Electrical Code" or "CEC" shall mean the edition of the Canadian Electrical Code, Part I, CSA-C22.1, and the variations made thereto by Alberta regulation, which are in force on the date of bid closing for the Contract.

1.3 All electrical products shall be tested, certified and labelled in accordance with a certification program accredited by the Standards Council of Canada. Where a product is not so labelled, provide written approval by the authority having jurisdiction.

1.4 Submit to authority having jurisdiction and utility company, necessary number of drawings and specifications for examination and approval prior to commencement of electrical work. Pay associated fees.

1.5 If authority having jurisdiction conducts an electrical inspection, submit copy of certificate of acceptance provided by authority having jurisdiction.

2 OPERATION AND MAINTENANCE DATA

2.1 Provide the following for all systems and components:

.1 Manufacturer's product data, including performance curves and schematic and wiring diagrams for all electrical control systems.
.2 Manufacturer's installation instructions.
.3 Manufacturer's operation instructions.
.4 Manufacturer's maintenance instructions, including complete parts list for all serviceable components.

2.2 Provide a comprehensive list of Subcontractors, Sub▲subcontractors and suppliers who supplied and installed systems and components.

2.3 Provide copies of all inspection certification reports from authorities having jurisdiction.

3 SOURCE OF SUPPLY

3.1 All like materials shall be by a single manufacturer.

4 REFERENCE STANDARDS

4.1 Comply with standards of following organizations:

4.2 Electrical and Electronic Equipment Manufacturers Association of Canada (EEMAC).

4.3 Institute of Electrical and Electronic Engineers (IEEE).

5 TESTING

5.1 Prior to energizing any portion of the electrical system, perform megger tests on all parts of the distribution system. Results shall meet the requirements of the CEC, authority having jurisdiction and the Contract Documents.

6 ELECTRICAL IDENTIFICATION

6.1 Colour Identification of Equipment:

.1 Electrical equipment shall be prefinished in coded colours as follows:

.1 120/208V or 120/240V Line Voltage Equipment: grey.
.2 Fire Alarm System Equipment: red.
.3 Telephone Cabinets: green.
.4 Ballast Cabinets: green.

6.2 Where impracticable to obtain equipment prefinished in coded colours, equipment may be site painted in coded colours.

6.3 Nameplate Identification: Identify following equipment with lamicoid nameplates, 1/8" thick, black face, white core, mechanically attached, 3/4" high with 5/16" high letters:

.1 Panelboards.
.2 Disconnection switches, magnetic motor starters and contactors.
.3 Transformers, inverters.
.4 Wireways.
.5 Cabinets and enclosures.
.6 Pull and junction box covers over 4" size.

6.4 Panelboard Directories: Identify loads controlled by each overcurrent protective device in each panelboard, by means of a typewritten panelboard directory.

6.5 Colour Identification of Conduit and Cable: Identify all systems, except line voltage, with paint or colour banding tape.

6.6 Identification of Pull and Junction Boxes: Identify boxes for all systems, except line voltage, as follows:

.1 Boxes over 4" size: Spray paint inside and outside of boxes in coded colours.
.2 Boxes 4" or less in size: Spray paint inside of boxes in coded colours. Apply permanent identifying markings directly to box covers using indelible black ink.

6.7 Colour Identification of Wiring:

.1 Identify No. 4/0 AWG wiring and smaller by continuous insulation colour.
.2 Identify wiring larger than No. 4/0 AWG by continuous insulation colour or by colour banding tape applied at each end and at splices.
.3 Colour coding shall be in accordance with Canadian Electrical Code.
.4 Maintain phase sequence and colour coding throughout each system.

6.8 Name/Number Identification of Wiring:

.1 Identify No. 8 AWG wiring and smaller using one of the following materials:

.1 Heat shrink sleeves, blank.
.2 Clear plastic tape wrap-on strips with white writing section.
.3 Wrap-on strips, pre-numbered.
.4 Slip-on identification bead markers or sleeves, blank or pre-numbered.

.2 Type or print on blank wire identification materials using indelible black ink.

.3 Identify wiring at all pull boxes, junction boxes, and outlet boxes for all systems.

.4 Identify each conductor as to panel and circuit, terminal, terminal numbers, system number scheme, and polarization, as applicable.

END OF SECTION

1 General

Not Used

2 Products

2.1 CONDUIT

.1 EMT:to CSAC22.2 No.83-M1985. Provide rain-tight fittings in weatherproof and damp areas.

.2 Rigid Metal:to CSAC22.2 No.45-M1981.

.3 Flexible Metal Conduit:to CSA C22.2 No. 56-1977.

2.2 WIRE AND CABLE

.1 Building Wiring: to CSAC22.2 No.75-M1983, copper conductor, 600V RW90 X-link insulation. Use in all locations, except for underground wire which shall be RW90 X-Link -400C or TWU75 -400C.

.2 Wire Sizing:according to CEC except where otherwise indicated. Minimum wire size shall be #14 AWG.

.3 Do not use metallic or non-metallic sheathed cables or wire with aluminum conductors, except where otherwise indicated.

.4 Armoured Cable: to CSAC22.2 No.51-95. Use only for final connections to luminaires in lengths not exceeding 1.5m and for runs concealed in metal or wood frame partitions containing only one circuit.

.5 Flexible, jacketed copper conductors.

2.3 BOXES AND FITTINGS

.1 Provide boxes and fittings suitable for intended use and area installed and as follows:

.1 Outlet Boxes:to CSA C22.2No.18-92. Sheet steel, galvanized for concealed boxes and cast metal for surface and weatherproof boxes.
.2 Pull and Junction Boxes:to CSAC22.2No.40-M1989. Sheet steel with screw-on covers and barriers as required.
.3 Bushings, Knockout Closures, and Locknuts:to CSA C22.2No.18-92.

2.4 WIRING DEVICES

.1 Specification grade and as follows:

.2 Switches:to CSAC22.2No.111-M1986, toggle type, 15A, 125V, full load rated, white colour.

.3 Receptacles:to CSAC22.2No.42-M1984, duplex, 15A, 125V, U-ground, white colour.

.4 Cover Plates: Plastic, colour to match device, in finished areas, stamped sheet steel in unfinished areas, and cast or polycarbonate, gasketed, in wet areas.

2.5 DISCONNECTS

.1 Disconnects:to CAN/CSAC22.2No.4-M89, heavy duty, lockable, non-fused, with poles, voltage, amperage, kw ratings and enclosures as indicated on drawings and required by CEC to suit application.

2.6 CABINETS AND ENCLOSURES

.1 Cabinets and Enclosures:to CSAC22.2No.40-M1989, and as follows:

.1 Interior Cabinets:EEMAC-1 sheet steel with hinged cover, flush lock and latch.

.2 Backboards:19mm GIS plywood, as indicated on drawings, painted as specified in Section 09 90 00.

2.7 GROUNDING EQUIPMENT

.1 Grounding Equipment:to CSAC22.2No.41-M1987 and as follows:

.1 Ground Rods:20mmx3m, copper clad steel.
.2 Conductors:copper, stranded, bare or insulated as indicated.
.3 Connectors:thermaweld where underground or exposed to moisture, compression type bolt-on in other locations.

2.8 SUPPORTING DEVICES

.1 Provide metal brackets, frames, clamps, channels, straps and related devices to adequately support weight of equipment and raceways.

3 Execution

3.1 CONDUIT

.1 Except where otherwise indicated, install all wiring in conduit.

.2 Where practicable, install conduit concealed in walls, floors, ceilings above suspended ceilings and underground.

.3 Install conduit parallel or at right angles to building lines; minimize crossovers and conserve space and headroom.

.4 Install underground conduit minimum 1m below finished grade.

.5 Mount conduit on underside of metal roof deck by fastening to bottom of metal flutes.

3.2 BOXES

.1 Install boxes flush where practicable and for vertical mounting of devices. Install to nearest course line in masonry walls.

.2 Except where otherwise indicated, mount boxes at following heights to centreline of device:

.1 Switches:1200mm.
.2 Receptacles in unfinished areas:1200mm.
.3 Receptacles in finished areas:300mm.
.4 Telephone:300mm.

3.3 WIRING DEVICES

.1 Install devices and covers flush and level.

.2 Ensure that outlet boxes are clean prior to installing devices.

3.4 GROUNDING

.1 Ground all metal parts of building structure and mechanical equipment including piping systems.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Supply and installation of groud cover materials:

.1 Sand
.2 Mulch
.3 Boulders

.2 Supply and installation of trees and planting and planting accessories (pots)

1.2 DELIVERY, STORAGE AND HANDLING

.1 Handle plants with reasonable care and skill to prevent injuries to trunk, branches and roots.

.2 Protect plants during shipment and until planted on site, with tarpaulin or other suitable covering to prevent frost damage, excessive drying from sun and wind, and/ or breakage from wind and equipment.

.3 Do not use plants whose soil balls have been cracked or broken prior to or during planting or when burlap ropes required in connection with their transplanting have been removed.

.4 Maintain moisture levels in root zones.

2 Products

2.1 PLANTS - GENERAL

.1 Nursery Grown Plants:

.1 All nursery grown plants shall have been grown in Alberta for a minimum of one growing season.
.2 Plants true to type, structurally sound, well balanced, healthy, vigorous, of normal growth habits, densely foliated and healthy well developed root system.
.3 Plants free of disease, insect infestations, insect eggs, rodent damage, sun scald, frost cracks and other abrasions or scars to bark.

2.2 PLANTS - CHARACTERISTICS

.1 Trees: straight bodied trees according to their habit of growth. Double leaders not acceptable.

.2 Shrubs: natural form, typical of genus, species and variety; minimum of four canes.

.3 Ground Covers: with healthy tops, size proportionate to root requirements, typical of species and variety.

2.3 PLANT MEASUREMENT

.1 Measure trees and shrubs, in centimetres, with branches in their normal positions.

.2 Height and spread dimensions, in centimetres, specified refer to main body of plant.

.3 Caliper size, in millimetres, takes precedence over height. Take calliper measurement 30 cm above ground.

.4 Measure ground cover plants and herbaceous plants by:

.1 Units of plants of specified age
.2 Size of clump
.3 Number, and length of runners in centimetres.

2.4 PLANTS - SOIL BALLS

.1 Container grown plants:

.1 Grown in containers for minimum of three months.
.2 Established root system which will "hold" soil when removed from container.
.3 Container sized in proportion to plant size.
.4 Root bound plants are not acceptable.

.2 Balled and burlapped plants:

.1 Soil balls secured with burlap, heavy twine and rope, or burlap wire baskets and rope.
.2 Protect balls against exposure to elements.
.3 Deliver with firm natural ball of soil and free from pernicious perennial plants and their roots.

2.5 SOIL

.1 Fertile Topsoil: as specified in Section 02920.

.2 Peat Moss: decomposed plant material, fairly elastic and homogeneous, free of decomposed colloidal residue, wood, sulphur and iron. Minimum of 60% organic matter b, pH value between 5.9 and 7.0.

.3 Sand: hard, granular sharp sand to CSA A82.56-M1976, washed, and free of impurities, chemical or organic matter.

.4 Bonemeal: finely ground; chemical analysis: 2-11-0.

2.6 POTS

.1 Standard nursery pots, fired clay or concrete, c/w drain holes.

2.7 WATER

.1 Water: Owner will supply water.

.2 Water shall be potable, free from any harmful chemicals.

2.8 PLANTING MEDIA

.1 Soil mix: 3 parts fertile topsoil; 1 part horticultural peat moss; 1 part sharp sand; bonemeal - 0.6 kg/m3 soil mix.

2.9 PLANT ACCESSORIES

.1 Mulch: shredded coniferous tree mulch.

.2 Sand: course sand, to City of Calgary standard.

.3 Boulders: Granite, 8" to 15" rough diameter.

3 Execution

3.1 PREPARATION

.1 Locate and stake locations of electrical services, utility lines, irrigation lines and other underground obstructions.

.2 If underground services interfere with plan, notify Consultant, stop work and await further instructions.

.3 Stake out locations of trees and planting beds. All locations shall then be verified by the Consultant prior to planting.

.4 Protect bench marks and hubs which form part of legal site survey.

.5 Ensure plant material is acceptable to the Consultant.

.6 Remove damaged roots and branches from plant material.

.7 Apply anti-desiccant to conifers and deciduous trees in leaf in accordance with manufacturer's instructions.

3.2 PREPARATION OF PLANT BEDS AND PITS

.1 Shrub Beds: excavate minimum of 450 mm deep.

.2 Trees and Specimen Shrubs: excavate plant pits large enough for soil ball and 150 mm around and beneath soil ball.

.3 Place soil in planting beds to establish elevations. Slope grade away from building.

3.3 PLANTING

.1 Loosen soil at bottom of pit to depth of 150 mm prior to placing soil. Cover bottom of each excavation with minimum of 150 mm of soil.

.2 Place plants at same depth they were originally grown. Face for best appearance.

.3 Measure minimum depth of plant pit from downward side of slope when planting on incline.

.4 Remove non-degradable containers and keep soil ball intact while placing plant in pit.

.5 Balled and burlapped plants:

.1 Keep burlap and twine intact while placing plant in pit.
.2 Backfill around ball in layers of 150 mm and tamp to eliminate air voids.
.3 When 75% of soil has been placed, fill hole with water.
.4 After water has completely penetrated soil, cut and fold burlap before placing final layer of soil.

.6 Complete backfilling to build 100 mm high soil lip around outer edge of plant pit. Fill with water and allow it to be absorbed.

.7 Do not install any plants, except ground covers, vines and herbaceous plants, closer than 750 mm to edge of walkways, driveways or building foundations.

.8 Support trees immediately after installation.

3.4 STAKING TREES

.1 Use single stake support for deciduous trees less than 3 m in height and evergreens less than 2 m.

.2 Place stake on prevailing wind side 150 mm from trunk.

.3 Drive stake 150 mm into undisturbed soil beneath roots. Ensure stake is secure and vertical.

.4 Install Type 1 guy wire with 150 mm long bark protector 1500 mm above grade and secure to stake.

.5 Cut off excess wire.

3.5 PRUNING

.1 Limit pruning to minimum required to remove dead or injured branches, stray branches, double leaders and to compensate for loss of roots as a result of transplanting.

.2 Use clean, sharp tools; make cut clean and flush, leaving no stubs. Remove cuts, bruises or scars on bark to living tissue on all edges; shape so as not to retain water.

.3 Do not cutback main leader of tree.

3.6 MULCH

.1 Ensure soil settlement has been corrected prior to mulching.

.2 Spread mulch in shrub beds and as noted on the drawings. Apply 75mm deep. Keep material 50mm away from trunks and stems to prevent rotting of bark.

3.7 MAINTENANCE

.1 Regularly maintain plants for one (1) year from completion and acceptance of installation of work of this Section.

.2 Maintenance program:

.1 Cultivate plant pits and beds, keep free of weeds.
.2 Supply labour, all hoses and attachments necessary to provide adequate watering.
.3 Water plants weekly; apply sufficient water to saturate root zone.
.4 Water evergreen plant material thoroughly in late fall prior to freeze up to saturate soil around root system.
.5 Maintain plant accessories in proper condition, including tree ties, stakes, guys and soil lips.
.6 Control disease and insects. Where possible use physical methods to eliminate cause of insect infestation. If chemical treatment is necessary apply in accordance with manufacturer's recommendations and government regulations.
.7 Remove and replace dead plants and plants in unhealthy condition. Make replacement in some manner as specified for original plantings.

3.8 ACCEPTANCE

.1 Plant material will be accepted six (6) weeks after date of substantial completion provided that plant material exhibits healthy growing condition and is free from disease, insects and fungal organisms.

.2 Plant material installed after August 1st will be accepted the following spring, six (6) weeks after start of growing season provided that acceptance conditions are met.

3.9 CLEAN-UP

.1 Broom clean pavement and sidewalks on daily basis.

.2 Clear soil and rubble from underground or surface storm sewer lids.

.3 Remove excess materials from site.

.4 Leave site in neat condition.

END OF SECTION

1 General

1.1 REGULATORY REQUIREMENTS

.1 Ion Exchange Purification Equipment shall be approved by the authority having jurisdiction.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Ship ion exchange purification equipment and accessories in original, unopened cartons and ensure they are not damaged during shipping or storage.

1.3 SUBMITTALS

.1 Submit 2 copies of equipment Owning and Operating Manuals to Owner.

2 Products

2.1 EQUIPMENT

.1 Ion Exchange Purification Equipment: Manufacturer: LiquiTech, model # QL TF4-/3.

3 Execution

3.1 INSTALLATION

.1 Comply with manufacturer's installation instructions and plumbing codes.

END OF SECTION

cascade engineering group

25 YEARS

May 30, 2009
Project No. 09-137

STRUCTURAL CALCLULATIONS SUMMARY

SOLAR DECATHLON HOUSE

Location: **Washington DC (temporary), Calgary Alberta (permanent)**

For: Alberta Solar Decathlon
University of Calgary
c/o ISEEE, room: ES1040
2500 University Dr NW
Calgary, AB T2N 1N4

SCOPE OF WORK
- Structural design for house structure
- Review and coordination of pre-engineered structural systems

APPLICABLE CODES
- Alberta Building Code 2006
- United States (IBC and IRC)
- Solar Decathlon Building Code
- Engineering Design in Wood CAN/CSA-086-01/ NDS

CONTENTS:

Pages	Content
1-5	Load calculations
6-24	Member design calculations
25-27	Point load calculation
28-31	Temporary house footing size calculation
32	Lateral design
33	Temporary deck footing size calculation
34-39	SIP design calculations
40-57	Guardrail manufacturers specifications and test report
58	Solar panel anchorage calculation
59	Guardrail base connection calculation
60	Stair thread calculation

Project Engineer:
Robin Zirnhelt, EIT

Reviewed by:
Reid Costley, PEng.

PROFESSIONAL ENGINEER THOMAS REID COSTLEY ALBERTA
Permit # 7957
May 30, 2009

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S:\Projects\2009\09-137 Solar Decathlon House\Reports\CALCULATION COVER.docx

Structural Calculations

Project: Solar Decathlon House **Project #:** 09-137

By: RZ **Date:** March 4/09

DESIGN LOADS: 2009 SOLAR DECATHLON CODE SECTION 5-2.

a) -WIND:- 60mph (28.8m/s) (3-second gust)
- exposure C
- hold-down not required if FOS > 2 for overturning.

b) RAILINGS:
- 200 lb concentrated load @ top of rail.

c) FLOORS/DECKS/RAMPS
- Live Load: LL = 50psf (2.39 kPa)
- 100 psf for egress

d) Roof: - 20 psf live Load.

e) Soil: 1500 psf (71.8 KPa) allowable bearing

DESIGN LOADS: ABC 2006 (Alberta Building Code)

- Location: Calgary, Alberta
- Roof Loads:
  Snow: $S_s = 1.1$ KPa
  $S_r = 0.1$ KPa
  Min Roof Live = 1.0 KPa (~21 psf)
- WIND:
  - 1/50 yr hourly wind pressure = 0.50 KPa
- SEISMIC:
  $S_a(0.2) = 0.15$

ADDITIONAL STRUCTURAL REQUIREMENTS: ABC 2006 10.2.2.2
- WIND min for relocatable structures = 0.7 KPa (14.7psf)
  - For use in transportation design.

Project: Solar Decathalon House Project #: 09-137

By: RZ Date: March 4/09.

WIND ANALYSIS TO IBC / ASCE-7

- Building Partially open by ASCE-7 Sec 6.2

CL. 6.5.12.2.2 Low Rise

$$p = q\,[(GC_{pf}) - (GC_{pi})]$$

$$q_z = 0.613\,K_z\,K_{zt}\,K_d\,V^2 I \quad (V \text{ in } m/s)$$
$$= 0.613\,(0.9)(1)(0.85)(26)^2(1.0) \div 1000\ \frac{N/m^2}{KPa}$$
$$= .317\ KPa \approx 6.7\ psf.\ (\text{use } 7$$

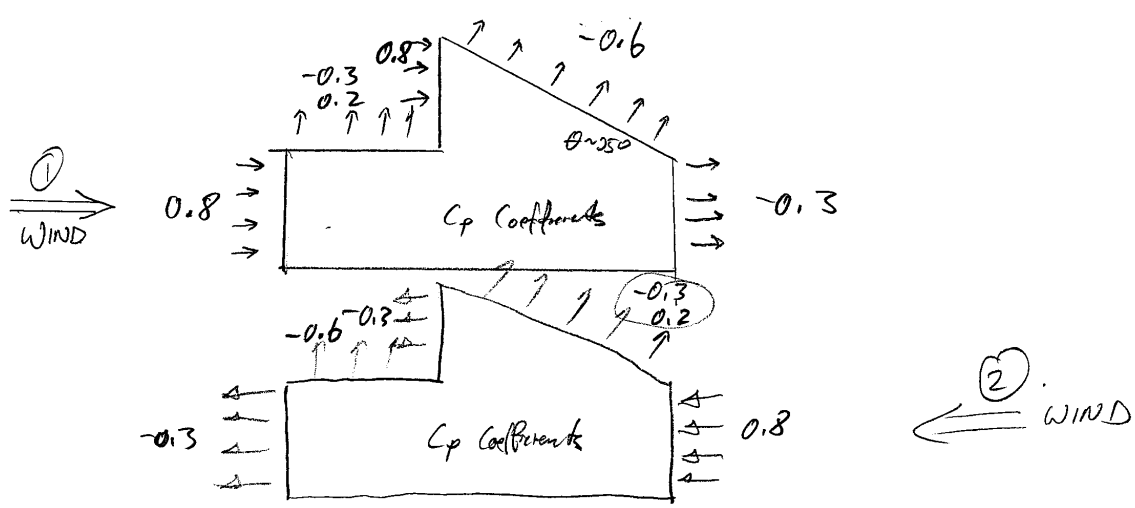
$$p = 0.317\,KPa\,(GC_{pf} - GC_{pi})$$

See Figure 6-6 ASCE-7

- Monoslope Roof
- Enclosed / Partially Enclosed Structures

$GC_{pi} = \pm 0.55$ (Fig 6.5) $h/L \approx 0.75$, $L/B \approx 2$

- Assume $G = 2$.



cascadeengineeringgroup

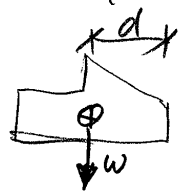
Project: Solar Decathlon House **Project #:** 09-137

By: RZ **Date:** March 5/09

- Calculate Overturning + Siding Loads + Resistances

- Estimate total weight of building (floor system up):

SIP Floor	10 psf	× 770 sqft	=	7700
Main level ext walls	12 psf	× 8' × 128' perimiter	=	12288
Main level int walls	12 psf	× 8' × 41' length	=	3280
Roof/upper Deck (incl. parts	= 15 psf	× 770 sqft	=	11550
				34,818 lbs.



$d \sim 10'$ Overturning Resistance:

$M_r = 34{,}818 \times 10$

$= 340$ kip-ft.

- Calculate overturning moment due to wind:
  - assume wind direction ① governs by inspection:

		Wind Load	Lever	Overturn.
Windward: (low)	7psf (2)(0.8) × 8' × 38'	= 3404 lbs	4'	= 13616
(upper)	7psf (2)(0.8)(6.7)(14.5' × 17.5')	= 2401	× 11'	= 26414
Deck:	7psf (2)(0.3)(4.7')(14.5' + 17.5')	= 632	× 15'	= 9475
Leeward Roof:	7psf (2)(0.6)(17')(14.5' + 17.5')	= 4569	× 14'	= 63974
Leeward Wall:	7psf (2)(0.3)(8' × 38')	= 1276	× 4'	= 5107
	total siding =	12,282	total overturn =	118 kip

Overturning F.O.S. $= \frac{340}{118} = 2.88$ ∴ no overturning hold-down required

Project: Solar Decathlon House Project #: 09-137

By: RZ Date: March 5/09

Calculate Sliding Resistance:

- Assume $\mu = 0.4$ for wood footings on ground

$\mu F_g = 0.4(34,800 \text{ lbs}) = 13,920 \text{ lbs}$

sliding force $= 12,282$ $\therefore$ FOS $= \frac{13920}{12282} = 1.13$

this low FOS. acceptable due to low consequence of sliding building.

- further, this calc is likely conservative, as the footings will likely be dug flat and will provide additional lateral resistance from bearing on the side-cut.

G Co-efficient also assumed high for conservative design.

Project: Solar Decathlon House Project #: 09-137

By: RZ Date: March 7/09.

LATERAL LOAD DESIGN TO ABC 2006

Seismic: from experience seismic loads won't govern design of major lateral load resisting system (LLRS) - Design for wind Loads.

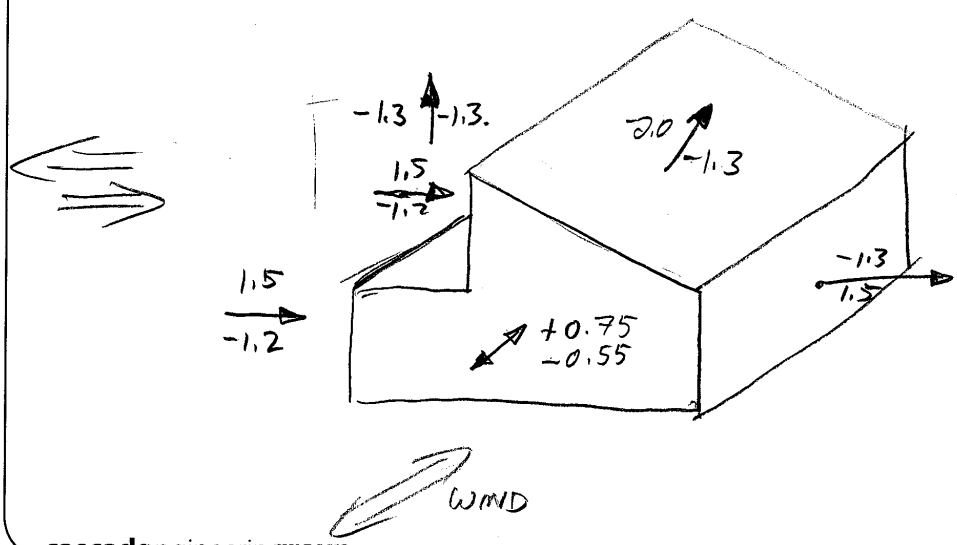
Wind: Loads for Calgary, Alberta to ABC will govern design of LLRS. Design to ABC and structure will be sufficient for SD loads.

$q_{50} = 0.50\,KPa \approx 10.5\,psf$

$p = p_e + p_i = I_w q C_e (C_g C_p + C_{gi} C_{pi})$

$= 1.0(0.5)(0.7)(C_p C_g + 2.0(0.15))$

$C_p C_g$ to NBC Commentary Fig I-7.



WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 26, 2009 08:06	Attic joists.wwb

Design Check Calculation Sheet

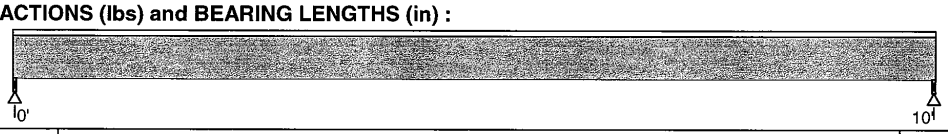
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [ft] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				10.00	(24.0)*	psf
Load2	Live	Full Area				20.00	(24.0)*	psf

*Tributary Width (in)

MAXIMUM REACTIONS (lbs) and BEARING LENGTHS (in) :



Unfactored:			
Dead	107		107
Live	200		200
Factored:			
Total	434		434
Bearing:			
Load Comb	#2		#2
Length	0.50*		0.50*
KB	1.00		1.00
Kd	1.00		1.00

*Min. bearing length for joists is 1/2" for exterior supports

Lumber, S-P-F, No.1/No.2, 2x6"

Floor joist spaced at 24" c/c; Self-weight of 1.49 plf included in loads;
Load sharing: case 2; Lateral support: top= full, bottom= at supports;

Force vs. Resistance (lbs) and Deflection (in) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 394	Vr = 2110	Vf/Vr = 0.19
Moment(+)	Mf = 1086	Mr = 1906	Mf/Mr = 0.57
Perm. Defl'n	0.17 = L/717	0.33 = L/360	0.50
Live Defl'n	0.31 = L/385	0.33 = L/360	0.93
Total Defl'n	0.48 = L/250	0.67 = L/180	0.72

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	218	1.00	1.40	1.400	-	1.00	1.00	-	#2
Fb+	1711	1.00	1.40	1.400	1.000	1.00	1.00	-	#2
Fcp	769	-	-	1.000	-	1.00	1.00	-	#-
Es	1.4 million		-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 29e06 lb-in2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. JOISTS: unless otherwise noted, sawn lumber joists require lateral bracing as follows:
a) restraint against lateral displacement and rotation at points of bearing. b) compression edges held in line by sheathing.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:49	BUILTU~1.WWC

Design Check Calculation Sheet

Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Axial		(Ecc. = 0 mm)		3.00		kN
Load2	Live	Axial		(Ecc. = 0 mm)		6.00		kN

MAXIMUM REACTIONS (kN):

Built-up, S-P-F, No.1/No.2, 38x140 mm, 2-Plys

Self-weight of 0.044 kN/m included in loads;

Pinned base; Loadface = width(b); Built-up fastener: nails; Load sharing: case 1; Ke x Lb: 1.00 x 2.40= 2.40 [m]; Ke x Ld: 1.00 x 2.40= 2.40 [m];

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Axial	Pf = 12.88	Pr = 24.88	Pf/Pr = 0.52

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	Kc	KL	KT	KS	LC#
Fc	11.5	1.00	1.00	1.300	0.326	-	1.00	1.00	#2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BUILT-UP COLUMNS: built-up rectangular compression members shall consist of 2 to 5 individual members of at least 38mm(2in. nominal) thickness joined with bolts, nails or bolts and split ring connectors.

The minimum values of end distance, edge distance and spacing for fasteners must conform to Clause 10 of CSA-O86.

- Spacing of nails along the member shall not exceed 6 times the thickness of the thinnest piece and spacing perpendicular to the member length shall not exceed 20 times the nail diameter.
- All nails shall penetrate through at least 3/4 of the thickness of the last individual piece and nails shall be driven alternately from either face of the built-up member along the length
- When individual pieces of the built-up member are wider than 3 times their thickness, there shall be at least 2 rows of nails across the member width.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:49	DB1(#1).wwb

Design Check Calculation Sheet

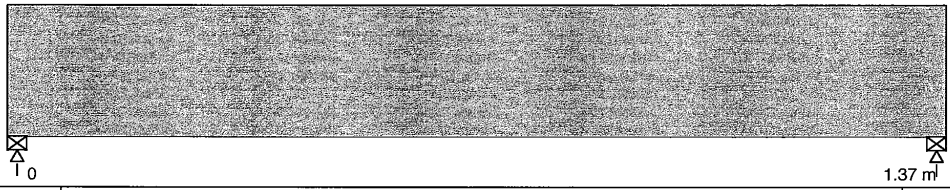
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				0.72 (1.65)*		kN/m2
Load2	Live	Full Area				4.80 (1.65)*		kN/m2

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	0.85		0.85
Live	5.41		5.41
Factored:			
Total	9.18		9.18
Bearing:			
Load Comb	#2		#2
Length	28		28
KB	1.00		1.00
Kd	1.00		1.00

Built-up, S-P-F, No.1/No.2, 38x191 mm, 2-Plys

Self-weight of 0.06 kN/m included in loads;
Load sharing: case 1; Lateral support: top= at supports, bottom= at supports;

WARNING: this CUSTOM SIZE is not in the database. Refer to online help.

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 6.61	Vr = 17.25	Vf/Vr = 0.38
Moment(+)	Mf = 3.13	Mr = 6.48	Mf/Mr = 0.48
Perm. Defl'n	0.1 = <L/999	3.8 = L/360	0.04
Live Defl'n	0.9 = <L/999	3.8 = L/360	0.23
Total Defl'n	1.0 = <L/999	7.6 = L/180	0.13

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.10	1.200	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.10	1.200	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

```
    EI =    419e06 kN-mm2/ply
```

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BEAMS require restraint against lateral displacement and rotation at points of bearing
4. BUILT-UP BEAMS: it is assumed that each ply is a single continuous member (that is, no butt joints are present) fastened together securely at intervals not exceeding 4 times the depth and that
each ply is equally top-loaded. Where beams are side-loaded, special fastening details may be required.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:49	DB1(#2).wwb

Design Check Calculation Sheet

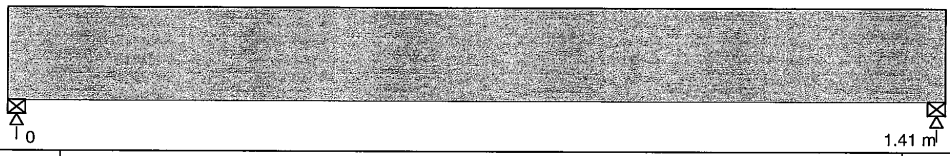
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				0.72 (1.55)*		kN/m2
Load2	Live	Full Area				4.80 (1.55)*		kN/m2

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	0.82		0.82
Live	5.25		5.25
Factored:			
Total	8.90		8.90
Bearing:			
Load Comb	#2		#2
Length	28		28
KB	1.00		1.00
Kd	1.00		1.00

Built-up, S-P-F, No.1/No.2, 38x140 mm, 2-Plys

Self-weight of 0.044 kN/m included in loads;
Load sharing: case 1; Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 7.13	Vr = 14.75	Vf/Vr = 0.48
Moment(+)	Mf = 3.14	Mr = 4.06	Mf/Mr = 0.77
Perm. Defl'n	0.4 = <L/999	3.9 = L/360	0.09
Live Defl'n	2.3 = L/609	3.9 = L/360	0.59
Total Defl'n	2.7 = L/527	7.8 = L/180	0.34

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.10	1.400	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.10	1.400	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 83e06 kN-mm2/ply

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BEAMS require restraint against lateral displacement and rotation at points of bearing
4. BUILT-UP BEAMS: it is assumed that each ply is a single continuous member (that is, no butt joints are present) fastened together securely at intervals not exceeding 4 times the depth and that
each ply is equally top-loaded. Where beams are side-loaded, special fastening details may be required.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:50	DB2(#1).wwb

Design Check Calculation Sheet

Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				0.72 (0.83)*		kN/m2
Load2	Live	Full Area				4.80 (0.83)*		kN/m2

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :

Unfactored:			
Dead	0.89		0.89
Live	5.41		5.41
Factored:			
Total	9.23		9.23
Bearing:			
Load Comb	#2		#2
Length	29		29
KB	1.00		1.00
Kd	1.00		1.00

Built-up, S-P-F, No.1/No.2, 38x191 mm, 2-Plys

Self-weight of 0.06 kN/m included in loads;
Load sharing: case 1; Lateral support: top= at supports, bottom= at supports;

WARNING: this CUSTOM SIZE is not in the database. Refer to online help.

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 7.94	Vr = 17.25	Vf/Vr = 0.46
Moment(+)	Mf = 6.29	Mr = 6.48	Mf/Mr = 0.97
Perm. Defl'n	1.1 = <L/999	7.6 = L/360	0.15
Live Defl'n	6.8 = L/400	7.6 = L/360	0.90
Total Defl'n	7.9 = L/343	15.2 = L/180	0.52

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.10	1.200	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.10	1.200	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 419e06 kN-mm2/ply

11

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:50	DB3(#2).wwb

Design Check Calculation Sheet

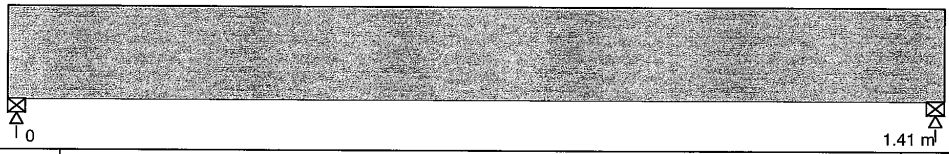
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				0.72 (1.55)*		kN/m2
Load2	Live	Full Area				4.80 (1.55)*		kN/m2

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	0.82		0.82
Live	5.25		5.25
Factored:			
Total	8.90		8.90
Bearing:			
Load Comb	#2		#2
Length	28		28
KB	1.00		1.00
Kd	1.00		1.00

Built-up, S-P-F, No.1/No.2, 38x140 mm, 2-Plys

Self-weight of 0.044 kN/m included in loads;
Load sharing: case 1; Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 7.13	Vr = 14.75	Vf/Vr = 0.48
Moment(+)	Mf = 3.14	Mr = 4.06	Mf/Mr = 0.77
Perm. Defl'n	0.4 = <L/999	3.9 = L/360	0.09
Live Defl'n	2.3 = L/609	3.9 = L/360	0.59
Total Defl'n	2.7 = L/527	7.8 = L/180	0.34

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.10	1.400	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.10	1.400	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

```
    EI =      83e06 kN-mm2/ply
```

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BEAMS require restraint against lateral displacement and rotation at points of bearing
4. BUILT-UP BEAMS: it is assumed that each ply is a single continuous member (that is, no butt joints are present) fastened together securely at intervals not exceeding 4 times the depth and that
each ply is equally top-loaded. Where beams are side-loaded, special fastening details may be required.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:50	DB4(#1).wwb

Design Check Calculation Sheet

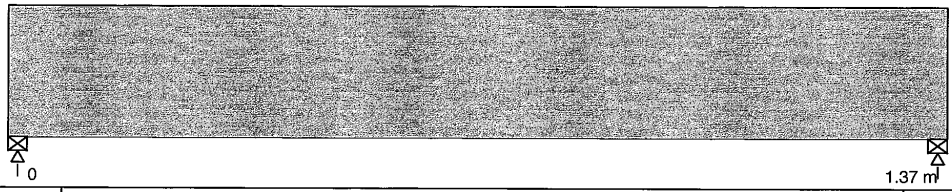
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				0.72 (1.65)*		kN/m2
Load2	Live	Full Area				4.80 (1.65)*		kN/m2

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	0.85		0.85
Live	5.41		5.41
Factored:			
Total	9.18		9.18
Bearing:			
Load Comb	#2		#2
Length	28		28
KB	1.00		1.00
Kd	1.00		1.00

Built-up, S-P-F, No.1/No.2, 38x191 mm, 2-Plys

Self-weight of 0.06 kN/m included in loads;
Load sharing: case 1; Lateral support: top= at supports, bottom= at supports;

WARNING: this CUSTOM SIZE is not in the database. Refer to online help.

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 6.61	Vr = 17.25	Vf/Vr = 0.38
Moment(+)	Mf = 3.13	Mr = 6.48	Mf/Mr = 0.48
Perm. Defl'n	0.1 = <L/999	3.8 = L/360	0.04
Live Defl'n	0.9 = <L/999	3.8 = L/360	0.23
Total Defl'n	1.0 = <L/999	7.6 = L/180	0.13

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.10	1.200	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.10	1.200	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 419e06 kN-mm2/ply

13

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:50	JOIST#1.wwb

Design Check Calculation Sheet

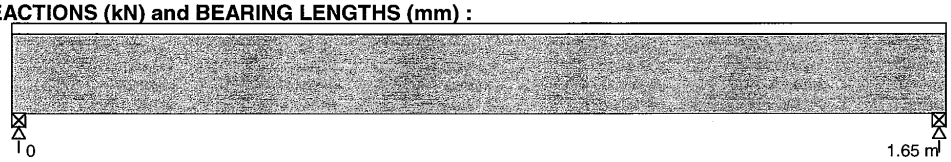
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
d	Dead	Full Area				0.72	(600)*	kN/m2
L	Live	Full Area				4.80	(600)*	kN/m2

*Tributary Width (mm)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	0.37		0.37
Live	2.38		2.38
Factored:			
Total	4.03		4.03
Bearing:			
Load Comb	#2		#2
Length	25		25
KB	1.00		1.00
Kd	1.00		1.00

Lumber, S-P-F, No.1/No.2, 38x140 mm

Floor joist spaced at 600 mm c/c; Self-weight of 0.022 kN/m included in loads;
Load sharing: case 2; Lateral support: top= full, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 3.35	Vr = 9.38	Vf/Vr = 0.36
Moment(+)	Mf = 1.67	Mr = 2.58	Mf/Mr = 0.64
Perm. Defl'n	0.5 = <L/999	4.6 = L/360	0.12
Live Defl'n	3.4 = L/491	4.6 = L/360	0.73
Total Defl'n	3.9 = L/424	9.2 = L/180	0.42

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.40	1.400	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.40	1.400	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 83e06 kN-mm2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. JOISTS: unless otherwise noted, sawn lumber joists require lateral bracing as follows:
a) restraint against lateral displacement and rotation at points of bearing. b) compression edges held in line by sheathing.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:50	JOIST#2.wwb

Design Check Calculation Sheet

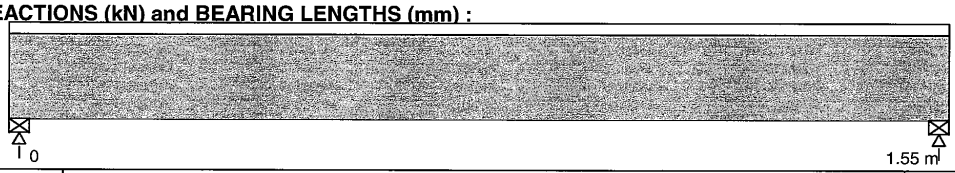
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
D	Dead	Full Area				0.72	(600)*	kN/m2
L	Dead	Full Area				4.80	(600)*	kN/m2

*Tributary Width (mm)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored: Dead	2.59		2.59
Factored: Total	3.63		3.63
Bearing: Load Comb	#1		#1
Length	35		35
KB	1.00		1.00
Kd	0.65		0.65

Lumber, S-P-F, No.1/No.2, 38x140 mm

Floor joist spaced at 600 mm c/c; Self-weight of 0.022 kN/m included in loads;
Load sharing: case 2; Lateral support: top= full, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 2.98	Vr = 6.10	Vf/Vr = 0.49
Moment(+)	Mf = 1.41	Mr = 1.68	Mf/Mr = 0.84
Perm. Defl'n	3.1 = L/508	4.3 = L/360	0.71
Live Defl'n	negligible		
Total Defl'n	3.1 = L/508	8.6 = L/180	0.35

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	0.65	1.40	1.400	-	1.00	1.00	-	#1
Fb+	11.8	0.65	1.40	1.400	1.000	1.00	1.00	-	#1
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#1

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #1  = 1.4D only
 Moment(+)  : LC #1  = 1.4D only
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #0  = Self-weight  (live)
             LC #1  = 1.0D only  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 83e06 kN-mm2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. JOISTS: unless otherwise noted, sawn lumber joists require lateral bracing as follows:
a) restraint against lateral displacement and rotation at points of bearing. b) compression edges held in line by sheathing.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:50	JOIST#3.wwb

Design Check Calculation Sheet

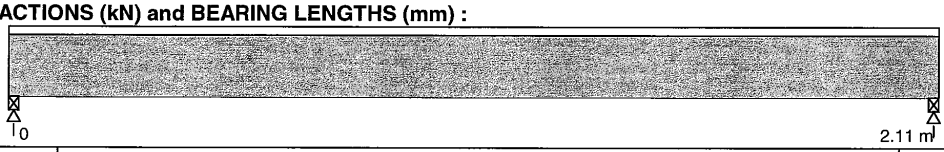
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				0.72	(300)*	kN/m2
Load2	Dead	Full Area				4.80	(300)*	kN/m2

*Tributary Width (mm)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored: Dead	1.77		1.77
Factored: Total	2.48		2.48
Bearing: Load Comb	#1		#1
Length	24		24
KB	1.00		1.00
Kd	0.65		0.65

Lumber, S-P-F, No.1/No.2, 38x140 mm

Floor joist spaced at 300 mm c/c; Self-weight of 0.022 kN/m included in loads;
Load sharing: case 2; Lateral support: top= full, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 2.15	Vr = 6.10	Vf/Vr = 0.35
Moment(+)	Mf = 1.31	Mr = 1.68	Mf/Mr = 0.78
Perm. Defl'n	5.2 = L/405	5.9 = L/360	0.89
Live Defl'n	negligible		
Total Defl'n	5.2 = L/405	11.7 = L/180	0.44

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	0.65	1.40	1.400	-	1.00	1.00	-	#1
Fb+	11.8	0.65	1.40	1.400	1.000	1.00	1.00	-	#1
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#1

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #1  = 1.4D only
 Moment(+)  : LC #1  = 1.4D only
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #0  = Self-weight  (live)
             LC #1  = 1.0D only  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 83e06 kN-mm2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. JOISTS: unless otherwise noted, sawn lumber joists require lateral bracing as follows:
a) restraint against lateral displacement and rotation at points of bearing. b) compression edges held in line by sheathing.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:51	ROOFBE~1.WWB

Design Check Calculation Sheet

Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				1.00	(1.00)*	kN/m2
Load2	Live	Full Area				1.92	(1.00)*	kN/m2

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :

Unfactored:			
Dead	1.26		1.26
Live	2.34		2.34
Factored:			
Total	5.09		5.09
Bearing:			
Load Comb	#2		#2
Length	32		32
KB	1.00		1.00
Kd	1.00		1.00

Built-up, S-P-F, No.1/No.2, 38x235 mm, 1-ply

Self-weight of 0.037 kN/m included in loads;
Load sharing: case 1; Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 4.11	Vr = 8.84	Vf/Vr = 0.46
Moment(+)	Mf = 3.10	Mr = 4.09	Mf/Mr = 0.76
Perm. Defl'n	1.2 = <L/999	6.8 = L/360	0.18
Live Defl'n	2.3 = <L/999	6.8 = L/360	0.33
Total Defl'n	3.5 = L/699	13.5 = L/180	0.26

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.00	1.100	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.00	1.100	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 390e06 kN-mm2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BEAMS require restraint against lateral displacement and rotation at points of bearing
4. This beam requires compression edge to be fastened to decking or to joists spaced no more than 610mm (24in.) apart.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:51	ROOFBE~2.WWB

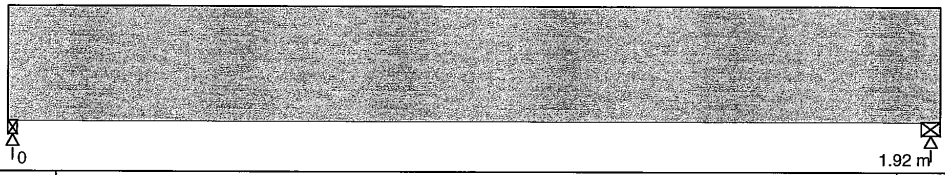
Design Check Calculation Sheet

Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Point		1.28		2.33		kN
Load2	Live	Point		1.28		4.48		kN

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	0.80		1.60
Live	1.49		3.00
Factored:			
Total	3.23		6.49
Bearing:			
Load Comb	#2		#2
Length	20		40
KB	1.00		1.00
Kd	1.00		1.00

Built-up, S-P-F, No.1/No.2, 38x235 mm, 1-ply

Self-weight of 0.037 kN/m included in loads;
Load sharing: case 1; Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 6.48	Vr = 8.84	Vf/Vr = 0.73
Moment(+)	Mf = 4.10	Mr = 4.09	Mf/Mr = 1.00
Perm. Defl'n	0.8 = <L/999	5.3 = L/360	0.14
Live Defl'n	1.4 = <L/999	5.3 = L/360	0.27
Total Defl'n	2.2 = L/877	10.6 = L/180	0.21

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.00	1.100	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.00	1.100	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

```
    EI =    390e06 kN-mm2
```

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BEAMS require restraint against lateral displacement and rotation at points of bearing
4. This beam requires compression edge to be fastened to decking or to joists spaced no more than 610mm (24in.) apart.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:51	ROOFBE~3.WWB

Design Check Calculation Sheet

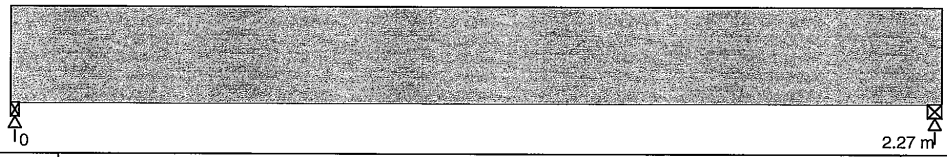
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Point		1.96		0.77		kN
Load2	Live	Point		1.96		1.48		kN
Load3	Dead	Full Area				1.00	(0.64)*	kN/m2
Load4	Live	Full Area				1.92	(0.64)*	kN/m2

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	0.87		1.43
Live	1.59		2.67
Factored:			
Total	3.47		5.80
Bearing:			
Load Comb	#2		#2
Length	22		36
KB	1.00		1.00
Kd	1.00		1.00

Built-up, S-P-F, No.1/No.2, 38x235 mm, 1-ply

Self-weight of 0.037 kN/m included in loads;
Load sharing: case 1; Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 5.17	Vr = 8.84	Vf/Vr = 0.58
Moment(+)	Mf = 2.24	Mr = 4.09	Mf/Mr = 0.55
Perm. Defl'n	0.8 = <L/999	6.3 = L/360	0.12
Live Defl'n	1.4 = <L/999	6.3 = L/360	0.23
Total Defl'n	2.2 = <L/999	12.6 = L/180	0.18

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.00	1.100	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.00	1.100	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 390e06 kN-mm2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BEAMS require restraint against lateral displacement and rotation at points of bearing
4. This beam requires compression edge to be fastened to decking or to joists spaced no more than 610mm (24in.) apart.

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:52	ROOFBE~4.WWB

Design Check Calculation Sheet

Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Point		0.32		1.56		kN
Load2	Live	Point		0.32		3.00		kN
Load3	Dead	Full Area				1.00	(0.35)*	kN/m2
Load4	Live	Full Area				1.92	(0.35)*	kN/m2
Load5	Live	Point		2.75		3.00		kN
Load6	Dead	Point		2.75		1.56		kN

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :

Unfactored:			
Dead	2.19		2.20
Live	4.02		4.03
Factored:			
Total	8.77		8.80
Bearing:			
Load Comb	#2		#2
Length	18		18
KB	1.00		1.00
Kd	1.00		1.00

Built-up, S-P-F, No.1/No.2, 38x140 mm, 3-Plys

Self-weight of 0.065 kN/m included in loads;
Load sharing: case 1; Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 8.59	Vr = 22.12	Vf/Vr = 0.39
Moment(+)	Mf = 3.81	Mr = 6.09	Mf/Mr = 0.63
Perm. Defl'n	4.2 = L/731	8.5 = L/360	0.49
Live Defl'n	7.4 = L/412	8.5 = L/360	0.87
Total Defl'n	11.6 = L/263	17.0 = L/180	0.68

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.10	1.400	-	1.00	1.00	-	#2
Fb+	11.8	1.00	1.10	1.400	1.000	1.00	1.00	-	#2
Fcp	5.3	-	-	1.000	-	1.00	1.00	-	#-
Es	9500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 83e06 kN-mm2/ply

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:52	RO0A8C~1.WWB

Design Check Calculation Sheet

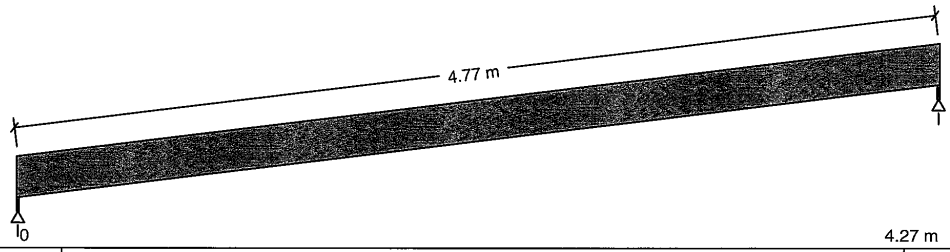
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				0.72 (1.37)*		kN/m2
Load2	Live	Full Area				1.92 (1.37)*		kN/m2

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	2.71		2.71
Live	5.62		5.62
Factored:			
Total	11.82		11.82
Bearing:			
F'theta	11		11
Load Comb	#2		#2
Length	13*		13*
KB	1.00		1.00
Kd	1.00		1.00

*Min. bearing length for beams is 13 mm for exterior supports

Timber, D.Fir-L, SS, 191x191 mm

Pitch: 6.0/12; Total length: 4.77 m; Self-weight of 0.175 kN/m included in loads;
Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 9.78	Vr = 42.68	Vf/Vr = 0.23
Moment(+)	Mf = 12.69	Mr = 24.86	Mf/Mr = 0.51
Perm. Defl'n	5.3 = L/904	13.3 = L/360	0.40
Live Defl'n	10.7 = L/446	13.3 = L/360	0.81
Total Defl'n	16.0 = L/298	26.5 = L/180	0.60

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.00	1.300	-	1.00	1.00	-	#2
Fb+	18.3	1.00	1.00	1.300	1.000	1.00	1.00	-	#2
Fcp	7.0	-	-	1.000	-	1.00	1.00	-	#-
Es	12000	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 1331e06 kN-mm2

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:52	RO1A8C~1.WWB

Design Check Calculation Sheet

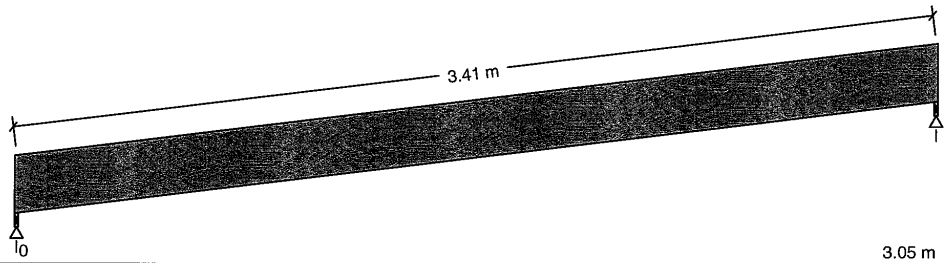
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				0.72 (1.07)*		kN/m2
Load2	Live	Full Area				1.92 (1.07)*		kN/m2

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	1.58		1.58
Live	3.13		3.13
Factored:			
Total	6.67		6.67
Bearing:			
F'theta	10		10
Load Comb	#2		#2
Length	13*		13*
KB	1.00		1.00
Kd	1.00		1.00

*Min. bearing length for beams is 13 mm for exterior supports

Timber, D.Fir-L, No.1, 191x191 mm

Pitch: 6.0/12; Total length: 3.41 m; Self-weight of 0.175 kN/m included in loads;
Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 5.33	Vr = 42.68	Vf/Vr = 0.12
Moment(+)	Mf = 5.12	Mr = 18.75	Mf/Mr = 0.27
Perm. Defl'n	1.3 = <L/999	9.5 = L/360	0.13
Live Defl'n	2.5 = <L/999	9.5 = L/360	0.26
Total Defl'n	3.8 = L/906	18.9 = L/180	0.20

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.00	1.300	-	1.00	1.00	-	#2
Fb+	13.8	1.00	1.00	1.300	1.000	1.00	1.00	-	#2
Fcp	7.0	-	-	1.000	-	1.00	1.00	-	#-
Es	10500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 1165e06 kN-mm2

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:52	RO88EF~1.WWB

Design Check Calculation Sheet

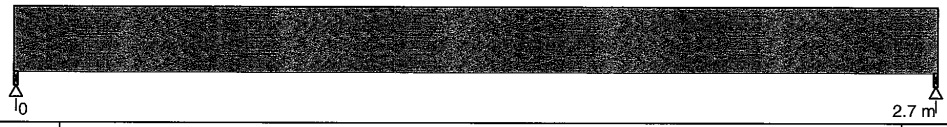
Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				1.00 (0.76)*		kN/m2
Load2	Live	Full Area				1.92 (0.76)*		kN/m2
Load3	Live	Point		1.35		6.15		kN
Load4	Dead	Point		1.35		3.20		kN

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :



Unfactored:			
Dead	2.86		2.86
Live	5.04		5.04
Factored:			
Total	11.15		11.15
Bearing:			
Load Comb	#2		#2
Length	13*		13*
KB	1.00		1.00
Kd	1.00		1.00

*Min. bearing length for beams is 13 mm for exterior supports

Timber, D.Fir-L, No.1, 191x191 mm

Self-weight of 0.175 kN/m included in loads;
Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 10.50	Vr = 42.68	Vf/Vr = 0.25
Moment(+)	Mf = 11.99	Mr = 18.75	Mf/Mr = 0.64
Perm. Defl'n	1.7 = <L/999	7.5 = L/360	0.22
Live Defl'n	3.0 = L/890	7.5 = L/360	0.40
Total Defl'n	4.7 = L/572	15.0 = L/180	0.31

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.00	1.300	-	1.00	1.00	-	#2
Fb+	13.8	1.00	1.00	1.300	1.000	1.00	1.00	-	#2
Fcp	7.0	-	-	1.000	-	1.00	1.00	-	#-
Es	10500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 1165e06 kN-mm2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BEAMS require restraint against lateral displacement and rotation at points of bearing

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 30, 2009 11:53	RO9CFB~1.WWB

Design Check Calculation Sheet

Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [m] Start	End	Magnitude Start	End	Unit
Load1	Dead	Full Area				1.00 (0.76)*		kN/m2
Load2	Live	Full Area				1.92 (0.76)*		kN/m2
Load3	Live	Point		1.07		3.46		kN
Load4	Dead	Point		1.07		1.80		kN
Load5	Dead	Point		2.14		1.80		kN
Load6	Live	Point		2.14		3.46		kN

*Tributary Width (m)

MAXIMUM REACTIONS (kN) and BEARING LENGTHS (mm) :

Unfactored:			
Dead	3.29		3.30
Live	5.78		5.81
Factored:			
Total	12.79		12.84
Bearing:			
Load Comb	#2		#2
Length	13*		13*
KB	1.00		1.00
Kd	1.00		1.00

*Min. bearing length for beams is 13 mm for exterior supports

Timber, D.Fir-L, No.1, 191x191 mm

Self-weight of 0.175 kN/m included in loads;
Lateral support: top= at supports, bottom= at supports;

Force vs. Resistance (kN) and Deflection (mm) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 12.19	Vr = 42.68	Vf/Vr = 0.29
Moment(+)	Mf = 12.22	Mr = 18.75	Mf/Mr = 0.65
Perm. Defl'n	2.9 = <L/999	8.9 = L/360	0.33
Live Defl'n	5.2 = L/620	8.9 = L/360	0.58
Total Defl'n	8.1 = L/397	17.8 = L/180	0.45

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	1.5	1.00	1.00	1.300	-	1.00	1.00	-	#2
Fb+	13.8	1.00	1.00	1.300	1.000	1.00	1.00	-	#2
Fcp	7.0	-	-	1.000	-	1.00	1.00	-	#-
Es	10500	-	-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 1165e06 kN-mm2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BEAMS require restraint against lateral displacement and rotation at points of bearing

Climatic data in calgary					
	Ground snow load			1.10	Kpa
	Rain load			0.10	Kpa
	Wind	q1/50		0.50	Kpa
	Seismic	Sa(0.2)		0.15	
		Sa(0.5)		0.08	
		Sa(1.0)		0.04	
		Sa(2.0)		0.02	
		PGA		0.09	
Floor load Above					
	dead load			0.57	Kpa
	Live load			1.92	Kpa
INPUT	Snow Load		1.00		
	Dead load		0.72		
Main Floor load					
	dead load			0.57	Kpa
	Live load			2.40	Kpa

SERVICE LOAD FROM ROOF — SEE "LOAD DISTRIBUTE_ROOF.DWG" FOR LOCATION OF POINT LOAD

	Location		Roof Area	Roof Load (kN)		Roof Load (kPa)		Dead Load (kPa)		Live Load (kPa)	
	Grid line E-1		0.50	25.30		2.35		2.35		1.89		0.00	
	Grid line E-2		0.50	35.08		3.26		3.26		2.62		0.00	
	Grid line E-3		0.50	35.08		3.26		3.26		2.62		0.00	
	Grid line E-4		0.50	30.21		2.81		2.81		2.26		0.00	
	Grid line B-1		0.50	27.47		2.55		2.55		2.05		0.00	
	Grid line B-2		0.50	38.08		3.54		3.54		2.85		0.00	
				6.23		0.58		0.00		0.33		1.11	
							sum	3.54		3.18		1.11	
	Grid line B-3		0.50	38.08		3.54		3.54		2.85		0.00	
				10.68		0.99		0.99		0.71		1.00	
							sum	4.53		3.56		1.00	
	Grid line B-4		0.50	45.36		4.21		4.21		3.39		0.00	
				5.79		0.54		0.00		0.31		1.03	
							sum	4.21		3.70		1.03	
	Grid line A-2,A-4			12.76		1.19		0.00		0.68		2.28	
	Grid line D-6		0.50	31.43		2.92		2.92		2.35		0.00	
	Grid line D-8		0.50	33.16		3.08		3.08		2.48		0.00	
	Grid line D-9		0.50	15.96		1.48		1.48		1.19		0.00	
	Grid line B-6		0.50	30.51		2.83		2.83		2.28		0.00	
				5.12		0.48		0.00		0.27		0.91	
							sum	2.83		2.55		0.91	
	Grid line B-7		0.50	20.93		1.94		1.94		1.57		0.00	
				8.32		0.77		0.00		0.44		1.48	
							sum	1.94		2.01		1.48	
	Grid line B-8		0.50	20.93		1.94		1.94		1.57		0.00	
				8.32		0.77		0.00		0.44		1.48	
							sum	1.94		2.01		1.48	
	Grid line B-9		0.50	15.12		1.40		1.40		1.13		0.00	
				6.01		0.56		0.00		0.32		1.07	
							sum	1.40		1.45		1.07	
	Grid line A-6,A9			14.86		1.38		0.00		0.79		2.65	
			Roof Area	Roof Load (kN)		Roof Load (kPa)		Dead Load (kPa)		Live Load (kPa)	
See Plan	#1			13.87		1.29		0.00		0.73		2.47	
	#2			15.36		1.43		0.00		0.81		2.74	
	#3			13.96		1.30		0.00		0.74		2.49	
	#4			7.72		0.72		0.00		0.41		1.38	
	#5			2.67		0.25		0.00		0.14		0.48	
	#6			15.61		1.45		0.00		0.83		2.78	
	#7			17.29		1.61		0.00		0.92		3.08	
	#8			15.71		1.46		0.00		0.83		2.80	
	#9			8.69		0.81		0.00		0.46		1.55	
	#10			3.00		0.28		0.00		0.16		0.54	
	#11			7.29		0.68		0.00		0.39		1.30	
	#12			17.05		1.58		0.00		0.90		3.04	
	#13			26.95		2.50		0.00		1.43		4.81	
	#14			24.49		2.28		0.00		1.30		4.37	
	#15			18.23		1.69		0.00		0.97		3.25	

	#16			7.21		0.67		0.00		0.38		1.29	
	#17			16.86		1.57		0.00		0.89		3.01	
	#18			26.64		2.47		0.00		1.41		4.75	
	#19			24.22		2.25		0.00		1.28		4.32	
	#20			18.02		1.67		0.00		0.95		3.21	
SERVICE LOAD FROM FLOOR ROOF					SEE "LOAD DISTRIBUTE_MAIN FLOOR.DWG" FOR LOCATION OF POINT LOAD								
See Plan	#1			8.33		0.77		0.00		0.44		1.86	
		Add point load above		GL E1				2.35		1.89		0.00	
							sum	2.35		2.33		1.86	
	#2			8.08		0.75		0.00		0.43		1.80	
	#3,#4			17.05		1.58		0.00		0.90		3.80	
	#5			9.98		0.93		0.00		0.53		2.23	
		Add point load above		B1				2.55		2.05		0.00	
							sum	2.55		2.58		2.23	
	#6			9.67		0.90		0.00		0.51		2.16	
	#7			18.22		1.69		0.00		0.96		4.06	
		Add point load above		E2				3.26		2.62		0.00	
				0.5*E3				1.63		1.31		0.00	
							sum	4.89		4.90		4.06	
	#8			18.36		1.71		0.00		0.97		4.09	
		Add point load above		E4				2.81		2.26		0.00	
				0.5*E3				1.63		1.31		0.00	
							sum	4.44		4.54		4.09	
	#9,#10			37.60		3.49		0.00		1.99		8.38	
	#11			35.53		3.30		0.00		1.88		7.92	
		Add point load above		B2				3.54		3.18		1.11	
				0.5*B3				2.26		1.78		0.50	
							sum	5.80		6.84		9.53	
	#12			35.81		3.33		0.00		1.90		7.98	
		Add point load above		B4				4.21		3.70		1.03	
				0.5*B3				2.26		1.78		0.50	
							sum	6.48		7.38		9.52	
	#13			13.71		1.27		0.00		0.73		3.06	
		Add point load above		A2				0.00	0.00	0.68	0.00	2.28	
							sum	0.00		1.40		5.33	
	#14			13.81		1.28		0.00		0.73		3.08	
		Add point load above		A4				0.00		0.68		2.28	
							sum	0.00		1.41		5.36	
	#15			3.80		0.35		0.00		0.20		0.85	
	#16!			7.83		0.73		0.00		0.41		1.74	
		Add point load above		#11				0.00		0.39		1.30	
							sum	0.00		0.80		3.05	
	#16			4.97		0.46		0.00		0.26		1.11	
		Add point load above		#16				0.00		0.38		1.29	
							sum	0.00		0.64		2.39	
	#17			26.90		2.50		0.00		1.42		6.00	
		Add point load above		#1				0.00		0.73		2.47	
				#6				0.00		0.83		2.78	
				#12				0.00		0.90		3.04	
							sum	0.00		3.89		14.30	
	#18			27.05		2.51		0.00		1.43		6.03	
		Add point load above		#17				0.00		0.89		3.01	
							sum	0.00		2.33		9.04	
	#19			42.19		3.92		0.00		2.23		9.41	
		Add point load above		#2				0.00		0.81		2.74	
				#7				0.00		0.92		3.08	
				#13				0.00		1.43		4.81	
							sum	0.00		5.39		20.04	
	#20			42.42		3.94		0.00		2.25		9.46	
		Add point load above		#18*1.5				0.00		2.12		7.13	
							sum	0.00		4.36		16.59	
	#21			44.51		4.14		0.00		2.36		9.92	
		Add point load above		#3				0.00		0.74		2.49	
				#8				0.00		0.83		2.80	
				#14				0.00		1.30		4.37	

							sum	0.00		5.23		19.59	
	#22			44.76		4.16		0.00		2.37		9.98	
		Add point load above		#19				0.00		1.28		4.32	
							sum	0.00		3.65		14.30	
	#23			10.52		0.98		0.00		0.56		2.35	
		Add point load above		#4				0.00		0.41		1.38	
				#5				0.00		0.14		0.48	
							sum	0.00		1.11		4.20	
	#23!			19.38		1.80		0.00		1.03		4.32	
		Add point load above		#9				0.00		0.46		1.55	
				#10				0.00		0.16		0.54	
				#15				0.00		0.97		3.25	
							SUM	0.00		2.61		9.66	
	#24			16.06		1.49		0.00		0.85		3.58	
		Add point load above		#20				0.00		0.95		3.21	
							sum	0.00		1.80		6.80	
	#25			8.77		0.81		0.00		0.46		1.95	
		Add point load above		1.5*D6				4.38		3.53		0.00	
							sum	4.38		3.99		1.95	
	#26			9.71		0.90		0.00		0.51		2.16	
		Add point load above		D8				3.08		2.48		0.00	
				D9				1.48		1.19		0.00	
							sum	4.56		4.19		2.16	
	#27			30.05		2.79		0.00		1.59		6.70	
	#28			33.29		3.09		1.00		1.76		7.42	
	#29			38.08		3.54		0.00		2.02		8.49	
		Add point load above		B6				2.83		2.55		0.91	
				B7				1.94		2.01		1.48	
							sum	4.78		6.58		10.89	
	#30			42.18		3.92		0.00		2.23		9.40	
		Add point load above		B8				1.94		2.01		1.48	
				B9				1.40		1.45		1.07	
							sum	3.35		5.69		11.96	
	#31			17.06		1.58		0.00		0.90		3.80	
		Add point load above		A6				0.00		0.79		2.65	
							sum	0.00		1.69		6.45	
	#32			18.88		1.75		0.00		1.00		4.21	
		Add point load above		A9				0.00		0.79		2.65	
							sum	0.00		1.79		6.86	

Hawse Footing design (temp)

Name	S(sq ft)	DL(pound)	LL(pound)	Total(pound)	s_{min}(aq ft)	e(inch)
F1	16.2	243.648	1624.05	1867.698	1.245132	13.39026
F2	32.4	487.296	3248.1	3735.396	2.490264	18.93668
WWT-1				1490.5	0.99366667	11.96194
GLT-1				1620.9	1.0806	12.47423
TK4				382.2	0.2548	6.057326
TST-1				783.5	0.52233333	8.672716

NAME	a(inch)	b(inch)	h(inch)	S(sq ft)	S(sq meter)	d(m)	V(cubic meter)
WWT-1&DCWT-1	101	51	42	23070	14.884	0.01	0.14884
GLT-1	130	81	41	38362	24.75	0.01	0.2475
TK4			37	773.3567	0.5	0.01	0.005
TST-1			48	6470.157	4.174	0.01	0.04174

M(kN)	M0(kN)	Total	Load(kN)	Load(pound)
3.512624	23	26.51262	6.628156	1490.5
5.841	23	28.841	7.21025	1620.9
0.118	1.7	1.818	1.818	382.2
0.985064	2.5	3.485064	3.485064	783.5

WWT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
WWT-1&DCWT-1	101	51	42	23070	14.884	0.01	0.14884	3.512624	23	26.51262	6.628156	1490.5
GLT-1	130	81	41	38362	24.75	0.01	0.2475	5.841	23	28.841	7.21025	1620.9
TK4			37	773.3567	0.5	0.01	0.005	0.118	1.7	1.818	1.818	382.2
TST-1			48	6470.157	4.174	0.01	0.04174	0.985064	2.5	3.485064	3.485064	783.5

Vertical load

	Ground snow load	1.1	Kpa
	Rain load	0.1	Kpa
Roof load			
	dead load	1	Kpa
	Live load	1.92	Kpa
	Snow load	1	Kpa
Total building area in plan		65.78	m2
	Total roof dead load	65.78	KN
	Total roof snow load	65.78	KN

Emerco exterior wall racking capacity

one side OSB	300 plf	4.38	KN/m
Two side OSB	400 plf	5.84	KN/m

Wind load p=Iw(q1/50)CeCgCp

height	4.2672	M
Iw	1	
q1/50	0.5	Kpa
Ce	0.90	for open terrain
CgCp	0.75	for inward wall face
	-0.55	for leeward wall face
p=	0.585	Kpa

Direction East-West

vertical tributary	2.7432		
horizontal tributary	7.7724		
Total wind load	12.5	KN	
For each building side	6.2	KN	
factored value	8.7	KN	
wall length required	2.0	m	

along GL-A consider 2 segments at 3-4 and 6-7 each segment 4.5' length

wall segment length	1.4	m		
wall segment height	2.4	m		
Uplift force	7.8	KN	Use LSTHD8 13.88KN	
SDS anchorage	9.6	SDS1/4x3	274.32	mm o/c

along GL-E consider cross brace at 1-2 and 8-9 and a segment 6' length from 5 to 6

Use same hold down and anchorage type

Direction North-South

vertical tributary	2.7432		
horizontal tributary	11.643		
Total wind load	18.7	KN	
For each building side	9.34		
factored value	13.1	KN	
wall length required	3.0	m	

Along GL-1 use EMERCO panel with both side OSB for segment 8' length

wall segment length	2.4	m		
wall segment height	2.4	m		
Uplift force	13.1	KN	Use LSTHD8 13.88KN	
SDS anchorage	14.4	SDS1/4x3	162.56	mm o/c

arrange SDS 8" O/C we have 12 SDS within segment.

Accound for SDS on the left segment under window so anchorage requirement will be ok

Along GL-1 use EMERCO panel one side OSB for segment 11' length

wall segment length	3.4	m		
wall segment height	2.4	m		
Uplift force	9.5	KN	Use LSTHD8 13.88KN	
SDS anchorage	14.4	SDS1/4x3	223.52	mm o/c

No.	SL (KN)	DL (KN)	LL (KN)	Service Load (KN)	Point Load (Pound)	Pad Size (in)	
#1	2.35	2.33	1.86	6.54	1470.192	11.88017	16
#8 & #17	4.44	5.96	10.09	20.49	4606.152	21.02833	24
#15	0	0.2	0.85	1.05	236.04	4.760235	16
#16!	0	0.8	3.05	3.85	865.48	9.115157	16
#16	0	0.64	2.39	3.03	681.144	8.086397	16
#18	0	2.33	9.04	11.37	2555.976	15.66441	16
#25	4.4	4	2	10.4	2337.92	14.98133	16
#26	4.6	4.2	2.2	11	2472.8	15.40743	16
#30	3.4	5.7	12	21.1	4743.28	21.33905	24
#32	0	1.8	6.9	8.7	1955.76	13.7023	16
#31	0	1.7	6.5	8.2	1843.36	13.30273	16
#23	0	1.1	4.2	5.3	1191.44	10.69478	20
#23!	0	2.61	9.7	12.31	2767.288	16.29907	20
#14	0	1.4	5.4	6.8	1528.64	12.11402	16
#13	0	1.4	5.3	6.7	1506.16	12.02461	16
#6 & #11	5.8	7.4	11.7	24.9	5597.52	23.18107	24
#5	2.6	2.6	2.3	7.5	1686	12.72226	16
#3	0	0.9	3.8	4.7	1056.56	10.07123	16
#4 & #9	0	2.9	12.2	15.1	3394.48	18.05187	20
#10 & #19	0	7.3	28.4	35.7	8025.36	27.7567	28
#20 & #27	0	6	23.3	29.3	6586.64	25.14592	28
#28	0	1.8	7.5	9.3	2090.64	14.16691	16
#12 & #21	6.5	12.6	29.1	48.2	10835.36	32.25205	36
#22 & #29	4.8	10.3	15.2	30.3	6811.44	25.57143	28

based on 1500 psf.

David C. Woodall Structural Engineering Ltd.

Project:	**Solar Decathlon House** **Emercor Panel Design Notes**
Client:	**Emercor**
File No.	**20607.57**
Date:	**May 28 2009**
Prepared By:	**David C. Woodall, M.Sc., P.Eng., FCSCE**
Enclosed :	**5 Pages**

PROFESSIONAL ENGINEER D.C. WOODALL ALBERTA
28/5/09

DAVID C. WOODALL
Signature
Date 28/5/09
PERMIT NUMBER: P 9100
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Box 7 Site 8 RR1 Priddis AB T0L 1W0 Phone/Fax: 403-931-2723 Mobile: 403-831-8610 E-mail: dcwstructeng@davincibb.net

Enclosure Panels:

Components:
- Roof Panels
- Wall Panels
- Floor Panels – PSL reinforced.
- Grade Beams.

Loads: per S-0 General notes:

Roof: Dead 1 kPa
Live

GSL 1.1 } 1 kPa sloped
SR 0.1 }
Flat roof 1.92 kPa flat.

Floor: Dead 0.57 kPa
Live 2.40 kPa

Wind: q_{50} 0.5 kPa

Seismic: N/A Panels.

Roof Panels:

Max span 4'-6"; load SLS = 42 psf – 21L
21D

6½" OSB/OSB Max capacity @ 20L } 8'-03" span @ l/360 ✓
20D } 7'-06" " " l/480 ✓

Walls: Non load bearing:

$p = I_w q C_e C_g C_p$

I_w = SLS 0.75 ULS 1
q = 0.5
C_e = 0.9
C_g = 2.0 *
Roof 25° $C_p C_g$ = 1.5 max new comm

P_{SLS} = 0.51
= 11 psf

David C. Woodall Structural Engineering Ltd.

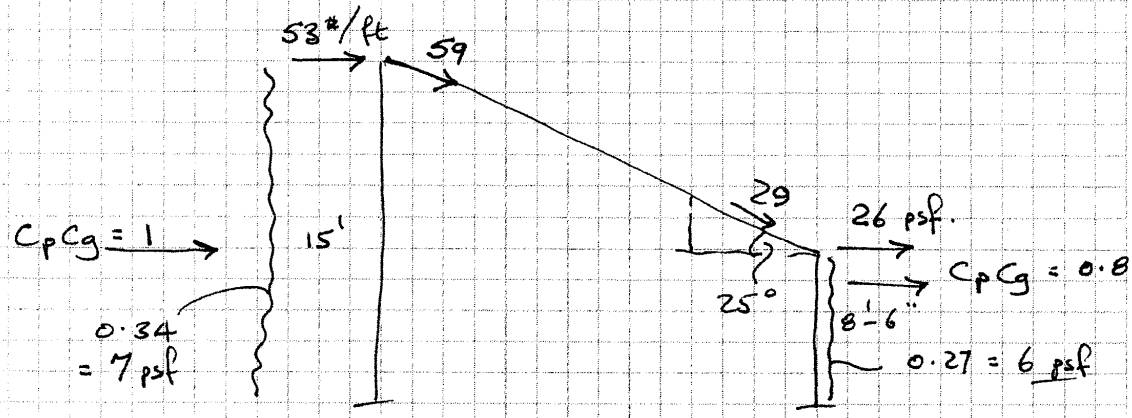
PROJECT: Solar Decathlon JOB NO: 20607.57
DATE: 2009
CHECKED BY: DESIGN BY: SHEET NO 1

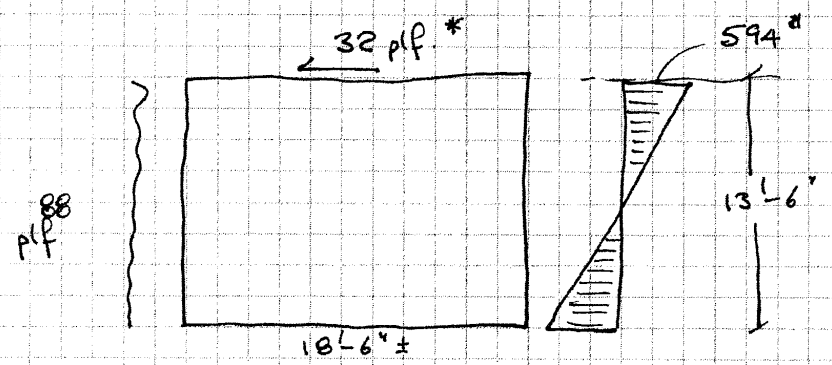
Axial panel: 6½ OSB/OSB @ 8' panel can resist 30 psf @ ✓
low axial = 1058#/ft.

As transverse load: allow = 30 psf to 8'-3" ✓
@ Δ ℓ = ℓ/360

∴ Panels ok for wind:

Roof diaphragm: blind from 1" ⊄ A.





* ≡ 0.7 kN/m ULS Nominal (under lightest sheathing CSA 086, allow = 2→3 kN/m)
Encroar diaphragms & connections – nominal throughout.

David C. Woodall Structural Engineering Ltd.

PROJECT: Solar Decathlon. JOB NO: 20607.57
DATE: 2009
CHECKED BY: DESIGN BY: DCW SHEET NO 2

Walls racking: Allowable is 400 plf 6½ OSB/OSB – 8' High.
Max here is 38 plf so is nominal.

So Roof & Wall Panels ok for transverse & shear loadings

Roof:

					ULS
0.57 kPa	=	12 psf	D	×1.25	15 psf
2.40 kPa	=	50 psf	L	×1.5	75 psf
		62 psf	SLS		90 psf ULS.

Panel span allow: 6' allowable @ l/360
Span in this case ok @ 4'

Trib to LVL = 4' load ULS = 90 × 4 = 360 plf.

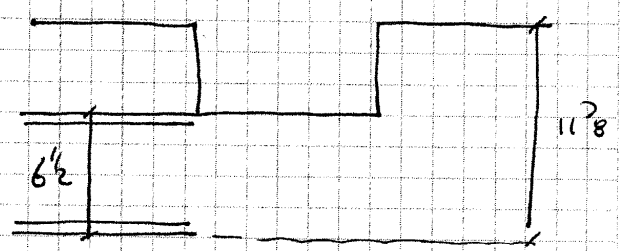
LVL Span = 11'-8¾ − 6½ − 6½ = 10'-8"

$V = \frac{360 \times 10.67}{2} = 1921$ #

$M = \frac{360 \times (10.67)^2}{8} = 5123$ ft-lbs.

} ULS } 1¾ × 11⅞ } 6735 / 16555

Section @ mech notch



So section is 6½" deep × 1¾.

f_b = 5360 psi depth factor = 1.07 $f_{b_{6.5}}$ = 5737

$M_{allow\ ULS} = 5737 \times \frac{1.75 \times 6.5^2}{6} = 5891$ ft-lbs.

Applied is 5123 so notch is strong everywhere in span.

Check Δ; LVL is supplemented by 2 – 2×6: For compatability assume LVL has E = SPF.
Section is: 4¾ × (say) 5½; E = 9500 MPa (1377500 psi)

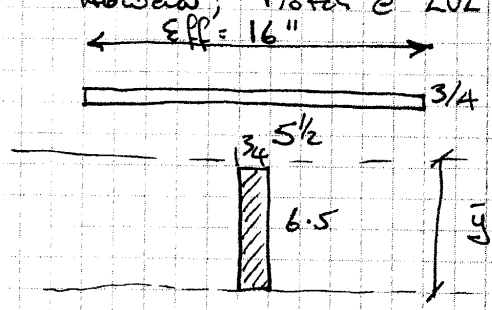
David C. Woodall Structural Engineering Ltd.

PROJECT: Solar Decathlon JOB NO: 20607.54
DATE: 2009
CHECKED BY: DESIGN BY: DCW SHEET NO 3

$$\Delta = \frac{5 \times 20.67 \times 128^4}{384 \times 1.37 \times 10^6 \times 66} = 0.8'' = \ell/160 \text{ T.L.}$$

$$u = 0.645'' = \ell/200 \text{ u.}$$

Notching may create deflection problem.
However, Notch @ LVL has plywood top flange.



$$\bar{y} = \frac{(\tfrac{3}{4} \times 6.5 \times 3.25) + (16 \times .75 \times 12.375)}{23.375} = \underline{7.7}$$

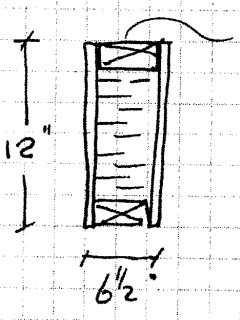
$$I_{eff} = (16 \times .75 \times 4.675^2) + (\tfrac{3}{4} \times 6.5 \times 4.45^2) =$$

$$= 262 + 225 = 487 \text{ in}^4$$

$$\therefore \Delta_{TOTAL} = 0.1 = \ell/\underline{1182}.$$

Provided plywood is properly fastened to all 2x6 joists and LVL each side of 12" notch, then strength & deflection should be satisfied.

Now Check Grade Beams:



1½x5½ 2.0E LVL
+ & G

See Spreadsheet

$M_+ = 63.5$ kNm
$= \underline{46.8}$ 'K

$V_+ = 21.6$ kN
$= 4860$ #

∴ For 8' span all Emerson grade beams are v. safe — no point loads from roof frame are carried.

Δ ok

Trib to gbeams = 6' x 90 = 540 plf
in 8' M = 4320 ft-lbs ✓ << 46,800

Max shear from LVL = 1921# w udl 2160 ✓ < 4860

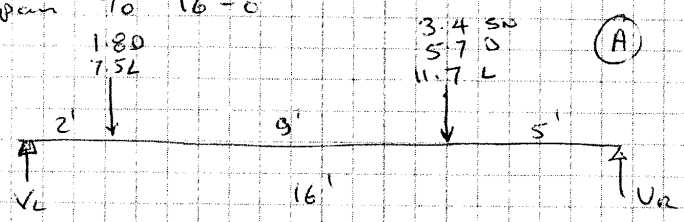
David C. Woodall Structural Engineering Ltd.

PROJECT: Solar Decathlon.
JOB NO: 20607.57
DATE: 2009
CHECKED BY:
DESIGN BY: DW
SHEET NO 4

Check Grade Beam Capacities - temporary support conditions

[Point loads from Cascade dwg S-2]

℄ 9 Span c/o 16'-0"



$1.8 \times 1.25 = 2.25$
$7.5 \times 1.50 = 11.25$
13.50 kN $= 3.03^k$ (f)

$5.7 \times 1.25 = 7.125$
$3.4 \times 1.50 = 5.1$
$11.7 \times 1.50 = 17.6$
29.8 kN $= 6.7^k$

$V_L = \frac{(6.7 \times 5) + (3.03 \times 14)}{16} = 4.75$

$V_R = 4.98$

$M_{max} = V_R \times 5 = 4.98 \times 5 = 24.9$ 'k

$1^3/_4 \times 11^7/_8$ PSL 2.0E ; $M_R = 16.6$ 'k $\times$ < 24.9

Clearly ℄ 9 doesn't work - 9 beams are spliced so cannot be used.

∴ Supports indicated on S-2 must be provided before temporary or permanent occupancy - clearly under → DL only it will work.

Corner connections : to ensure load transfer around corner joints: Max is 4.1 SW, 3.8 D, 7.5 L } 10.4 kN or 2.34 ^{k} Service load.

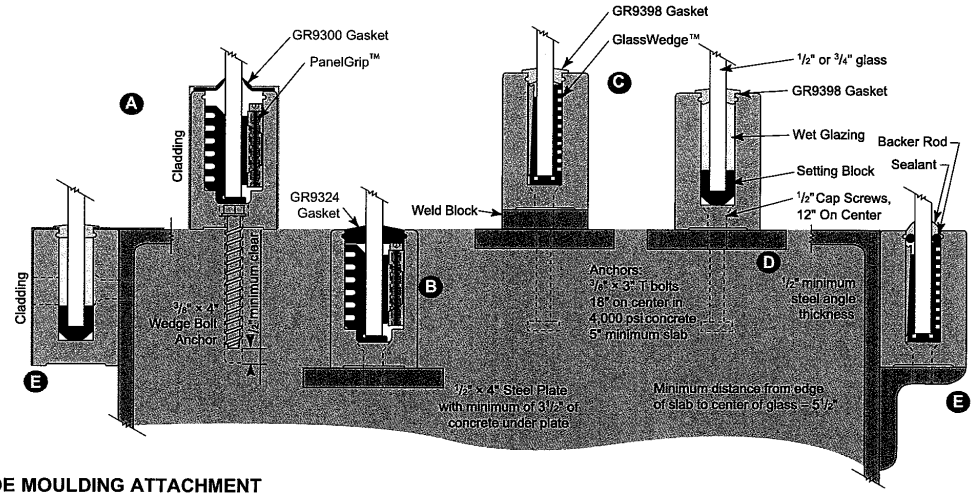
Post load is shared @ corner but positive interconnection is recommended → use Simpson LTP5 - nailed for G_{max}. Capacity 1165 # = 50% of total support reaction - reasonable.

David C. Woodall Structural Engineering Ltd.

PROJECT: Solar Decathlon. JOB NO: 20607.57

DATE: May/09

CHECKED BY: DESIGN BY: SHEET NO 5



SHOE MOULDING ATTACHMENT

Attachment of the aluminum shoe moulding is critical to the success of any glass railing installation. The details above depict six typical attachment methods. Other methods of attachment are possible but their integrity would need to be determined by the installer in cooperation with their own engineer.

Note: To avoid corrosion, aluminum should be kept from directly contacting steel Portland based cement and grout by painting with a heavy coat of an appropriate primer. For exterior applications, provide weep holes as needed.

A – ATTACHMENT TO CONCRETE

The ***Shoe Mouldings*** may be attached directly to concrete – 4,000 psi minimum – using a ⅜" × 4" ***Wedge-Bolt, Orange Tip, Anchor.***

- Use the pre-drilled holes in the shoe moulding as a template to drill holes in the concrete. The ***Wedge-Bolt***, Orange Tip, Anchor allows the use of a standard ⅜" × 12" masonry bit.
- Holes must be drilled a minimum of ½" deeper than the required embedment.
- Vacuum all loose debris and thread in the ***Wedge-Bolt Anchor.***
- Insert the ***Wedge-Bolt*** through the base ***Shoe Moulding*** and into the drilled hole. Use downward pressure and begin to turn the ***Wedge-Bolt*** clockwise thereby engaging the first few threads.
- Continue tightening until firmly seated against the ***Shoe Moulding.*** An impact wrench is recommended to facilitate tightening to a torque of 40 ft/lbs.

B – EMBEDDED IN CONCRETE

When design parameters require a hidden floor attachment, a poured in place ***Shoe Moulding*** may be appropriate. With this attachment method, the glass will appear to rise directly out of the floor.

C – WELD BLOCK WITH STEEL SUBSTRATE

If a structurally sound steel substrate is present and you wish to avoid drilling and matching ***Shoe Moulding*** holes with substrate holes, steel ***Weld Blocks*** may be used.

- ***Weld Blocks*** are mechanically attached to the base of the ***Shoe Moulding*** with ***½"-13 × 1¼" Cap Screws***.
- The assembly is then placed and aligned in the field and welded to the steel substrate.
- Custom sized ***Cladding*** is available to cover your ***Weld Block*** attachment.

D – ATTACHMENT TO EMBEDDED STEEL

- A ½" × 4" steel strip is drilled and tapped for ½"-13, 12" on center; and ⅜" × 3" T bolt anchors are welded to the underside of the steel strip,18" on center.
- Prior to placing in wet concrete, insert ***Nylon Allen Screws*** to protect threaded holes and cover the ***Cap Screw*** socket heads with duct tape to keep out the concrete.
- When cured, remove the ***Nylon Allen Screws*** and secure the ***Shoe Moulding*** with ***½"-13 × 1¼" Cap Screws.***

E – FASCIA MOUNT

- The ***Shoe Moulding*** may be side mounted to a steel angle or substrate as shown.
- **Wagner** can pre-drill ***Shoe Moulding*** for fascia mounting as required.

ATTACHMENT LOCATIONS:

- Lengths less than 1'-6", two attachment minimum.
- Lengths between 1'-6" and 2'-6", three attachment minimum.
- Lengths over 2'-6", space attachments 12" on center.
- The first hole should be located 3" from the end of the shoe moulding on lengths less than 2'-6" and 6" from the end on lengths over 2'-6".
- Drill additional holes in shoe moulding as required.
- For exterior applications, the heads of the attachments should be covered with silicone.

Recommended Tools:	
Concrete Drilling: • 15/16" Heavy-Duty Rotary Hammer • ⅜" × 12" Masonry Bit	**Setting Wedge-Bolt®:** • Impact Wrench or Ratchet • ⅜" Drive, 9/16", Deep Socket, 6 pt Socket **Setting Cap Screw:** • ⅜" Drive, ⅜" Hex Bit

GME CONSULTANTS, INC.
CONSULTING ENGINEERS
9824 Industrial Drive, Unit C / Bridgeview, IL 60455
Phone (708) 430-1071 / Fax (708) 430-9854

April 10, 2002

Mr. Dick Gordon
MTH Industries
2630 W. Bradley Place
Chicago, Illinois 60618

Structural Load Test Report
PIW Glass Wedge Balustrade System
Lockport, Illinois

GME Project No.: B-2632

Dear Mr. Gordon:

In compliance with your request, GME Consultants, Inc has completed the Load Testing of the Mechanical Glass Balustrade System using the Wedge System designed and assembled by PIW Corporation. This work was completed in general accordance with our verbal agreement discussed at our pretesting meeting on

In the body of this report we will present a summary of our findings, test data, graphical representation, photographs, and product documents. Video tapes of the test specimen have also been provided for your use.

Thank you for selecting our firm to assist in this phase of your development. If there are any questions concerning this report please feel free to contact us at your convenience.

Sincerely,
GME Consultants, Inc

Anthony R. Opila
Engineering Technician

Scott Bierbaum
Project Manager

Umar T. Ahmad, P.E.
Senior Project Engineer
Registered Professional Engineer – Illinois

WILLIAM C. KWASNY, P.E.
UMAR T. AHMAD, P.E.
SCOTT R. BIERBAUM, E.I.T.
R. ERIC ZIMMERMAN, PH.D., P.E.
THOMAS P. VENEMA, P.E.
GREGORY R. REUTER, P.E., P.G.
An Equal Opportunity Employer

Structural Load Test Report
PIW Glass Wedge Balustrade System
Lockport, Illinois

Executive Summary

In compliance with MTH Industries request, GME Consultants, Inc has completed the Load Testing of the Mechanical Glass Balustrade System using the Wedge System designed and assembled by PIW Corporation. On March 19, 2002 we conducted a full-scale load and deflection test on four Structural Glass Balustrade Systems using the Wedge System and compared it to the standard Por Roc System. These tests were conducted at PIW Corporation's office in Lockport, Illinois. We performed a visual and dimensional confirmation that the test specimens reasonably reflected the materials and configuration shown on the product documents provided. Based on our conversations with Mr. John Shepard, PIW Corporation, each specimen was prepared for testing on March 18, 2002.

The four specimens consisted of two 48 inches wide, 42 inches tall specimens and two 18 inches wide, 42 inches tall specimens with ½ inch fully-tempered glass. In each size grouping one specimen was tested using the standard Por Roc System and the other specimen tested using the PIW Corporation's Wedge System. These specimens were mechanically attached to a steel table at PIW Corporations' office.

The test specimens were load tested at the top center of each piece of glass, the 48 inch wide specimens were also load tested at the top left corner. The loading was performed based on a 200 pound design load as stated in Peter R. Krallitsch & Associates' letter dated February 4, 2002 and consisted of loading each specimen to 50% of the design load (initial set of 100 lbs.). Each test specimen then was tested using applied load increments of 25 lbs (12.5%) and held for a two-minute time period. Each specimen was loaded to a minimum of 2 times the 200 pound design load (400 lbs.). The two 48 inch wide specimens were loaded to 3 times the design load (600 lbs.) at the corner test. During each load increment the deflection of the glass, aluminum shoe and wedges (if applicable) were measured and recorded.

No apparent failures of the Por Roc or the PIW Corporation's Wedge System were observed during the load testing. The test data was recorded and plotted on a load versus deflection curve. In summary, each specimen experienced similar deflection responses. Photographs and video tapes of the load tests are enclosed with the report along with the testing frame assembly sketches, product documents provided and the calibration curves for the load gauge.

The information presented in this report is intended solely for the materials and configurations tested. This information is not intended to be reused on other situations. All reports, photographs and other documents prepared by GME Consultants, Inc as instruments of services shall remain the property of GME Consultants, Inc.

These specimens were tested by applying a static load. Dynamic or cyclic load application was not part of our scope. This letter does not represent a response of this system under dynamic or cyclic loading conditions.

This work was performed in accordance with commonly accepted procedures consistent with applicable standards of practice and is not a guarantee or warranty, either expressed or implied.

Project Summary

On March 19, 2002 we conducted a full scale load and deflection test on four Structural Glass Balustrade Systems using the PIW Corporation's Wedge System and comparing it to the standard Por Roc System previously used by the industry. These tests were conducted at PIW Corporations office in Lockport, Illinois. We performed a visual and dimensional confirmation that the test specimens reasonably reflected the materials and configuration shown on the product documents provided. A comprehensive measurement of the components was also conducted prior to load testing the specimens. After loading each specimen to 50% of the design load (initial set of 100 lbs.), each test specimen was tested using applied load increments of 25 lbs (12.5%) and held for a two-minute period. Each specimen was loaded to a minimum of 2 times

the 200 pounds design load (400 lbs.). The two 48 inch wide glass pieces were loaded to 3 times the 200 pounds design load (600 lbs.) at the corner test. During each load increment the deflection of the glass, aluminum shoe and wedges (if applicable) were measured and recorded. No apparent failures of the standard Por Roc System or PIW Corporation's Wedge System were observed during the load testing.

Test Specimen Preparation

Based on our conversations with Mr. John Shepard of PIW Corporation, the following procedures were used to prepare each of the four test specimens. Each specimen was prepared for testing on March 18, 2002 by PIW Corporation. The two types of grade 5, 3/8 inch diameter bolts were installed through the pre-drilled and countersunk or flush mounted holes in the aluminum shoe and bolted into tapped 3x3x1/2 inch steel anchor blocks that were welded to a steel table. The glass setting blocks and pre-drilled holes in the shoe were located as noted on the documents. The 48x41x ½ fully tempered glass was then installed.

Specimen No. 1 (48 inch) and 2 (18 inch) had counter sunk holes in the aluminum shoe and the space between the glass and the vertical legs of the shoe was filled with Por Roc. Specimen No. 3 (48 inch) and 4 (18 inch) had flush mounted holes in the aluminum shoe and the PIW Corporation's Wedge System was used for mounting the glass into the aluminum shoe. The Wedge System was installed at approximately 18 inches on center. Please reference the enclosed diagrams and photographs.

Test Method and Procedure

During our review of the ASTM and industry standards we were unable to identify a specific test for Glass Balustrade Systems. The test method we used was based upon our review of similar ASTM tests conducted on metal railing systems framing. The test method is based upon reviewing the ASTM E985, E894 and E935 tests that were used as a guide in preparing the load

test.

This testing procedure was conducted as follows:

1. The specimen was visually reviewed for plumbness and location within the test framing and any discontinuities with the specimen assembly were noted.
2. The deflection gauges were installed and dimensions from the top of the glass and bottom of the shoe were recorded. All Gauges were set to zero number. (See attachment Test Configuration Sketch.)
3. The testing was conducted in a horizontal mode applying force to the upper center of all test specimens and at the corner of 48 inch wide test specimen at the approximate top rail location. Location of each load test is noted on the enclosed diagrams and data reports. We applied the load to the test specimen with a 1x1 inch, 70 durometer padded 12 ton hydraulic ram attached to a calibrated gauge. The hydraulic ram was mounted to a loading framing that was attached to the steel table by two ½ inch diameter bolts. Deflections were monitored with dial gauges with reading in increments of 0.001 inches and attached to a load frame or to the steel table. Please reference the enclosed diagrams and photographs for assembly schematics.
4. The initial preload was applied to 50 % (100 lbs) of the 200 pound design load. Upon release of the preload load the deflection gauge measurements were taken and recorded. All gauges were reset to zero.
5. Loading began at 125 lbs. and continuously increasing the load in increments of 25 pounds (12.5%) with each increment held for a two minute period.
6. At the end of each interval of loading the specimen was reviewed for visual indications of failure or stress of each component and the deflection recorded.
7. Both of the 48 inch wide specimens were loaded at the top center point in increments of 25 lbs. (12.5%) to two times the 200 pound design load and three times the 200 pound design load at the top left hand corner at 50 lbs. increments. The 18 inch wide specimens were loaded at the top center point in intervals of 25 lbs (12.5%) to two times the 200 pound design load. Deflection measurements were recorded at each load increment.

Data

Enclosed is the test data for each of the four specimens. The data includes gauge readings that were converted to load (pounds) by using the enclosed calibration chart for the hydraulic ram gauge. Each dial indicator was installed as noted in the photographs. The dial readings were recorded in 0.001 inches. Periodically during the loading procedures, the dial gauges were reset to zero due to the deflections exceeding the dial length limitations. Our review of the data indicated similar deflections for all four specimens.

Curves

Enclosed are six graphical load vs. deflection curves showing the deflection vs. the load for each specimen tested. Our review of the data indicated similar deflections for all four specimens.

Photographs

All components were photographed along with actual load assembly and loading operations. In many photographs the deflection of the glass can be seen in comparison to the dial gauge location and plumbness of the glass.

Test frame and Assembly

Enclosed is a sketch of the actual testing assembly used to measure the deflections and apply the loads. The loading mechanism was a 12 ton EnerPac Hydraulic Ram with a 3 ½ inch through and a calibrated load gauge. The test frame was built to secure the loading mechanism and attached to the steel table. The Glass Balustrade System components were supplied and assembled by PIW Corporation.

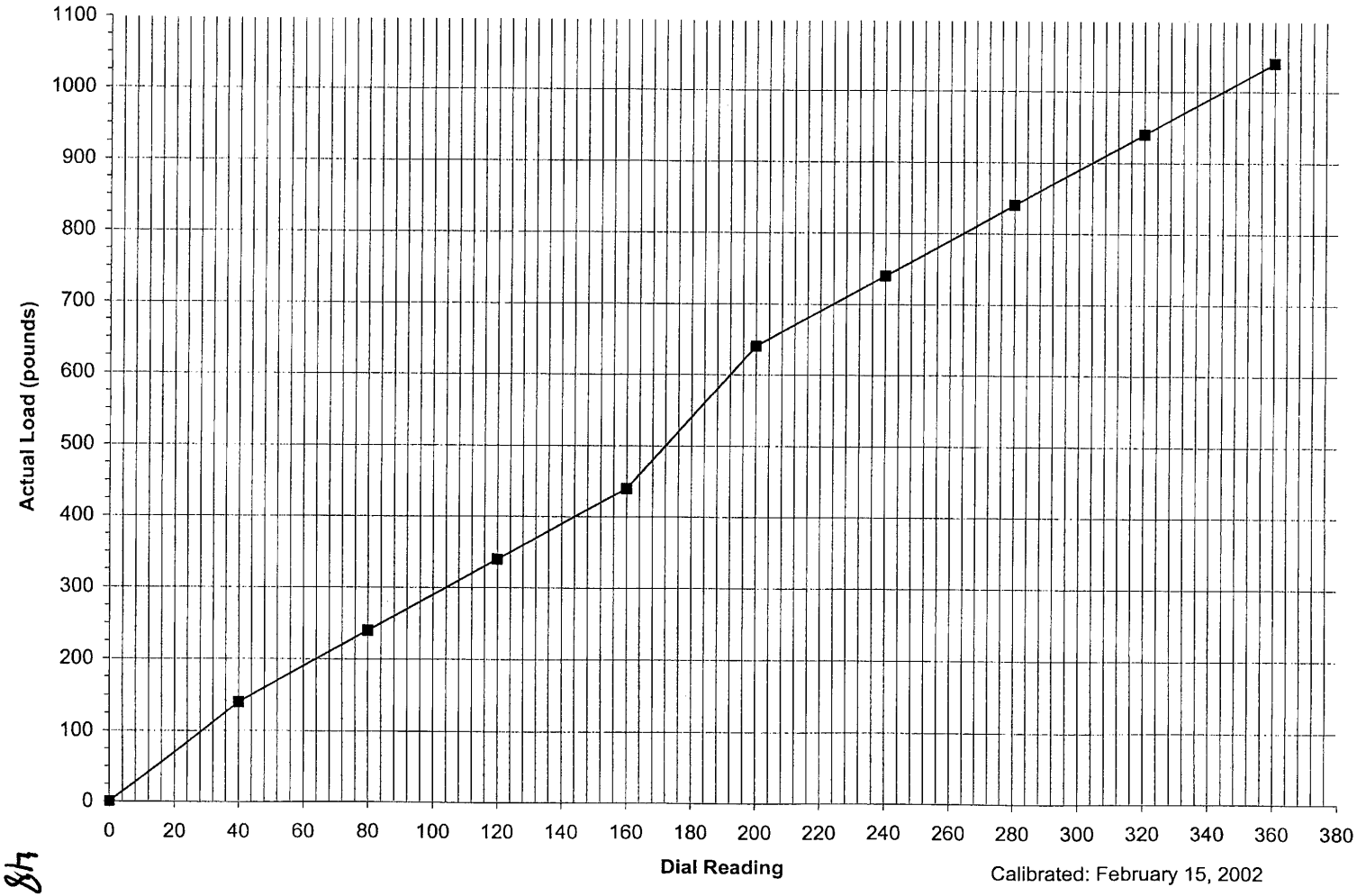
Standard of Care

The results contained in this report are based on our interpretation of the test and test procedures we observed at PIW Corporation's office on March 18, 2002. These results were arrived at in accordance with currently accepted engineering practices at this time and locations. No conclusion or comparisons were drawn from these tests nor were any recommendations provided by GME Consultants, Inc. for the two systems used during our testing. Other than this, no warranty is implied or intended.

Enclosures: Photographs
Hydraulic gauge Calibration Curve
Load vs. Deflection Graphs
Glass Wedge System Sketch
Peter R. Krallitsch & Associates' letter dated February 4, 2002

GME Consultants, Inc
9824 Industrial Drive, Unit C
Bridgeview, Illinois 60455

12 Ton Ram with 400 psi Gauge



Calibrated: February 15, 2002

48

GME Consultants, Inc
9824 industrial Drive, Unit C
Bridgeview, Illinois 60455

Test Specimen No. 1
Center Test

Por Roc System

Gauge No. 1- Top Location: 2.0 inches below the top of glass @ Center
Gauge No. 2 - Bottom Location: 1/4 inch below the top of the shoe @ Center
Load Application Location: 1/4 inch below top of glass @ Center

Comments	Gauge Reading	Load (pounds)	Dial No. 1 (inches)	Dial No. 2 (inches)
Start	0	0	0	0
Initial Preload	28	100	0.056	0
Preload Release	0	0	0	0
Reset	0	0	0	0
Loading Start	36	125	0.432	0
	44	150	0.502	0
	52	175	0.578	0
	64	200	0.703	0.003
	72	225	0.793	0.005
	84	250	0.884	0.006
	92	275	0.971	0.008
	104	300	1.091	0.010
	112	325	1.175	0.012
	124	350	1.289	0.014
	132	375	1.381	0.016
	144	400	1.499	0.018

1/2 Inch Fully-Tempered Glass Data

> 41 inches tall
> 48 inches wide

Thickness of Glass (inches)		
Right Side	Top	Left Side
0.490	0.489	0.488
0.491	0.487	0.489
0.486	0.490	0.492
0.485	0.491	0.491
0.485	0.490	0.490

PIW Corporation
Glass Balustrade Wedge System

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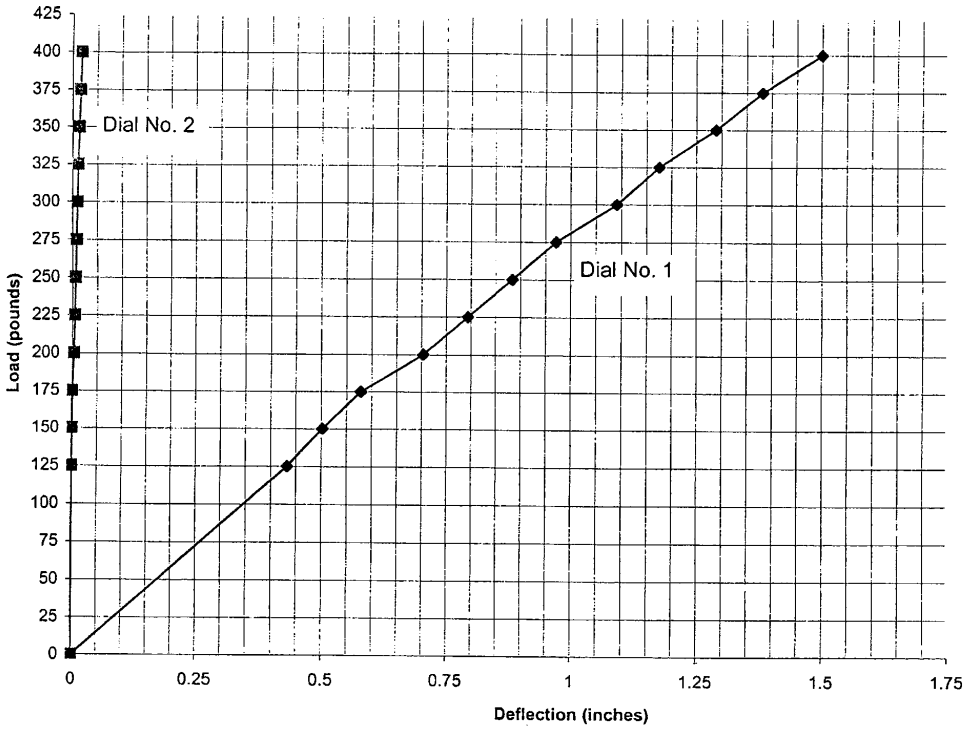
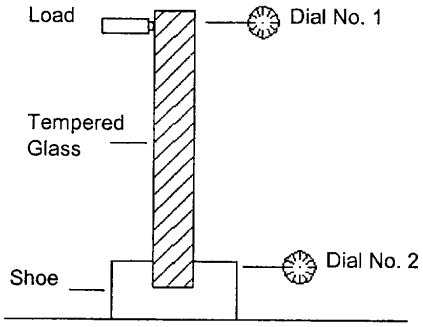
9824 Industrial Drive, Unit C
Bridgeview, Illinois
Ph. (708) 430-1071

Specimen No. 1 - Center Test
48 inches wide
Por Roc System

Load Vs Deflection





Test Apparatus Configuration

Gauge No.1 - 2.0 inches below the top of glass @ center

Gauge No. 2 - 1/4 inch below the top of the shoe @ center

Load Application Location: 1/4 inch below the top of glass @ center

GME Consultants, Inc
9824 industrial Drive, Unit C
Bridgeview, Illinois 60455

Test Specimen No. 1
Corner Test
Left Hand Side
Por Roc System

Gauge No. 1- Top Location: 2.0 inches below the top of glass @ Center
Gauge No. 2 - Bottom Location: 1/4 inch below the top of the shoe @ Center
Load Application Location: 1/4 inch below top of glass @ Center

Comments	Gauge Reading	Load (pounds)	Dial No. 1 (inches)	Dial No. 2 (inches)
Start	0	0	0	0
Initial Preload	28	100	0.056	0
Preload Release	0	0	0	0
Reset	0	0	0	0
Loading Start	36	125	0.560	0
	44	150	0.660	0.006
	52	175	0.767	0.008
	64	200	0.907	0.010
	72	225	0.995	0.011
	84	250	1.121	0.013
	92	275	1.209	0.015
	104	300	1.321	0.016
	112	325	1.425	0.018
	124	350	1.515	0.020
	132	375	1.621	0.022
	144	400	1.741	0.024
	152	425	1.929	0.025
	160	450	2.009	0.027
	164	475	2.049	0.028
	172	500	2.168	0.030
	176	525	2.184	0.031
	180	550	2.270	0.032
	184	575	2.329	0.034
	192	600	2.425	0.036

1/2 Inch Fully-Tempered Glass Data

> 41 inches tall
> 48 inches wide

Thickness of Glass (inches)		
Right Side	Top	Left Side
0.490	0.489	0.488
0.491	0.487	0.489
0.486	0.490	0.492
0.485	0.491	0.491
0.485	0.490	0.490

PIW Corporation
Glass Balustrade Wedge System

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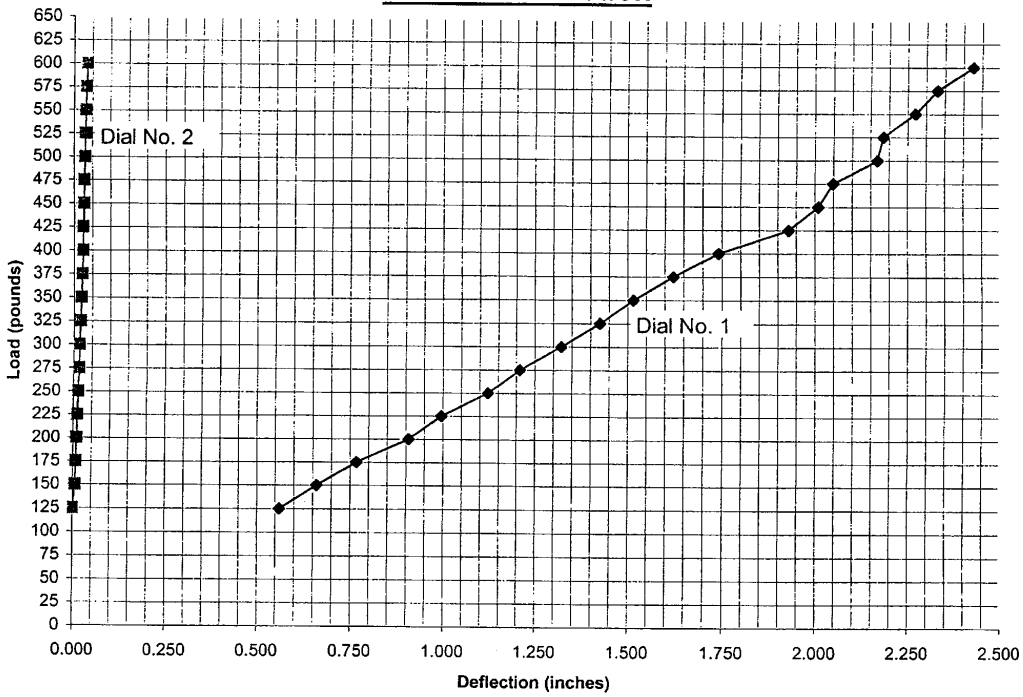
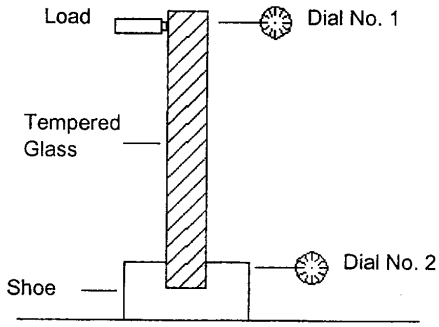
Bridgeview, Illinois
Ph. (708) 430-1071

Specimen No. 1 - Corner Test
48 inches wide
Por Roc System

Load Vs Deflection





Test Apparatus Configuration

Gauge No.1 - 2.0 inches below the top of glass @ center

Gauge No. 2 - 1/4 inch below the top of the shoe @ center

Load Application Location: 1/4 inch below the top of glass @ center

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Bridgeview, Illinois 60455

Test Specimen No. 4
Center Test

Glass Wedge System

Gauge No. 1- Top Location:	2.0 inches below the top of glass
Gauge No. 2 - Bottom Location:	1/4 inch below the top of the shoe @ Center
Gauge No. 3 -	Top of Wedge @ Center
Gauge No. 4 -	Top Side Corner of Wedge
Load Application Location:	1/4 inch below top of glass

Comments	Gauge Reading	Load (pounds)	Dial No. 1 (inches)	Dial No. 2 (inches)	Dial No. 3 (inches)	Dial No. 4 (inches)
Start	0	0	0.100	0.080	0.200	1.001
Intial Preload	28	100	0.460	0.085	0.200	1.005
Preload Release	0	0	0.105	0.080	0.200	1.001
Reset	0	0	0.105	0.080	0.200	1.001
Loading Start	36	125	0.563	0.086	0.200	1.004
	44	150	0.666	0.088	0.200	1.004
	52	175	0.778	0.090	0.200	1.004
	64	200	0.917	0.093	0.200	1.005
	72	225	1.040	0.096	0.200	1.0055
	84	250	1.169	0.099	0.200	1.006
	92	275	1.280	0.102	0.200	1.008
	104	300	1.415	0.105	0.2005	1.009
	112	325	1.523	0.109	0.201	1.0095
	124	350	1.669	0.111	0.2015	1.011
	132	375	1.773	0.113	0.202	1.012
	144	400	1.890	0.116	0.2025	1.013

1/2 Inch Fully-Tempered Glass Data

> 41-1/8 inches tall
> 48-1/16 inches wide

Thickness of Glass (inches)		
Right Side	Top	Left Side
0.485	0.490	0.489
0.485	0.490	0.489
0.485	0.488	0.489
0.485	0.490	0.489
0.485	0.490	0.489

PIW Corporation
Glass Balustrade Wedge System

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9824 Industrial Drive, Unit C
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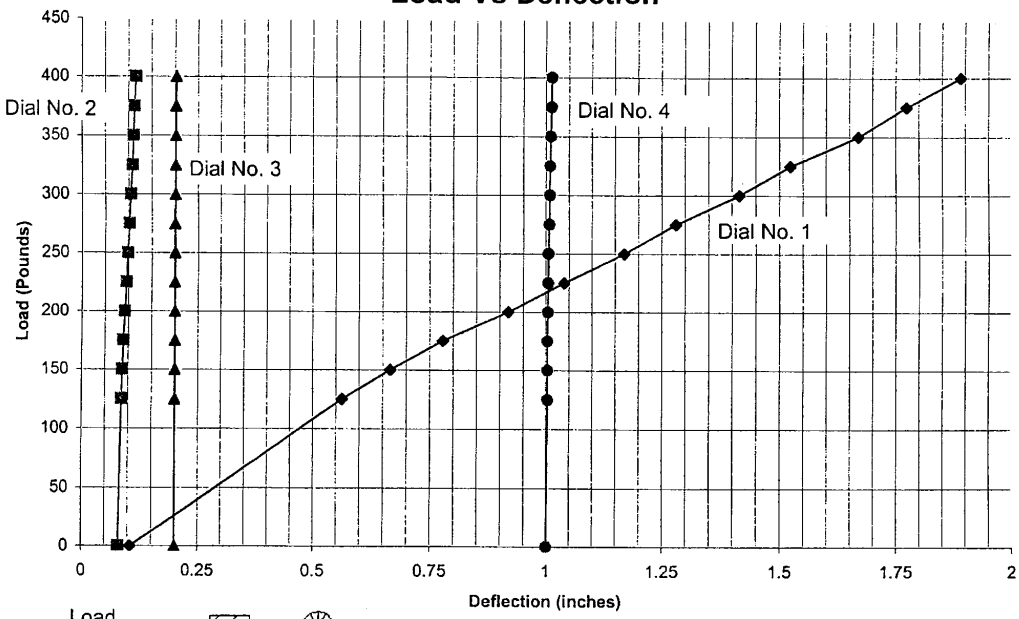
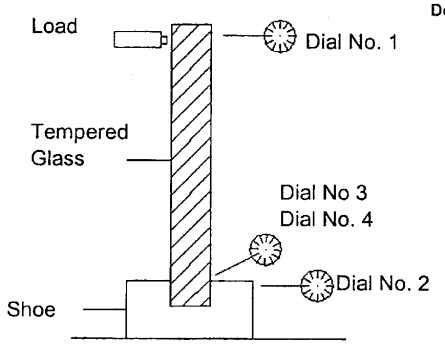
Specimen No. 4 - Center Test
48 inches wide
Glass Wedge System

Load Vs Deflection





Test Apparatus Configuration

Gauge No.1 - 2.0 inches below the top of glass @ center

Gauge No. 2 - 1/4 inch below the top of the shoe @ center

Gauge No.3 - Top of wedge @ center

Gauge No.4 - Top side corner of wedge

Load Application Location: 1/4 inch below the top of glass @ center

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Test Specimen No. 4
Corner Test
Left Hand Side
Glass Wedge System

Gauge No. 1- Top Location:	2.0 inches below the top of glass
Gauge No. 2 - Bottom Location:	1/4 inch below the top of the shoe @ Center
Gauge No. 3 -	Top of Wedge @ Center
Gauge No. 4 -	Top Side Corner of Wedge
Gauge No. 5 -	Top of Wedge at the Opposite Side @ Center
Load Application Location:	1/4 inch below top of glass

Comments	Gauge Reading	Load (pounds)	Dial No. 1 (inches)	Dial No. 2 (inches)	Dial No. 3 (inches)	Dial No. 4 (inches)	Dial No. 5 (inches)
Start	0	0	0	0	0.250	0.500	1.100
Initial Preload	28	100	0.005	0.018	0.250	0.500	1.100
Preload Release	0	0	0	8	0.250	0.500	1.100
Reset	0	0	0	0	0.250	0.500	1.100
Loading Start	36	125	0.009	0.023	0.250	0.500	1.101
	44	150	0.782	0.030	0.250	0.500	1.1015
	52	175	0.912	0.037	0.250	0.500	1.102
	64	200	1.063	0.045	0.250	0.500	1.1025
	72	225	1.192	0.052	0.251	0.500	1.103
	84	250	1.336	0.060	0.251	0.500	1.1035
	92	275	1.458	0.066	0.252	0.501	1.104
	104	300	1.592	0.073	0.252	0.501	1.104
	112	325	1.701	0.079	0.2525	0.501	1.1045
	124	350	1.848	0.087	0.253	0.501	1.105
Reset Dial Gauge	132	375	1.949	0.092	0.253	0.501	1.105
(no.1)	144	400	2.075	0.100	0.254	0.502	1.106
	152	425	2.193	0.105	0.254	0.502	1.106
	160	450	2.250	0.109	0.254	0.502	1.107
	164	475	2.303	0.112	0.255	0.502	1.107
	172	500	2.387	0.116	0.2555	0.502	1.107
	176	525	2.481	0.122	0.256	0.503	1.108
	180	550	2.481	0.122	0.256	0.503	1.108
	184	575	2.592	0.128	0.256	0.503	1.108
	192	600	2.592	0.128	0.256	0.503	1.108

1/2 Inch Fully-Tempered Glass Data

> 41 inches tall
> 48 inches wide

Thickness of Glass (inches)		
Right Side	Top	Left Side
0.490	0.489	0.488
0.491	0.487	0.489
0.486	0.490	0.492
0.485	0.491	0.491
0.485	0.490	0.490

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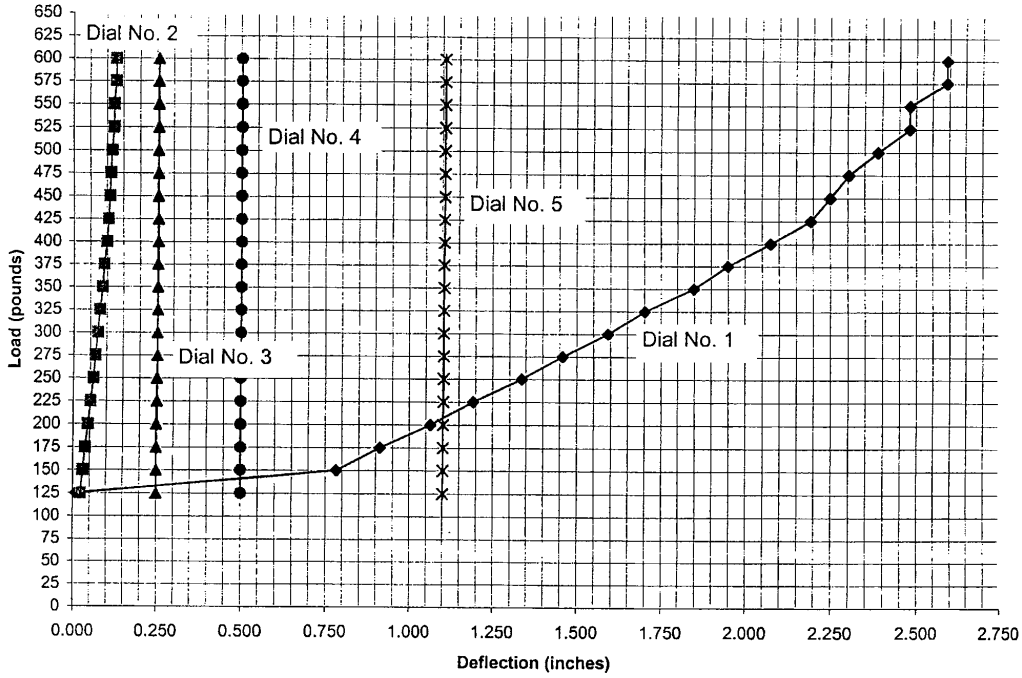
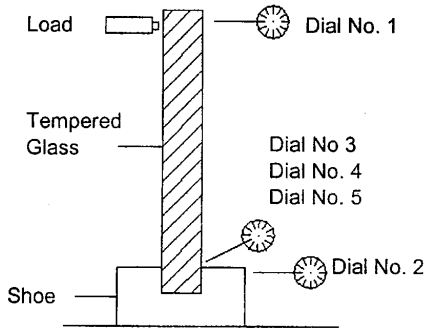
Bridgeview, Illinois
Ph. (708) 430-1071

PIW Corporation
Glass Balustrade Wedge System

Specimen No.4 - Corner Test
48 inches wide
Glass Wedge System

Load Vs Deflection





Test Apparatus Configuration

Gauge No.1 - 2.0 inches below the top of glass @ center

Gauge No. 2 - 1/4 inch below the top of the shoe @ center

Gauge No.3 - Top of wedge @ center

Gauge No.4 - Top side corner of wedge

Gauge No. 5 - Top of wedge at the opposite side @ center

Load Application Location: 1/4 inch below the top of glass @ center

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Bridgeview, Illinois 60455

Test Specimen No. 2
Center Test

Por Roc System

Gauge No. 1- Top Location:	5 inches below top of glass
Gauge No. 2 - Top of Shoe Location:	1/4 inch below the top of the shoe
Gauge No. 3 - Bottom of Glass Location:	2.0 inches above the top of the shoe
Load Application Location:	2.0 inches below top of glass

Comments	Gauge Reading	Load (pounds)	Dial No. 1 (inches)	Dial No. 2 (inches)	Dial No. 3 (inches)
Start	0	0	0	1.000	2.000
Initial Preload	28	100	0.469	0.997	1.990
Preload Release	0	0	0	1.000	2.000
Reset	0	0	0	0.995	1.982
Loading Start	44	150	0.882	0.991	1.972
	64	200	1.218	0.998	1.962
	84	250	1.522	0.983	1.951
Reset Dial Gauge 1	104	300	1.858	0.983	1.950
	124	350	2.092	0.979	1.939
	144	400			

** Specimen Broke- before reading

1/2 Inch Fully-Tempered Glass Data

> 41 inches tall
> 18 inches wide

Thickness of Glass (inches)		
Right Side	Top	Left Side
0.488	0.490	0.485
0.491	0.488	0.486
0.489	0.488	0.486
0.491	0.488	0.485
0.489	0.486	0.485

PIW Corporation
Glass Balustrade Wedge System

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9824 Industrial Drive, Unit C
Bridgeview, Illinois
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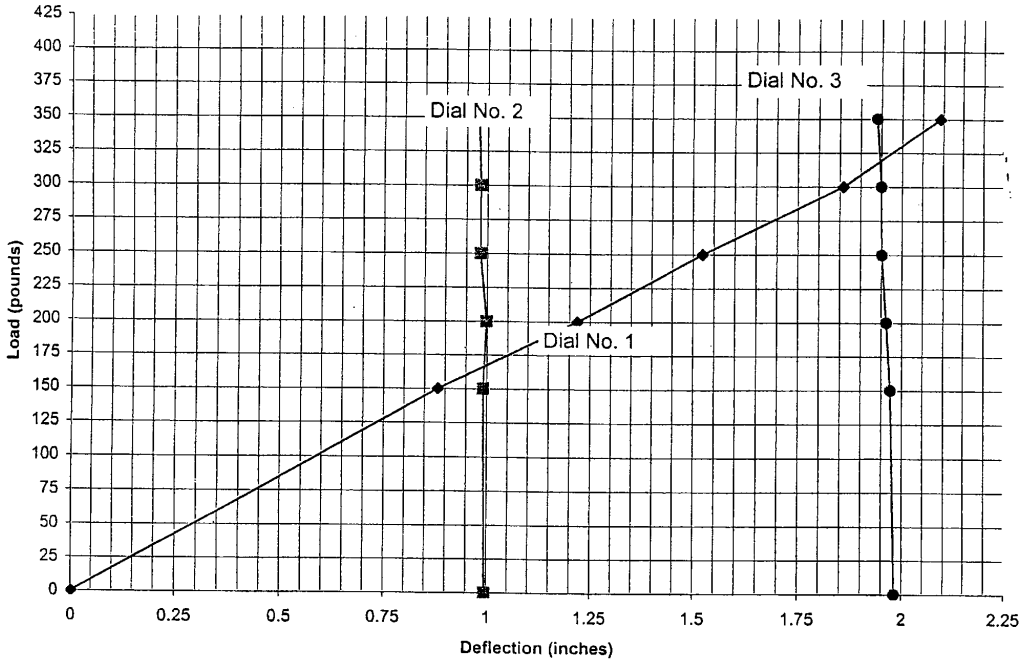
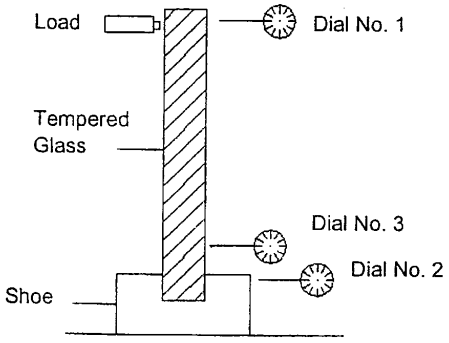
Specimen No. 2 - Center test
18 inches wide
Por Roc System

Load Vs Deflection





Test Apparatus Configuration

Gauge No.1 - 5 inches below the top of glass @ center

Gauge No. 2 - 1/4 inch below the top of the shoe @ center

Gauge No. 3 - 2.0 inches above the top of the shoe

Load Application Location: 2.0 inches below the top of glass @ center

GME Consultants, Inc
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Bridgeview, Illinois 60455

Test Specimen No. 3
Center Test

Glass Wedge System

Gauge No. 1- Top Location:	5 inches below top of glass
Gauge No. 2 - Top of Shoe Location:	1/4 inch below the top of the shoe
Gauge No. 3 - Bottom of Glass Location:	2.0 inches above the top of the shoe
Gauge No. 4 -	Top of Wedge @ Center
Gauge No. 5 -	Top Side Corner of Wedge
Load Application Location:	2.0 inches below top of glass

Comments	Gauge Reading	Load (pounds)	Dial No. 1 (inches)	Dial No. 2 (inches)	Dial No. 3 (inches)	Dial No. 4 (inches)	Dial No. 5 (inches)
Start	0	0	0	0.600	1.000	1.700	2.000
Initial Preload	28	100	0.68	0.693	0.973	1.700	2.000
Preload Release	0	0	0.002	0.600	0.999	1.700	2.000
Reset	0	0	0.002	0.600	0.999	1.700	2.000
Loading Start	44	150	0.906	0.686	0.956	1.697	2.001
	64	200	1.403	0.680	0.937	1.696	2.003
Reset Dial No. 1	84	250	1.724	0.674	0.921	1.695	2.004
Reset Ram	104	300	2.058	0.672	0.905	1.692	2.005
	124	350	2.815	0.655	0.870	1.690	2.005
	144	400	3.124				

** Specimen Broke- before reading

1/2 Inch Fully-Tempered Glass Data

> 41 inches tall
> 18 inches wide

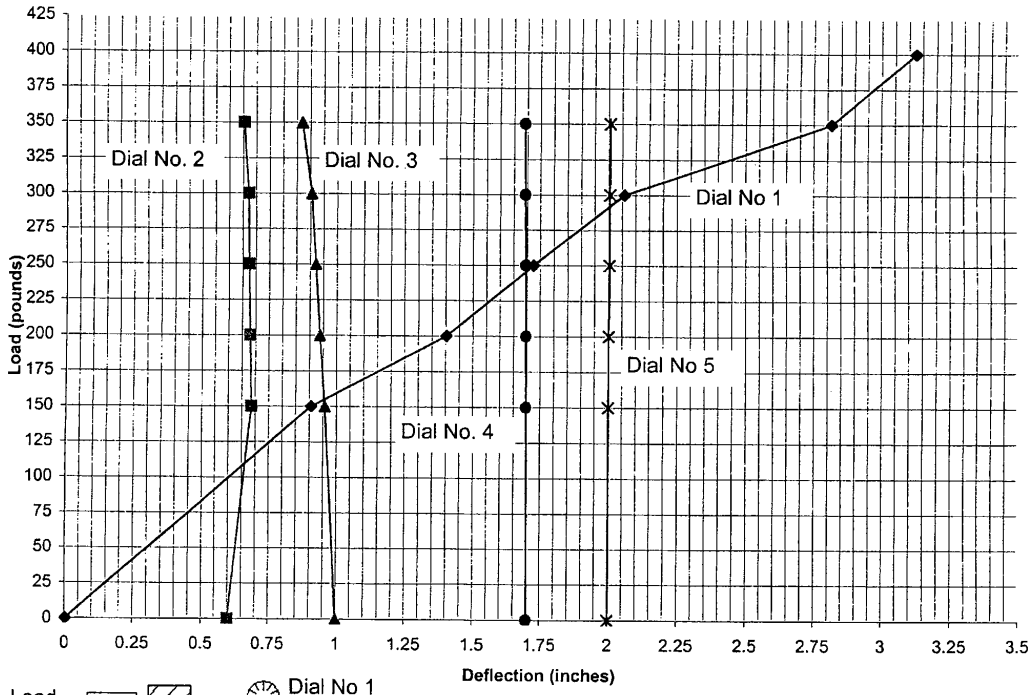
Thickness of Glass (inches)		
Right Side	Top	Left Side
0.488	0.490	0.485
0.491	0.488	0.486
0.489	0.488	0.486
0.491	0.488	0.485
0.489	0.486	0.485

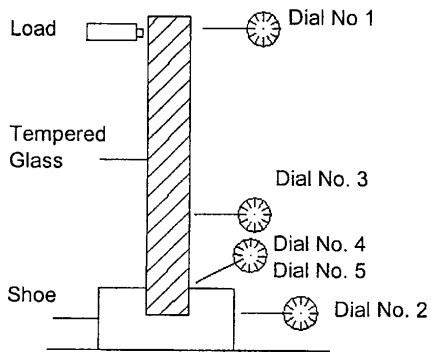
PIW Corporation
Glass Balustrade Wedge System

GME Consultants, Inc
9824 Industrial Drive, Unit C
Bridgeview, Illinois
Ph. (708) 430-1071

Specimen No. 3 - Center Test
18 inches wide
Glass Wedge System

Load Vs Deflection





Test Apparatus Configuration

Gauge No.1 - 5 inches below the top of glass @ center

Gauge No. 2 - 1/4 inch below the top of the shoe @ center

Gauge No.3 - 2.0 inches above the top of the shoe

Gauge No.4 - Top of wedge @ center

Gauge No. 5 - Top side corner of wedge

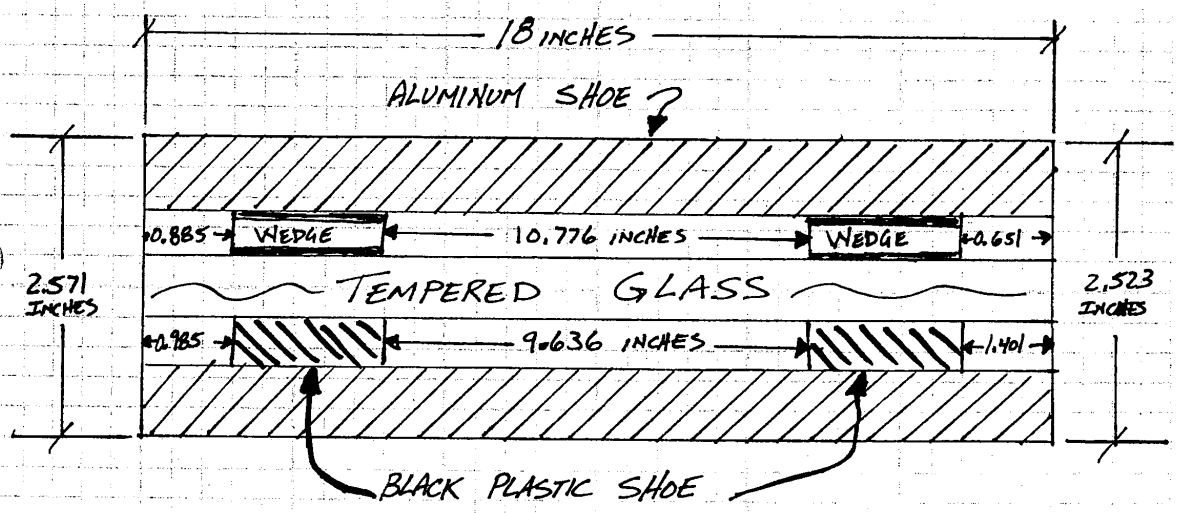
Load Application Location: 2.0 inches below the top of glass @ center

GME CONSULTANTS, INC.
Geotechnical • Materials • Environmental
Bridgeview, Illinois
(708) 430-1071
Fax (708) 430-9854

JOB NO. B-2632 SHEET _____ OF _____
JOB NAME PIW CORP. GLASS BALUSTRADE WEDGE SYSTEM
BY T. OPILA DATE _____
CHECKED BY _____ DATE _____

PIW CORPORATION GLASS BALUSTRADE WEDGE SYSTEM

SPECIMEN No.: 3



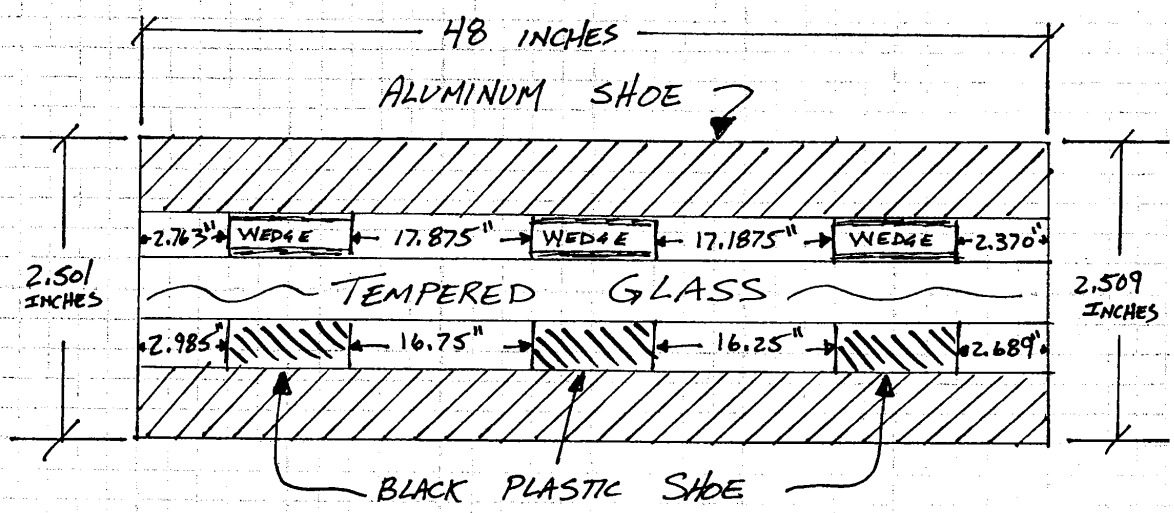
NOT TO SCALE

GME CONSULTANTS, INC.
Geotechnical • Materials • Environmental
Bridgeview, Illinois
(708) 430-1071
Fax (708) 430-9854

JOB NO. B-2632 SHEET _____ OF _____
JOB NAME PIW CORP. GLASS BALUSTRADE WEDGE SYSTEM
BY T. OPILA DATE _____
CHECKED BY _____ DATE _____

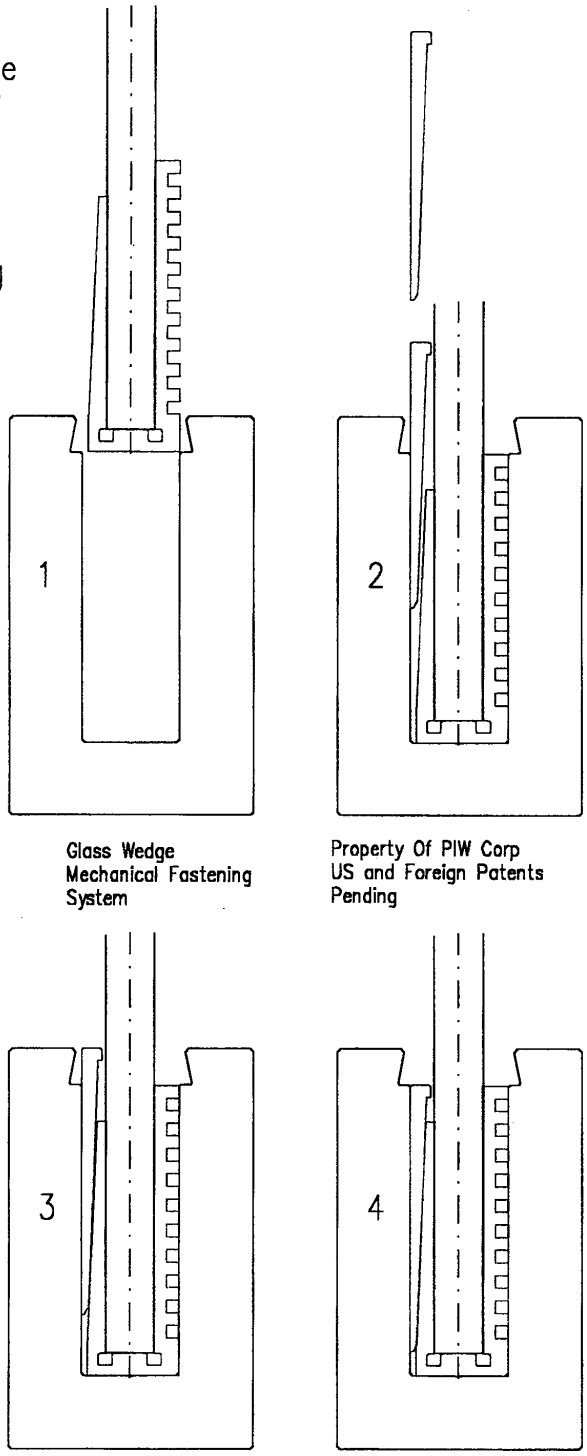
PIW CORPORATION GLASS BALUSTRADE WEDGE SYSTEM

SPECIMEN No.: 4



NOT TO SCALE

The Glass Wedge
Property of PIW
Corp and John
Shepherd
US and Foreign
patents pending

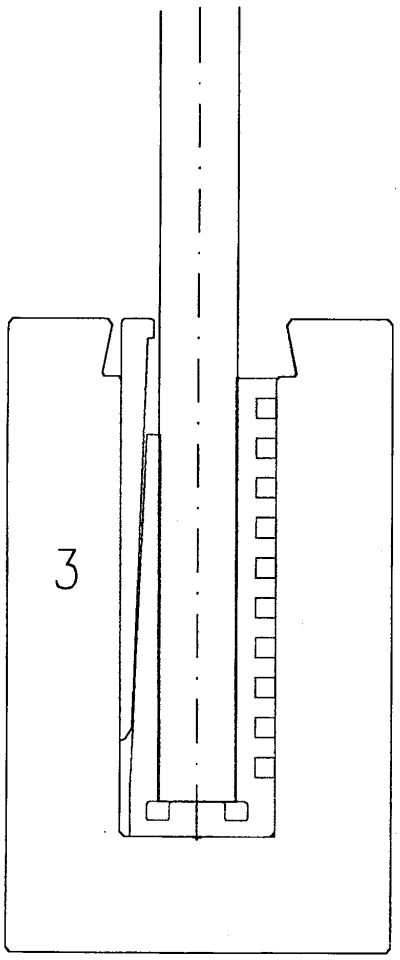


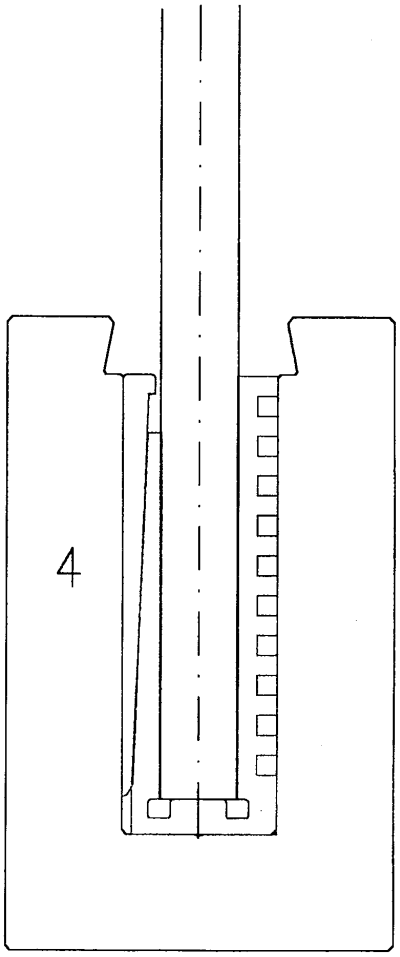
Glass Wedge
Mechanical Fastening
System

Property Of PIW Corp
US and Foreign Patents
Pending

The Glass Wedge
Property of PIW
Corp and John
Shepherd
US and Foreign
patents pending

Glass Wedge
Mechanical Fastening
System





PETER R. KRALLITSCH & ASSOC., LTD.

STRUCTURAL ENGINEERS

220 S. STATE STREET, SUITE 2112
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(312) 939-0603
FAX 939-8715

295 REBECCA STREET
CRYSTAL LAKE, IL 60014-3632
(815) 455-4880
FAX 455-3065

2/4/02

Mr. John Shepherd
P.I.W. Corporation
15765 Annico Drive
Lockport, IL 60441

Re: Glass Rail Base Support
PRKA #02004-3005

Dear John:

At your request, we evaluated your proposed mechanical glass rail base support, which you propose to use for 1/2" tempered glass guard rails of maximum 42" height. Guard rails and base connections were evaluated for 50 plf or 300# concentrated lateral load applied at he top of the rail, as required by both BOCA and Chicago Codes.

Base support, as proposed, consists of standard pre-manufactured aluminum rail shoe of minimum 4-1/8" high, which will be bolted to the concrete floor structure. The glass rail is proposed to be held in place within this rail shoe by 2-1/2"x3" PVC channels secured in place by means of aluminum wedges.

Based on our structural evaluation of the entire glass rail system, we recommend that PVC channels be spaced no more than 24" center to center, with minimum 2 channels per section of glass.

We have welcomed this opportunity to evaluate this rail support system for you. If you have any questions regarding the above, please call.

Very truly yours,
PETER R. KRALLITSCH & ASSOC., LTD.

Peter R. Krallitsch
PRK:emk
File: WP17\R\005-0202

STATE OF ILLINOIS
PETER R. KRALLITSCH
031-004470
LICENSED STRUCTURAL ENGINEER

PETER R. KRALLITSCH
& ASSOCIATES, LTD.
Structural Engineers
28 E. Jackson Blvd. Chicago, IL 60604
(312) 939-0603

JOB: PIW GLASS RAIL
SHEET NO. 1 OF
CALCULATED BY: PRK DATE: 1/20/02
CHECKED BY: DATE:
SCALE:

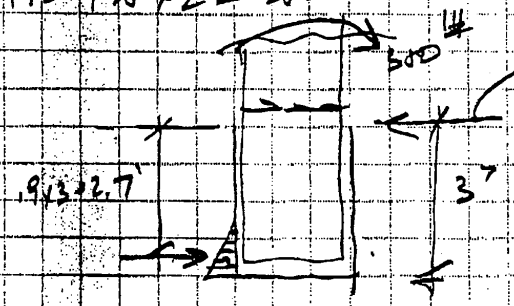
(A) 2" GLASS RAIL, 3'-6" HIGH
@50#/ft, M = 50 x 3.5 = 175#/ft

S_x = 12 x .5²/6 = .5 in³

f_b = 175 x 12/.5 = 4,200 PSI

(B) TWO 2½" BASE CLAMP @24"

M = 175 x 2 = 350#



350 x 12/2.7 = 1560#

ASSUME 2½" BRG. SURFACE

$f_v = \frac{1560 \times 1.5}{.5 \times 2.5}$ = 1872 P

FOR TEMPERED GLASS,
ASSUME F_v = 24,000 PSI

F_v = .4 x 24,000 = 9,600 PSI > 18

@300# CONC. LOAD, M = 300 x 3.5 = 1050# MAX

MIN. 2 CLAMPS, T = 1050 x 12/2.7 = 4667#

$f_v = \frac{4667 \times 1.5}{.5 \times 2 \times 2.5}$ = 2800 PSI < 9600 PSI

S_{MIN} = 1050 x 12/11,200 = 1.125 in³

C_t = .5", $\ell_{MIN} = \frac{1.125 \times 6}{.5^2}$ = 27" MIN. LENGTH OF GLASS REQ'D.

LIMIT SPACING OF BASE CLAMPS TO 24"

GLASS RAILING

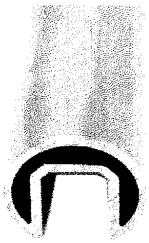
RAILING CAPS

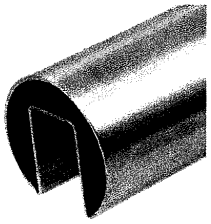
Aluminum
Extruded, 6063-T52, Mill Finish. Suitable for Anodizing.

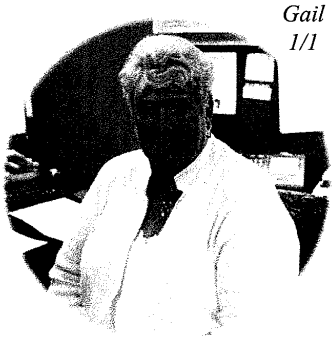
Brass
C27000, Yellow Brass, Satin or Polished Finish.

Stainless Steel
Type 304, Satin or Polished Finish.

Contact **Wagner** regarding other finishes.

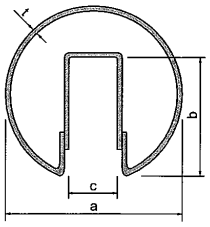






Gail 1/1

ROLL FORMED CAP RAIL 10' Length, except as noted

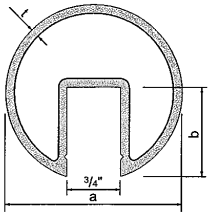


Two roll formed sections are welded together to provide this configuration. For ½" or ¾" glass, as noted. ***-14*** after the number indicates 14' lengths.

a	b	c	glass	t	Brass Satin Finish	Brass Polished	Stainless Satin Finish	Stainless Polished
1½"	1"	⅝"	½"	.050"	GR415L.4	GR415L.7	GR315L.4	GR315L.7
2"	1½"	¾"	½"	.050"	GR420L.4	GR420L.7	GR320L.4	GR320L.7
2"	1½"	⅞"	¾"	.050"			GR3207.4	GR3207.7
2"	1½"	⅞"	¾"	.050"			GR3207.4-14	GR3207.7-14
2½"	1½"	¾"	½"	.065"	GR425L.4	GR425L.7	GR325L.4	GR325L.7
2½"	1½"	⅞"	¾"	.062"			GR3257.4	GR3257.7
2½"	1½"	⅞"	¾"	.062"			GR3257.4-14	GR3257.7-14
3"	1½"	¾"	½"	.065"	GR430L.4	GR430L.7	GR330L.4	GR330L.7
3½"	1½"	¾"	½"	.065"	GR435L.4	GR435L.7	GR335L.4	GR335L.7
4"	1½"	¾"	½"	.065"	GR440L.4	GR440L.7	GR340L.4	GR340L.7

EXTRUDED CAP RAIL

20' Lengths, Mill Finish

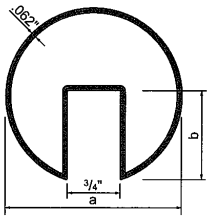


a	b	t	Aluminum	Satin Anodized Aluminum
1.66"	1"	.109"	GR2166	GR2166.4AN
1.90"	1¼"	.109"	GR2190	GR2190.4AN
2"	1¼"	.125"	GR2200	GR2200.4AN
2½"	1¼"	.125"	GR2250	GR2250.4AN

Suitable For Bending

DRAWN CAP RAIL

16' Lengths

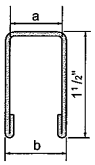


a	Brass Satin Finish	Brass Polished
2"	GR420V.4	GR420V.7
2½"	GR425V.4	GR425V.7

Suitable For Bending

U-CHANNEL CAP RAIL

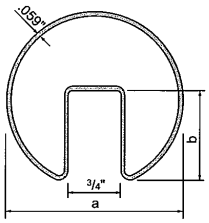
.062" Thick, 10' Lengths



a	b	glass	Stainless Satin Finish	Stainless Polished
¾"	⅞"	½"	GR30915.4	GR30915.7
1"	1⅛"	¾"	GR31115.4	GR31115.7

The U-Channel Cap protects the glass edge and secures glass panels together. Use with PVC inserts **GR9394** or **GR9395** with silicone **GR95CBL** to secure glass. Many local codes require that the glass cap railing meet a specific load requirement. Confirm with your local authorities prior to specifying the use of this glass cap style.

ROLL FORMED CAP RAIL 18' Lengths



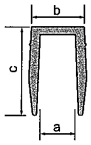
These stainless steel sections have *no visible seam*. For use with ½" glass or Wagnerail panels. See page 27 to 33. Type 316 alloy available on special order.

Suitable For Bending

a	Stainless Satin Finish	Stainless Polished
1¼"	GR3166.4	GR3166.7
1½"	GR3190.4	GR3190.7
2"	GR3200.4L	GR3200.7
2½"	GR3250.4L	GR3250.7

.4 indicates a circumferential satin finish; .4L indicates a longitudinal satin finish.

PROTECTIVE INSERT



a	b	c	length	PVC
⅜"	¾"	1"	10'	GR9396
½"	¾"	1"	10'	GR9397
½"	¾"	1¼"	10'	GR9394
¾"	⅞"	1¼"	10'	GR9395

These inserts protect the top edge of the glass from making contact with the metal rail cap. Secure with **GR95CBL** Silicone. Choose based on depth of Cap Rail and thickness of panel.

Code Note: *Many building codes require that glass railings have a minimum of 3 lites of glass with a guard rail cap in place that meets the structural load requirement for the guard. In the event of a panel failure, this will allow the guard rail to remain supported by at least two panels of glass.* ***In an end condition, if the cap rail is not affixed to the structure, this code may limit the width of the end panel since the cantilever stress on the cap rail needs to be taken into account.***

SCREW FASTENER CAPACITIES IN OSB

In order to finish a project that utilizes Premier Panels for the walls and roof of the structure, many types of materials need to be fastened to the panels. These materials can include, siding, roofing materials, other structural elements, cabinets, and a host of other items.

In many of these applications screws are the preferred fasteners. Data on the pullout and lateral withdrawal capacities of screws into OSB have not been readily accessible. To help clarify the performance of screws installed in OSB, a major manufacturer of OSB, took it upon itself to generate data on various screws installed in OSB. The OSB was exposed to three different environments. Fifteen repetitions of both direct and lateral withdrawal of each screw type, in each of the three environmental conditions were conducted. The following tables summarize the lowest, ultimate average, value achieved for a particular screw type when installed in three different thicknesses of OSB.

AVERAGE DIRECT WITHDRAWL (PULLOUT) – lbs.			
SCREW SIZE	7/16" OSB	5/8" OSB	3/4" OSB
#6 Deck Screw	177	272	324
#8 Deck Screw	182	309	359
#10 Deck Screw	198	355	363
#12 Roofing Screw	190	312	360
#14 Roofing Screw	177	340	393
These values are ultimate values. Appropriate safety factors should be applied to obtain design values.			

AVERAGE LATERAL WITHDRAWL (SHEAR) – lbs.			
SCREW SIZE	7/16" OSB	5/8" OSB	3/4" OSB
#6 Deck Screw	198	273	295
#8 Deck Screw	118	197	224
#10 Deck Screw	143	260	301
#12 Roofing Screw	436	581	561
#14 Roofing Screw	466	630	797
These values are ultimate values. Appropriate safety factors should be applied to obtain design values.			

Assume 10 psf net uplift on panels

10psf x 1'o/c x 4'o/c spacing = 40 lbs

#8 screw = 182 lbs

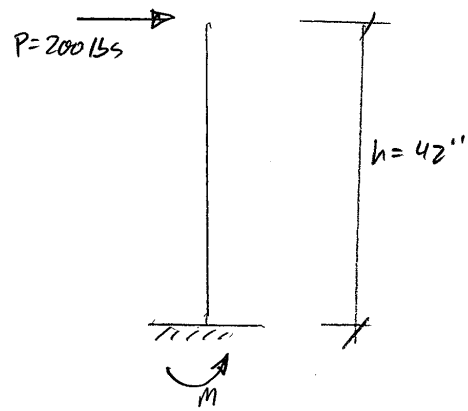
$FOS = \frac{182}{40} = 4.55$ ∴ Acceptable

Project: Solar Decathlon **Project #:** 09-137

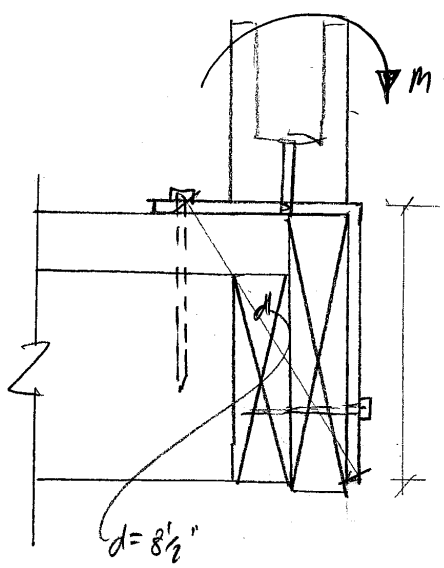
By: RZ **Date:** May 29/09.

Design Base Connection for handrail

- Design load = 200 lbs



Base Moment = P·h = 200x42 = 8400 in·lbs.



load shared by 2 connectors equally

∴ $\frac{8400 \text{ in·lbs}}{2} \div d = 8''$

= 525 lbs shear.

3/8"ϕ lag with 2½" embedment, single shear,

P_r = 2.87 kN = 645 lbs

∴ acceptable

WoodWorks® SOFTWARE FOR WOOD DESIGN	COMPANY	PROJECT
	May 28, 2009 20:31	08-137 SOLAR DECATHLON STAIR THREAD Beam1

Design Check Calculation Sheet

Sizer 7.0

LOADS:

Load	Type	Distribution	Pat-tern	Location [ft] Start	End	Magnitude Start	End	Unit
Load1	Live	Point		1.50		300		lbs

MAXIMUM REACTIONS (lbs) and BEARING LENGTHS (in) :

Unfactored:			
Dead	5		5
Live	150		150
Factored:			
Total	231		231
Bearing:			
Load Comb	#2		#2
Length	0.50*		0.50*
KB	1.00		1.00
Kd	1.00		1.00

*Min. bearing length for beams is 1/2" for exterior supports

Timber, D.Fir-L, No 2, 9-1/2x1-1/2"

Self-weight of 3.02 plf included in loads;
Lateral support: top= at supports, bottom= at supports;

WARNING: this CUSTOM SIZE is not in the database. Refer to online help.

Force vs. Resistance (lbs) and Deflection (in) using CSA O86-01:

Criterion	Analysis Value	Design Value	Analysis/Design
Shear	Vf @d = 230	Vr = 2046	Vf/Vr = 0.11
Moment(+)	Mf = 342	Mr = 384	Mf/Mr = 0.89
Perm. Defl'n	0.00 = <L/999	0.10 = L/360	0.01
Live Defl'n	0.08 = L/454	0.10 = L/360	0.79
Total Defl'n	0.08 = L/446	0.20 = L/180	0.40

ADDITIONAL DATA:

FACTORS:	f/E	KD	KH	KZ	KL	KT	KS	KN	LC#
Fv	218	1.00	1.00	1.100	-	1.00	1.00	-	#2
Fb+	1305	1.00	1.00	1.100	1.000	1.00	1.00	-	#2
Fcp	1015	-	-	1.150	-	1.00	1.00	-	#-
Es	1.4 million		-	-	-	1.00	1.00	-	#2

CRITICAL LOAD COMBINATIONS:

```
 Shear      : LC #2  = 1.25D + 1.5L
 Moment(+)  : LC #2  = 1.25D + 1.5L
 Deflection: LC #1  = 1.0D only  (permanent)
             LC #2  = 1.0D + 1.0L  (live)
             LC #2  = 1.0D + 1.0L  (total)
 Load Types: D=dead  W=wind  S=snow  H=earth,groundwater  E=earthquake
             L=live(use,occupancy)  Ls=live(storage,equipment)
 All Load Combinations (LCs) are listed in the Analysis Output
```

CALCULATIONS:

EI = 4e06 lb-in2

DESIGN NOTES:

1. WoodWorks analysis and design are in accordance with the 2005 National Building Code of Canada (NBCC) and the 2005 reprint of the CSA-O86-01 Engineering Design in Wood Standard, which includes the Jan. 2003 Update No. 1 and Jan. 2005 Supplement No. 1.
2. Please verify that the default deflection limits are appropriate for your application.
3. BEAMS require restraint against lateral displacement and rotation at points of bearing

* Stringer size acceptable by inspection

	Hot Water	Laundry	Dishwasher	Cooking	Dinner Party	
Day 8	45	30	13.5	2	5	
Day 9	45	30				
Day 10	45		4.5	2		
Day 11	45					
Day 12	45	30	9	2	5	
Day 13	45		4.5			
Day 14	45	30	4.5	2		
Day 15	45	30	4.5			
	360	150	40.5	8	10	

157 kWh/yr
1 load/day

30 g/load

16.4 L heavy wash
15 L heavy eco
15 normal
10 normal eco
10 delicate
5.7 fast

the yellow indicates that the dishwasher will be used to do dinner p

Fill Requirements (US Gallons)	
TST-1	512
GLT-1	1500
DCWT-1	800
Irrigation	50

"Ground"	Thermal Storage	Daily Use	* units are US gallons
1500	512	95.5	
		75	
		51.5	
		45	
		91	
		49.5	
		81.5	
		79.5	
1500			

TOTAL USGAL
2068.5
2172

5% Contingency

Total to Drain

USGAL

568.5

xurty dishes

NONE.

Sedmek Inc

514-3208 8th Ave NE, Calgary, AB T2A 7V8 (403) 804-3223 fax (403) 248-4248

Quote No. 2008-05030 retai

Pages 1

Customer

Company	Alberta Solar Decathlon	Attention	Matt
Address			
City	Calgary	Province	AB
Postal Code		Email	
Phone	403-210-7534	Fax	

Prepared By

David Kelly	
Prepared	29-Sep-08
Valid Until	29-Oct-08

Quote Description

36 Sanyo 205 watt modules retail price

Product Description	Qty	Model	Sale Quote Unit	Sale Quote Total
Sanyo 205 watt solar module BA19 Retail price	37	HIP205	$ 1,556.54	$ 57,581.98
			Subtotal	$ 57,581.98
			GST	$ 2,879.00
			Total	$ 60,471.98

FOB Calgary unless otherwise specified.

Notes

Retail PV Price Quotes

Summary of Reconfigurable Features

04-Dec-2008

Solar Decathlon 2009

INTERCONNECTION APPLICATION FORM

Team Alberta, Lot 106

team name and lot number

PV SYSTEMS

Module Manufacturer	Short Description of Array	DC Rating of Array (sum of the DC ratings)
Sanyo	1 HIT205-BA19 Module per inverter	205W

Total DC power of all arrays is 7.6 kW (in tenths).

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

INVERTERS

Inverter Manufacturer	Model Number	Voltage	Rating (kVA or kW)	Quantity
Enphase	M200-32-240-S01/2	240V	200W	37

Total AC power of all inverters is 7 kVA or kW (in whole numbers).

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Please include the following in the Project Manual:

1) One-line electrical schematic – the loads do not have to be detailed.
2) Calculations of service/feeder net computed load and neutral load (NEC 220)
3) Plan view of the lot showing the house, decks, ramps, tour paths and the service point.
4) Elevation view(s) showing the terminal box (contains the service point), meter, and other service equipment (such as the distribution panel or load center).

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

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.

Energy Analysis

Alberta Solar Decathlon Team
Faculty of Environmental Design, University of Calgary,
2500 University Drive NW, Calgary, AB T2N 1N4 Canada
403.210.7534 **www.solabode.ca**

Introduction

SolAbode engineers used simulation along with basic spreadsheet energy analyses throughout the design process to inform design decisions and arrive at an optimal solution that satisfied the home's energy demands while maintaining livability and excellence in design. Energy analysis is ongoing; the home is equipped with continuous monitoring equipment to measure many performance parameters (e.g., power demand/production at each circuit in the electrical panel, temperatures at various points in the system, flow rates in pressurized systems). Not only does this information allow us to calibrate our models, of which our TRNSYS one is the most advanced and complex, but it ensures the *SolAbode* will remain a positive research tool for generations of students to come.

This section is divided into three sections. The first, "Energy Supply Systems", briefly comments on the photovoltaic and solar thermal production capacity of the system as designed (refer to the mechanical and electrical plans for details). The second, "Static (Non-weather dependant) Load Analysis" summarizes plug loads and other weather independent loads (e.g., laundry) during contest week only. The final section, "Dynamic Load Analysis", explores output from the TRNSYS model of our HVAC system that is comprised of many integrated parts (refer to M-103: System Schematic for details) and uses advanced control technologies (refer to control philosophy in the Engineering Narrative and control schematic). TRYNSYS has allowed the team to optimize the control philosophy for the system as well as to understand the performance of the system in response to changing conditions.

Energy Supply Systems

Basic feasibility analyses were done using RETScreen to estimate the relative performance of our system throughout the design process. This allowed us to estimate the effects of things like panel selection, inverter selection and system losses (e.g., via shading from the rooftop patio railings). The final estimates are shown below, assuming 94% inverter efficiency and 6% system loss due to shading (refer to Appendix: PV System Shading for details).

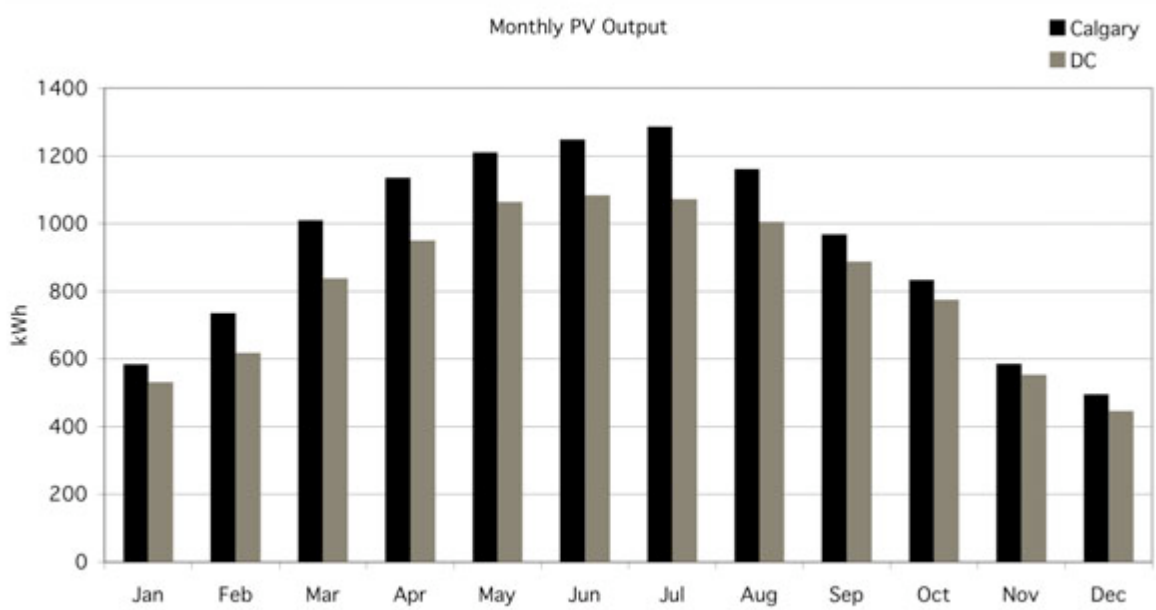


Figure ESS.1: Annual PV System Output

Solar thermal is a much more complicated energy supply to model, even at the level of feasibility analysis. The following chart shows an analysis done using FChart, for solar thermal energy, and EE4-DOE2.1, for monthly heating load (space and water heating), for a typical weather year in Calgary. It is obvious that the peak solar thermal production and peak heating demands are out of phase.

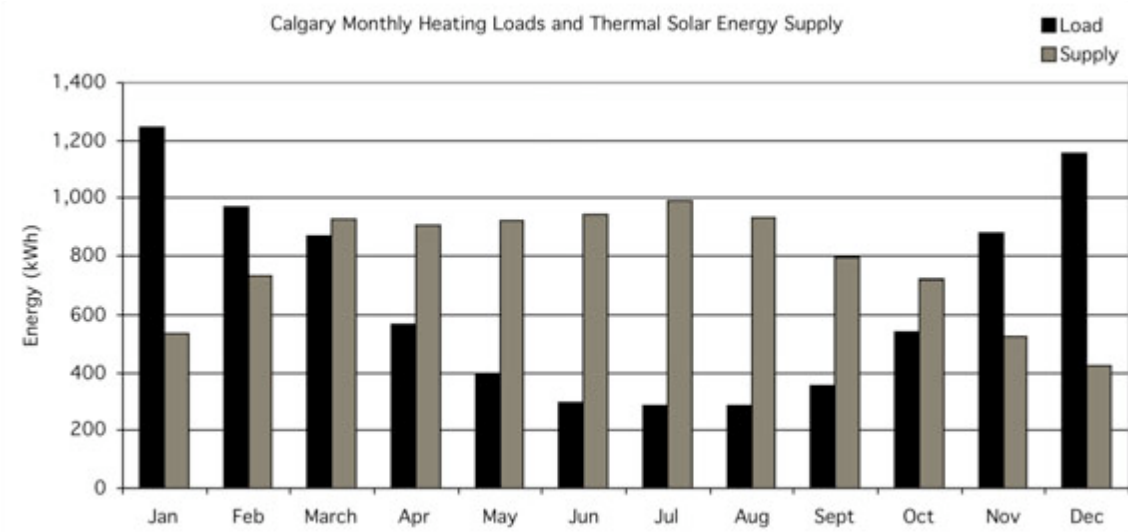


Figure ESS.2: Annual Heat Load and Supply for Calgary

The take away from the chart above is that the installation of large quantities of solar thermal may not necessarily benefit the homeowner, as the system will produce excess thermal energy when there is no load. Since there is no easy way to store large quantities of thermal energy seasonally, the team has sized the system such that the solar thermal will meet the domestic hot water load on an annual basis and that excess thermal energy be used and stored, as best it can, for the benefit of increasing the operational efficiency of a water-water heat pump. Refer to the Engineering Narrative for additional information.

Static (Non-weather dependent) Load Analysis:

The weather independent electrical loads for competition week were estimated using simulation as well as manual methods. Plug load energy use was estimated using nameplate or measured power ratings and run times from the competition schedule. High efficiency appliances and energy use estimates were identified using Natural Resources Canada's website and product information on the EnergyStar website. If published energy ratings were not available personal equipment was measured and usage rates applied. As a reasonability check, these numbers were then compared to those from the Building America's Miscellaneous Electric Load Analysis Spreadsheet as well as with data from an Equilibrium Home, a Canadian Mortgage and Housing Corporation sustainable building initiative.

Static loads during contest week are summarized in Table SLA.1.

Table SLA.1: Static Electrical Load Summary

LOAD DESCRIPTION	END USE CATEGORY	CONTEST ENERGY USE (Wh)
ERV	Ventilation	16000
Computer	Plug - Office/Home Entertainment	1150
TV	Plug - Office/Home Entertainment	2990
HTPC	Plug - Office/Home Entertainment	598
Home Audio	Plug - Office/Home Entertainment	24
Subwoofer	Plug - Office/Home Entertainment	144
Accessories	Plug - Office/Home Entertainment	30
PLC + Various Control	Controls/Automation	19200
Control4 Hardware	Controls/Automation	7680
Refrigerator	Kitchen Appliance	8921
Dishwasher	Kitchen Appliance	6698
Cooking Contest	Kitchen Appliance	8000
Cooktop - Dinner Party	Kitchen Appliance	3200
Oven - Dinner Party	Kitchen Appliance	3200
Clothes Washing	Laundry	1852
Clothes Drying	Laundry	14541
Hot Water	DHW	2000
Lighting - General	Lighting	14522
Lighting - Workstation	Lighting	301

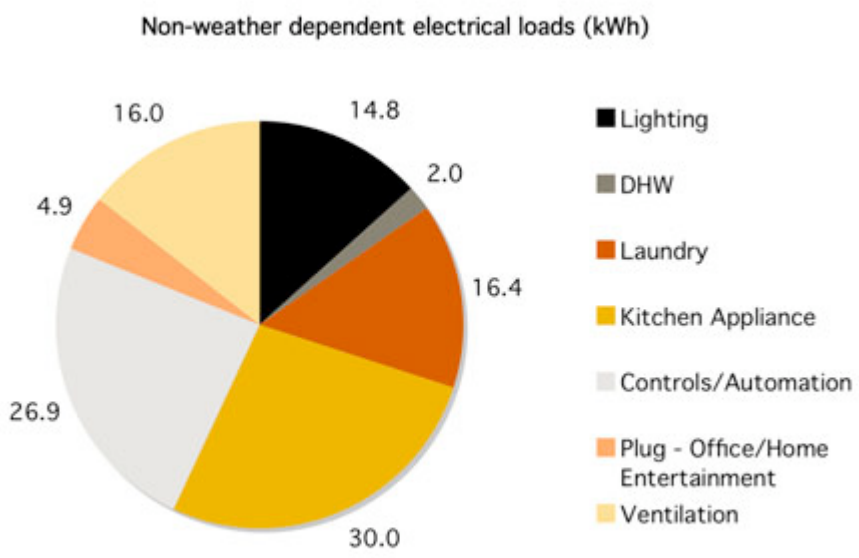


Figure SLA.1: Static Electrical Load Summary

It should be noted that the “Controls/Automation” estimate is likely high. At the time of writing the system had not been assembled or tested. Name-plate power ratings were used and assumed to be on for the 192 hours of contest week. It is highly unlikely that the devices will draw their name-plate power ratings continuously.

Dynamic Load Analysis and System Response:

A TRNSYS model was created for the home and mechanical systems to evaluate the performance over specific time periods. It can be seen in schematic view in Appendix: TRNSYS Schematic. The model allows us to view the operation at very short time intervals or cumulatively over long ones. This tool allowed the team to optimize and validate the control logic for different conditions and determine the cumulative benefits of the chosen logic. However, we recognize the complexity of the program and the need to make assumptions about different input parameters. Therefore, the team does not view the TRNSYS simulation as fact and recognizes the uncertainty inherent to its output. TRYNSYS has been

used as a tool to provide insight into the performance of the system and the relative benefits (or costs) of various design decisions.

Included in this Energy Analysis is a simulation over a 24 day period in October using typical meteorological year weather data. This simulates a range of operating scenarios that might be encountered during the competition. The simulation enabled the team to predict performance and evaluate contest strategies. The model was also run for a one-year period in Calgary to predict the performance in the home's target market. The results of both simulations are shown in Tables DLA.1 and DLA.2. It should be noted that only high-level output data is presented here for brevity and that the team has continuously used data at the component level to make system adjustments.

Table DLA.1 : Load Summary

	ENERGY USAGE (KWH)			
	WASHINGTON DC			CALGARY
ENERGY LOAD DESCRIPTION	OCTOBER 1 - 8	OCTOBER 9 - 16	OCTOBER 17 - 24	ANNUAL
House Cooling Load				
Sensible	35	30	19	863
Latent	34	29	11	466
Total Cooling	69	60	30	1330
House Heating Load	5	8	30	4242
Domestic Hot Water Load	60	60	60	3000
Equipment Electric Loads				
Heat Pump	29	19	11	2558
Fan Coil	14	14	19	1287
Pumps	7	7	9	481
Electric Hot Water Boost	2	0.4	0.4	213
Total Equipment	52	40	39	4539

Table DLA.2 shows the energy being exchanged between the house and the various components.

Table DLA.2: Thermal Energy Storage and Supply

ENERGY STORAGE/SUPPLY DESCRIPTION	ENERGY EXCHANGE (KWH)			
	WASHINGTON, DC			CALGARY
	OCTOBER 1 – 8	OCTOBER 9 – 16	OCTOBER 17- 24	ANNUAL
Heat Transfer – Ground Tank				
Energy from House	54	73	43	801
Energy Lost from Ground Tank to Atmosphere	-18	-83	-85	-788
Heat Transfer To Thermal Storage Tank				
Energy from House	5	-15	-44	-2565
Energy from Solar Collectors	45	70	83	3360
Energy Transferred to Domestic Hot Water Supply from Thermal Storage Tanks	-19	-35	-35	-518
Heat Transfer – Domestic Hot Water Tank				
Energy from Solar Collectors	8	19	23	520
Energy from Heat Pump	23	6	6	1727
Thermal Solar Energy				
Collected at panels	58	97	115	4182
Exchanged to Storage	-53	-90	-105	-3881

Figure DLA.1 provides a clearer picture of the sources of energy for heating the domestic hot water. The pre-heat from the thermal storage is shown to be a significant benefit. Direct solar heating from our flat-plate solar thermal collectors is also shown to be quite significant. The use of the heat pump for DHW heating can satisfy a large portion of the DHW load. This is significant: the heat pump is able to heat water to the set-point temperature (110 F) with a coefficient of performance (COP) of between two or three, if not greater. Compared to the instantaneous boiler, which has a resistance heater with an effective COP of 1, the heat pump results in significant energy savings.

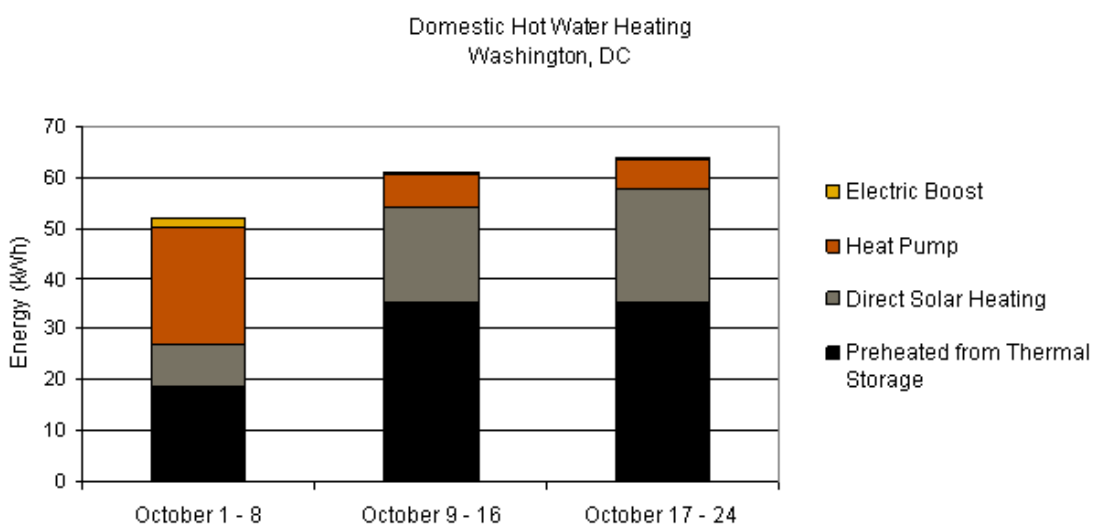


Figure DLA.1: Domestic Hot Water Heating

To demonstrate a detailed system response, several variables are graphed on an hourly basis over an 8 day period from October 9-16.

Figure DLA.2 shows the house and ambient temperatures. The model assumes the cooling and heating are turned off during public tours, and windows and doors are open allowing house conditions to match ambient conditions.

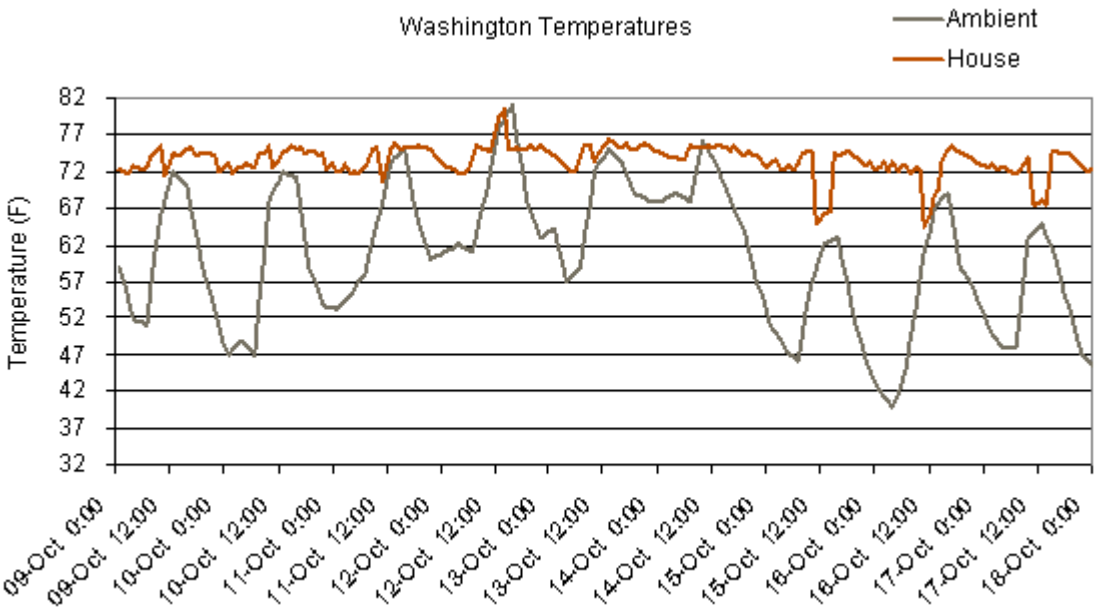


Figure DLA.2: Washington Temperatures

Figure DLA.3 shows solar radiation. This is presented to assist in understanding both the house temperatures in Figure DLA.2 and the thermal solar collection values below in Figure DLA.4.

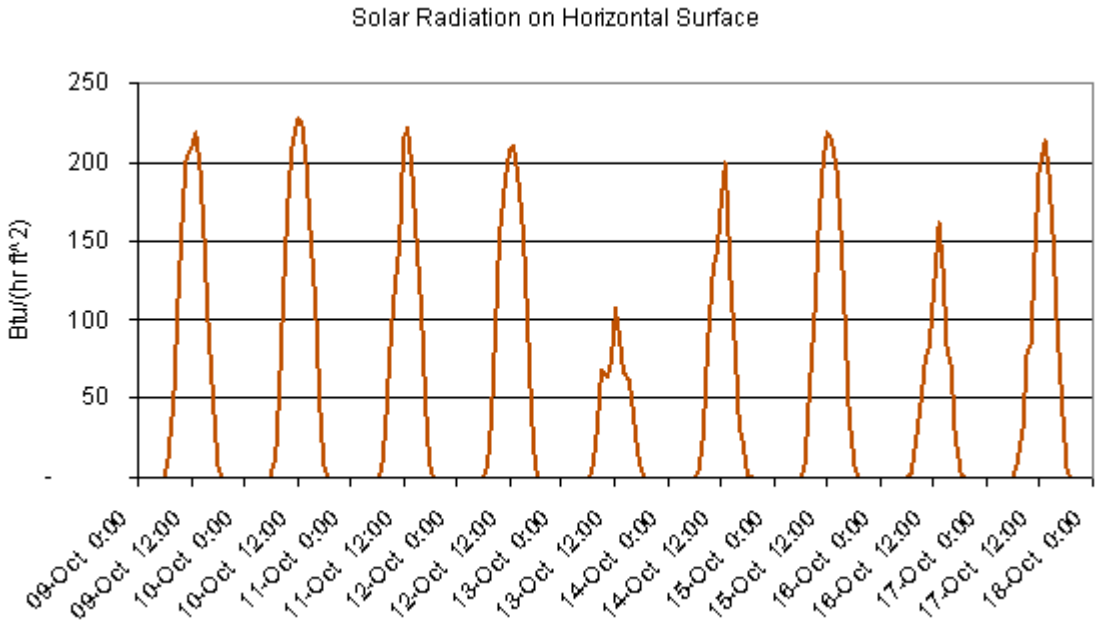


Figure DLA.3: Solar Radiation on a Horizontal Surface

It is interesting to note that when the radiation drops to just less than half of the normal peak values on October 13, the thermal solar energy collected that day is negligible. This suggests DHW will rely almost exclusively on electrical systems during a cloudy period. When this is the case, the efficiency gained by the heat pump relative to the resistance boiler becomes much more significant. Figure DLA.4 also shows that the east and west collectors extend the time during the day when energy is collected. This gives the DHW system a nice boost early in the day, prior to a morning shower, and late in the day, to allow for carry over through the night.

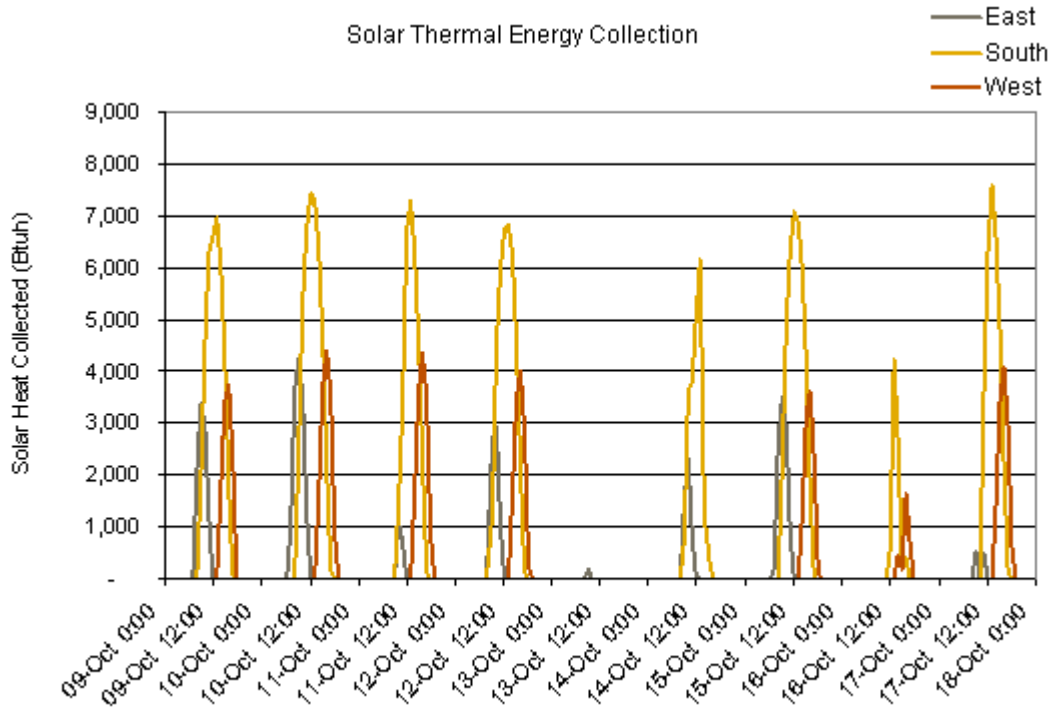


Figure DLA.4: Solar Thermal Energy Collection

Figure DLA.5 shows the electricity being used by the various mechanical components. There is a double-peak that is very noticeable on some days, particularly the first four days. The peaks occur when the heat pump and fan coil are cooling the house during the day. The dip in mid-day is due to public tours when the system is turned off and the windows and doors are opened. During the entire 24 day period in October, the maximum daily HVAC equipment electrical load is 14 kWh and the minimum daily load is 3.1 kWh.

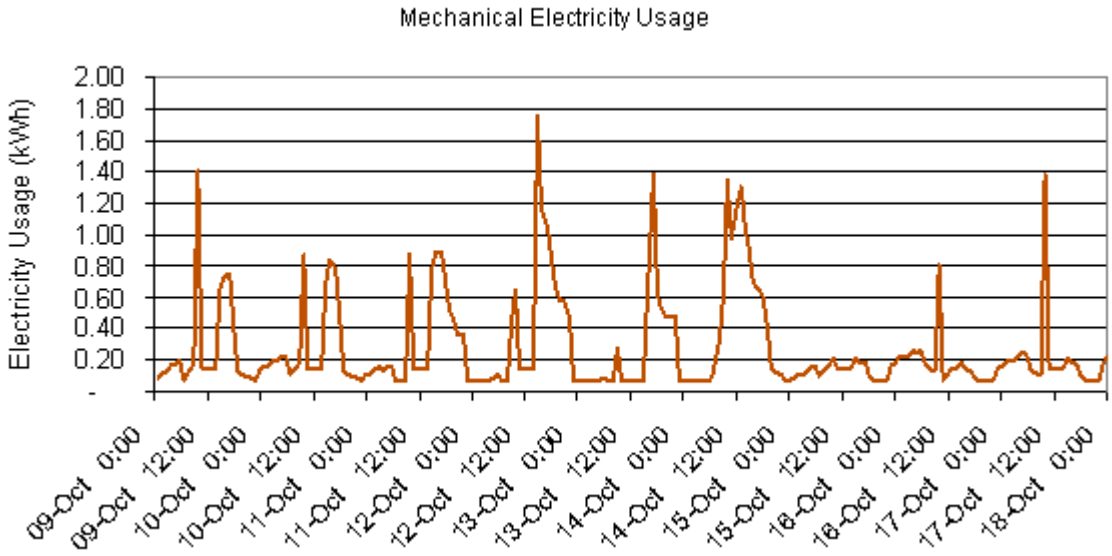


Figure DLA.5: Mechanical Electricity Usage

Only limited data has been presented here but the team has been able to observe in great detail the transient conditions as various points in the system and has used this information in determining

control logic and component sizing. The development of this model was very time consuming (and frustrating) but, once it was debugged and producing reasonable results, it has been an extremely valuable tool. The team was able to do hand calculations of system performance using a fixed set of initial conditions. This type of analysis was critical during the early stages of design. However, the complexity of the system warranted the development of a transient analysis tool.

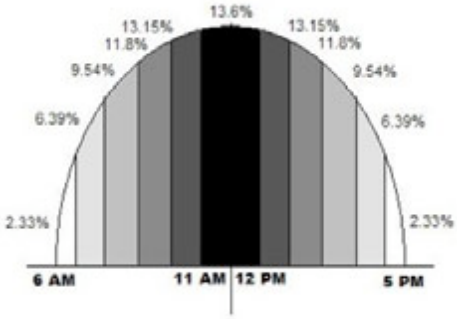
The team is continuing work on both the static and dynamic energy analyses, including the calibration of all models to observed data. The *SolAbode* is highly instrumented such that it can serve as a tool for further research to better understand the systems performance. This information will not only serve as a valuable learning experience for future students but will help develop more efficient systems and control scenarios.

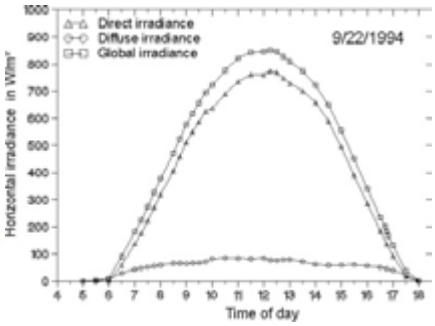
Appendix: PV System Shading Analysis

The following were used in estimating PV system losses due to the rooftop patio railings:

- The real-time shading engine in SketchUp and Google Earth

- Model Placed in National Mall at October 1, 2009
- Assumed that the power produced by the panels are proportional to the global solar irradiance at that time of day
- Estimated the irradiance curve using P = -900 / 5.5^2 * t^2 + 900. This produces a parabola over 11 hr of daylight.





- Integrated to calculate the energy produced as a percentage of the total power per hour, and estimated the number of panels covered for each interval.
- (total panels - panels lost to shading x percentage energy lost) / total panels = total efficiency after shading
- Estimate losses of 6% affecting 18 panels

1.07 ARCHITECTURAL DESIGN NARRATIVE

.1 This home is as much a reflection of the Alberta environment from the historic vernacular context of the wooden post and beam structure to the stone clad core. Sol Abode is a home that connects people a modular, sustainable, livable environment.

.2 Natural elements suspended in time have been incorporated into the design of this home. There are three main exterior materials of the home: weathered wood, oxidized steel, and stone tile. Secondary exterior materials create a relationship between the exterior and interior and include perforations in oxidized steel, clear glass and solar thermal panels.

.3The weathered wood siding encases the majority of the north, and half of the east and west elevations of the home. The horizontal wood siding protrudes from the main exterior envelope and is detailed with ½" spaces. This building component acts as a linear aesthetic element and a rain screen for the home exterior, while highlighting the importance of protecting north elevations from the harsh Canadian winter climate. Several students disassembled an old barn to collect this wood from a farm outside of Calgary.

.4 An oxidized steel cladding sits back from our wood cladding exterior, highlighting the paneled envelope sip exterior and acting as rain screen. Perforations throughout the steel cladding digitize a cloud scene crossing the north elevation. Both wood and steel elements tie together the three main modules of the home into a cohesive built environment.

.5 The exterior of Sol Abode has a roof top deck increasing the usable square footage and outdoor living space. This feature increases the market viability of such a small home in an urban environment.

.6 The primary structure of the home is an interior wood post & beam assembly. The post and beam highlights western Canadian timber frame design, utilizes natural ventilation techniques and aids in the modular assembly and disassembly of the home. The exterior wall assembly is an innovative use of stress skin panels (sips) mounted to the post and beams; typically these are used in a residential load bearing envelope. In this home these panels have applied as a commercial cladding in order to meet lateral loads while acting as a superior insulator.

.7 The east room of the home is a work and live environment, with full bedroom, storage, and adjustable office work surface. Low slung ceilings throughout the entry corridor, office and bedroom expand the relationship between interior and exterior and highlight the south facing full wall tract door. Built in cabinetry, storage and Murphy beds create flexibility within the bedroom and offer a cozy bedroom or an open yoga space.

.8 An open living-kitchen area in the west end of the home is conducive to large parties and conversational cooking. The kitchen island expands, allowing for intimate dinner parties. In contrast, a storage unit under the sofa wheels out inviting cocktail goers, diners, guests and occupants to relax in front of the tv.

.9 The inclusion of DIRTT modular wall system, Molo seating, flexible surface areas, cabinetry and the kitchen island provide a clean, multi-purpose modern interior finish which complements the vernacular timber structure. 3-form, Ice-stone (c2c) and Ozoloc are innovative, clean interior finishes boasting high recycled content while, creating a contemporary finish.

.10 The stone bathroom creates a play between public and private space, segregating the toilet through careful placement of washer and dryer while opening the shower and vanity into a wet room. Darker stone tiles are highlighted by feature tiles, lighting, and hardware while architectural features such as the light keyway and vision window increase the ambience of a cavernous core.

.11 Day lighting within the home plays with the SolAbode exterior material palette and is accented architecturally through south facing exterior blinds, oxidized steel perforations, north corner feature windows, passive solar glazing and the keyway light well. In addition, the keyway literally divides public space from private space while playing with this divide in moments of intimacy.

.12 The lighting design for Solabode is designed around three objectives: function, aesthetics and energy efficiency. To achieve these objectives, a majority of LED lamps of been implemented from a local Calgary company. The luminaires are primarily recessed while focal architectural areas have been accented by pendants and cove luminaires.

Market Viability Justification

Team Alberta's 2009 United States Department of Energy Solar Decathlon Entry, SolAbode, has been developed as a showcase of what is possible at the high end of the Calgary market when it comes to net-zero energy solar home construction. Finishes, technology, ecological design intent and designer millwork and furnishings set this modestly sized home apart from other options on the market today. The information included in this document serves to introduce you to the SolAbode. With references to information in our Construction Drawings, Specifications and Cost Estimate we intend to make the case that the SolAbode is not just a simple entry into an international competition, but in fact a home that Calgarians would (and already did) purchase for their own enjoyment, lifestyle and ecological values.

- We will show you how our entry responds to the specific needs and preferences of the target market outlined in Table 1 below.
- We will show you that the SolAbode is an eminently livable home, through its integration of technology, beauty, functionality and its ability to turn the complex nature of high-tech energy efficient homes into something that is secondary to the experience of living.
- We will show you that the SolAbode is ready to be built according to our team's design intent by any contractor who chooses to pick up our construction documents.
- We will show that the SolAbode is a market-ready product with quality craftsmanship and a design that is rooted in the Calgary of today, while drawing from its past and leading the way forward to a better future.
- And finally, we will provide you with a detailed cost estimate of our home as it is set up in Washington, DC for the competition week.

By the end of your review of our project, we hope you will agree that Team Alberta's SolAbode is well positioned to enter the Calgary real estate market and fulfill our team's goal of designing an innovative home for a brighter future.

MARKET ID PARAMETER	TEAM ALBERTA'S SOLABODE
Location of permanent site	Calgary, AB
Housing type	Single Family, eco-inovative residential
# of occupants	2
Occupant Demographic	Late 20's to Late 30's values-driven entrepreneurial couple
Home owner annual income	$200,000
# of Bedrooms	1
May 2009 Average Home price	$436,000

Engineering Narrative

Note: This section begins with a general introduction to the engineered systems within the Alberta Solar Decathlon's house, the *SolAbode*. **All jurors are encouraged to read the Introduction**. The balance of the "Engineering Narrative" is divided into sections that focus on particular aspects of our design. We understand not all jurors have similar areas of interest, and that the jury has a limited amount of time to review this document and our drawings in their entirety. We encourage those jurors who have an interest in a particular topic to take the time to review the relevant section. **We do, however, urge the jury to allocate enough time to review our drawings in detail.**

Table of Contents:

Introduction: 2
Determination of Heating and Cooling Loads 5
Energy Supply System Narrative 5
Solar Thermal, Domestic Hot Water & *Legionella* 5
Solar-Assisted Heat Pumps - Background Research 7

Introduction:

The design approach for the mechanical systems in Team Alberta's *SolAbode* was and is rooted in the following principles:

- energy savings shall not result from reductions in thermal comfort or indoor air quality (IAQ)
- the use of off-the-shelf components will illustrate the potential of today's technology, with proven reliability and support infrastructure, for energy-efficient system designs
- where possible, components should be multi-purposed and integrated to maximize overall system performance, capitalize on synergistic opportunities and reduce the number of pieces of equipment.

The resulting design, which is best seen as a schematic on drawing M-103, comes with a cost that homeowners today do not typically bear: the need for advanced control systems. We believe this cost is justified, especially given the nature of this project and the resulting benefits of having Web-enabled intelligent controls. It is well understood in the commercial building industry that controls play a large role in the overall energy use of a building, and better controls offer a significant opportunity for reducing energy use at no cost to comfort or IAQ. 'Low-tech' options, such as proper scheduling and set-back strategies, are easy to implement and can result in large energy savings at little marginal cost (once the system is in place)[1]. A specialized industry has developed that monitors commercial buildings online and can respond quickly to any system alarm or failure. To apply a similar model to the residential market, especially given the potential for energy use reductions, is not an unreasonable prospect. The *SolAbode* can be monitored and controlled from anywhere in the world. The system can email the homeowner and dispatch maintenance personnel at the time of failure, which will expedite repair and could prevent damage to the system or the home itself.

An implicit constraint when designing a heating, ventilating and air-conditioning (HVAC) system for a 100% solar powered home is that only direct solar thermal energy and electricity may be used. This limits equipment options and favors the use of heat pumps as plant equipment for heating and cooling. In response to this fact, the opposing load profiles between Washington, D.C. and Calgary, the constraints and requirements of the competition, and other technological limitations, our team is using a solar-assisted ground source heat pump with forced air for thermal control. An air-based system was selected in lieu of a low exergy[2] radiant one, which is more directly compatible with solar thermal systems, due to the flexibility and speed of forced air in meeting both heating and cooling loads[3]. Background research on solar-assisted heat pump systems can be found in the supplemental materials.

With these facts in mind, Team Alberta engineers designed a system and control philosophy that operates around these three tenets:

1. the heating efficiency of a heat pump is directly related to the source fluid's approach temperature

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[1] Murphy, J. and Maldeis, N. (2009). *Using Time-of-Day Scheduling to Save Energy*. ASHRAE Journal, vol. 51(5): 42-48.

[2] In this context exergy refers to the use of low-quality energy (e.g., solar thermal as compared to energy-dense natural gas) in heating and cooling applications Refer to the International Energy Agency's Annex 49 (www.annex49.com) for additional information.

[3] The competition defines thermal comfort only in terms of dry bulb air temperature and relative humidity. These comfort criteria penalize low exergy radiant systems; large radiant surfaces offer the possibility of maintaining lower ambient dry bulb temperatures while satisfying occupant comfort conditions (i.e. via an equivalent operative temperature). Large radiant surfaces designed to meet dry bulb air temperatures of 72-76° F effectively become large convectors that may use operating fluids at higher temperatures than would otherwise be employed in such systems. The operative temperature in this environment, which accounts for radiant effects, could be outside the traditional and industry recognized comfort range (please refer to ASHRAE Standard 55 for additional information on thermal comfort and operative temperature).

2. the cooling efficiency of a heat pump is inversely related to the source fluid's approach temperature (i.e., a higher approach temperature on the source side results in a lower efficiency for the heat pump)
3. the efficiency of solar thermal collectors is inversely related to the operating fluid's approach temperature (i.e., the cooler the fluid flowing into the panels, the greater their operational efficiency)

Generally speaking and as related to our system shown on M-103: the use of a large thermal storage tank (TST-1) addresses points (1) and (3), and the use of an even larger "ground loop tank" (GLT-1) addresses point (2). The devil, of course, is in the details of control.

Our control philosophy is guided by the three tenets stated above and uses temperature-based logic to determine system behavior in response to observed loads (i.e. space and/or water heating, space cooling and/or dehumidification). A summary of general control scenarios, including examples of how equipment has been integrated such that it is multi-purposed, is provided below:

- Heat from the domestic hot water (DHW) tank (DHWT-1), generated using solar thermal, can be drawn down for space heating. By using the DHW tank as a "buffer tank" and using the heat pump to heat domestic hot water directly, short cycling of the heat pump can be avoided. Short cycling behavior was observed in a TRNSYS simulation of the system when the heat pump load-side was directly supplying the fan coil unit (FCU-1) for heating.
- The heat pump is used for both space and service water heating and space cooling. The source-side flow configuration is determined in response to the relative temperatures in GLT-1 and TST-1 using logic based on points (1) and (2), above, although two unique scenarios are noted here. First, during space cooling, it may be desirable to reject heat to TST-1 for later use (for example, if the temperature in TST-1 was only marginally higher than in GLT-1). This comes with an electrical penalty relative to rejecting heat to the lower temperature fluid in GLT-1 due to reduced efficiency of the heat pump (as per point (2). Secondly, the situation may arise in heating mode where the temperature in TST-1 is high enough to cause the heat pump high-pressure switch to trip (refer to p. 11 of the Water Furnace EW product specifications at www.solabode.ca/specifications/). When this is the case, the proportional valve, V-202, mixes the high temperature fluid from TST-1 with lower temperature fluid from GLT-1.
- Water-side economizer cycles may be used when conditions permit for both heating and cooling using TST-1 and GLT-1, respectively. This is the preferred means of operation as it avoids the significant electrical load of the heat pump. Thermosyphons are used in GLT-1 to help facilitate greater use of this option. Specifically, they reject heat to ambient from GLT-1, effectively lowering the temperature of the water in the tank. This strategy is most effective when there are large diurnal temperature swings. With large diurnal swings, heat is rejected to TST-1 during the day (from house cooling), and at night the heat rejection effectiveness of the thermosyphons is improved via an increased difference in temperature between the two ends of the thermosyphon.
- Air-side economizer cycles use the "EconoCool" option of the energy recovery ventilator (ERV) (refer to p. 30 of UltimateAir 2000X manual at www.solabode.ca/specifications/). The control strategy makes full use of the ERV's capabilities for cooling and humidity control as well as for general ventilation.

The control sequencing is tailored to *SolAbode*'s mechanical systems. We recognize the detail and complexity of this design, but it is important to note that it need only be developed once to fit a common system. The marketability of a residential HVAC system such as that in *SolAbode*, or a similar system suited only for Calgary (i.e., one that is simplified for a single climate), becomes much more attractive once economies of scale are considered. The system and logic, once proven, are easily deployable despite the programming complexity.

Other system characteristics of note include:

- A DHW pre-heat coil is located in the solar thermal tank (TST-1) to temper incoming water for heating.
- The ERV draws exhaust air from the bathroom, which is centrally located in the house and is the location of the "dirtiest" air. Outside air is delivered through the central ductwork to the registers located at the perimeter of the home. The intent of this design is to allow the outside air (the "clean" air) to flow through the occupied living spaces prior to being

exhausted. Normal operation of the ERV can be manually overridden to increase bathroom exhaust as desired. This configuration maximizes ventilation effectiveness for IAQ.

- Due to inherent shading conditions imposed on the photovoltaic (PV) array because of the centrally located, protruding roof deck, micro-inverters were specified to minimize the negative effect of shading on PV system output.
- External louvered shading devices reduce cooling loads in summer and allow for passive heating in winter. Their control is integrated into *SolAbode*'s automation system.
- In response to the risk of *Legionella* bacteria development in solar thermal DHW systems, which can result from periods of sustained low-temperatures in the tank, our team has chosen an unconventional solution. The traditional solution comes with a large energy penalty (i.e. heating water to 140-160° F to kill the bacteria and then mixing down for scald prevention... Our team has installed a copper-silver ionization system typically used in commercial applications. While this may not be the best solution (a residential-scale unit would be preferred), we thought it was a good way to raise awareness of this issue. Should large-scale deployment of solar hot water heating occur, the issue of *Legionella* could become more prominent and we feel it is an issue worth thinking about today. Additional information can be found in the section titled "Solar Thermal, DHW and *Legionella*," below.
- The use of PLC controls permits the programming of the advanced logic required to operate the system as intended. As noted previously, because all the control components are Web-enabled, the system can alert the homeowner when problems arise. Additionally, the PLC drives all dimming and discrete circuits for the LED lighting and the operation of external shading devices. We took care to ensure the interface is user-friendly.
- The PLC exports performance data to an external server for logging. These data include: room temperature and humidity and system response; outside air temperature and humidity; flow rate and temperature difference across each solar thermal panel; flow rates and temperatures at various points in the heat pump system; and power demand and energy use at each circuit in the electrical panel. This information is then communicated back to the homeowner at his/her desired interval (daily reporting, weekly reporting, etc.). This report breaks down energy end use categorically, so the homeowner understands where the energy demands are greatest (e.g., lighting, laundry or hot water). This information can be very detailed or presented in a more simplified, aggregate form, depending on the homeowner's desires. Either way, greater knowledge and awareness about energy end use can drive greater behavioural-driven energy savings.

Engineering Narrative: Supplemental Information

Determination of Heating and Cooling Loads

Heating and cooling loads have been calculated using a variety of methods, including manual methods and simulation. Our home was initially modeled in HOT2000 and EE4/DOE2.1E to determine heating and cooling design loads and general energy use estimates. This was done for both the target market of Calgary and the competition site in Washington, DC. The tables below summarize the design heating and cooling loads, respectively, obtained using different methods.

Heating loads were calculated in Calgary, as it is the location where the home will be permanently sited and has the greater heating load relative to the two cities. Similarly, residential cooling is minimal in Calgary, so the cooling load was calculated for Washington, DC. These opposing load profiles complicated system design; however, *SolAbode* will be able to efficiently handle the opposing load profiles of the two climates.

Heating Design Loads (Btu/h)		
(Calgary)		
	Envelope	Ventilation/Infiltration
HRAI Method	18400	7200
Hot2000	20000	5000
EE4/DOE2	22000	6000

Cooling Design Loads (Btu/h)		
(Washington, DC)		
	Sensible	Latent
ASHRAE RLF	19000	3000
Hot2000	13800	4200
EE4/DOE2	18700	1900

Energy Supply System Narrative

The energy production potential and energy use of a house, in terms of envelope loads, are key factors in architectural design and must be weighed against aesthetic and lifestyle considerations. *SolAbode* seeks a functional balance between these two needs.

The heating requirements (i.e., space and DHW) in Calgary can be best met by using vertically oriented or near-vertical solar thermal collectors. Low angle to horizontally positioned thermal collection will perform poorly in the winter and would require a vast amount of thermal storage to carry over summer heat to the winter season. All the solar thermal installations on *SolAbode* home are oriented vertically. Flat plate collectors will be installed on the east-, south- and west-facing facades. The east-and west-facing panels were necessary to increase the total heat-generation potential,and analysis shows them to provide heating benefit (i.e. early morning and late day water heating when south-facing panels are not yet productive).

Grid-tied, net-metered photovoltaic (PV) modules essentially 'store' electricity in the grid. The supply does not, therefore, need to be timed to load. On an annual basis, PV modules perform best in Calgary at angles between 45 and 50 degrees. However, a single roof at this angle on *SolAbode*'s footprint would exceed the competition height constraint. A roof angle of 22 degrees results in an adequate surface area for sizing the PV array to meet our electrical load. The total installed capacity is 7.6 kW_p using Sanyo HIT-205 modules. Micro-inverters by Enphase Energy have been specified.

Solar Thermal, Domestic Hot Water & *Legionella*

SolAbode uses three means to meet the domestic hot water (DHW) load. The preferred method of heating water is solar thermal, followed by the heat pump and lastly by the flow-through electric boiler. The boiler will ensure proper delivery temperatures when the first two heating methods fail to adequately heat the water. The unit chosen, by Hubbel, is modulating (i.e., it 'steps up' the water temperature only to the desired set point regardless of incoming water temperature). Refer to control documentation for details as to how the water-based systems are controlled.

Warm water storage and distribution systems have been identified as potential major sources of *Legionella*. It has become evident that domestic (potable) water plumbing systems have become a significant source of the bacteria. In the past, large systems such as those of hotels and hospitals have been common modes of occurrence and transmission of the disease.

The dominant theory is that the disease is transmitted through aerosolized water droplets that people inhale directly. These droplets could be created by showers, humidifiers and evaporative coolers. Another emerging idea is that aspiration may be a disease vector. Aspiration is essentially what can happen during choking where fluids in the mouth bypass the choking reflex, going to the lungs instead of the esophagus and stomach.

Legionella growth in a building's water systems is dictated by one main parameter: temperature. The following table shows how *Legionella* production and water temperature (°F – highlighted) are related according to various organizations' standards.[4]

	CDC	ASHRAE	FREUE	ASHE/JCAHO
Store DCW (maximum) (°F)	-	68	68	-
Favorable for *Legionella* growth (°F)	90-105	77-108	68-122	77-108
Recirculating DHW (minimum)	-	124	122	124
Store DHW (minimum)	-	140	140	140
Bacteria die (°F)	-	140	131	131
Flush (thermal shock treatment) (°F) (minimum time in minutes)	149 (5)	160-170 (5-30)	158 (5-30)	131 (5)

As demonstrated above, there is little consensus among different governing professional groups as to what range conditions are most favorable for the bacteria's proliferation. However, one thing in common is the recommendation to store domestic water at a temperature at or above 140° F.

A recent study, of over 450 residences in Germany using district and solar heating for their domestic hot water systems, found a prevalence of more than 12% contamination with counts up to 100,000 CFU /mL in domestic water recirculation lines and storage tanks.[5] This demonstrates that *Legionella* is not just an issue for large facilities – it can even be present in our homes in the water we drink.

Since solar thermal domestic hot water systems can often provide hot water below the 140° F threshold, additional energy must be used to step up the temperature. While effective in addressing the *Legionella* concern, there is one problem with this technique: the water is too hot to use. The temperature must be reduced with a mixing valve for safe delivery at 110° F. This process uses significant amounts of energy. Additionally, this is in the prime incubation range for the microorganism, so it may not be entirely effective for downstream elimination.

When our team was tasked with dealing with this issue, we sought a solution that was going to be practical, effective, energy efficient and innovative. We wanted a solution that went beyond the

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[4] Adapted from: Fiek, J. (2003). *Controlling legionella: In health-care settings.* Heating/Piping/Air Conditioning Engineering, 75 (1) 64-68.

[5] Mathys, W., Stanke, J., Harnuth, M. & Junge-Mathys, E. (2008). *Occurrence of legionella in hot water systems of single-family residences in suburbs of two German cities with special reference to solar and district heating.* Int. J. Hyg. Environ. Health, 211, 179-185.

conventional approach of simply boosting water temperature with another energy source, such as electricity generated from limited (and expensive) PV panels.

We looked at what health care facilities used and compared their various control methods. Some were known to work, such as hyper-chlorination (which may be unpleasant for the consumer) and heat-and-flush methods (which uses a large amount of energy), but would not be practical at the residential scale.

Our team decided to use copper-silver (Cu-Ag) ionization – a tried-and-true method used in hospitals to rid their systems of *Legionella*. Using a flow-through chamber that injects a small amount of ions into the water stream, the bacteria are effectively attacked. At the small ion concentrations, there is no risk for humans.

Major benefits of Cu-Ag ionization:

- Our DHW set point temperature can be below 140° F (i.e., 110° F), so no need to boost temperature with limited electrical supply.
- We can use an efficient heat pump to heat DHW since the temperature set point is low enough to make it work.
- The electricity required to run the unit is small relative to heating the water to 140° F+.
- Minimal maintenance required – routine semi-annual inspection of the electrode, which can last up to five years.

Additional research is needed to fully understand the implications of *Legionella* if there were to be massive deployment of solar thermal for domestic hot water heating. We feel it is an issue worth considering and we welcome future discussion and suggestions about the best way to protect human health against the disease.

Solar-Assisted Heat Pumps – Background Research

Solar-assisted heat pumps (SAHP) have been considered for over half a century [1], but the idea has not seen widespread industry acceptance. SAHPs become attractive when desirable and/or necessary to use solar energy and there are constraints such as a prohibition on combustion appliances, as is the case with *SolAbode*. There are many configurations for SAHPs. Some do not couple the heat rejection/absorption loops with an "open" source such as the ground or air. These types of SAHPs rely exclusively on a bounded thermal storage system [2 & 3]. This type of system would be cheaper to install than a ground-coupled system, but because it is "closed" thermodynamically there is a risk of depleting the heat source should there be an extended period low energy production (i.e. multiple cloudy days). This problem becomes especially acute when there is limited solar thermal capacity installed. A resistance heater would then have to compensate for the lack of solar heat. This is damaging to the overall system efficiency. A benefit of this system is that the thermal collection efficiency can be improved by decreasing the return water temperature to the solar collector.

Other designs have connected the ground loop in series with a solar thermal system [4] or alternate between a solar source and ground source [5]. The series method has proved more efficient when compared to a standard horizontal ground loop system with no solar assistance. The water-based series method compares favorably to other configurations, but it could be improved by using either dual-storage (i.e. two thermal storage tanks) or dual-source (i.e. the heat pump can interact with either thermal storage or the ambient air) [6]. Another option for integrating solar energy into a GSHP system addresses the issue of thermal depletion within the ground. This refers to the decrease in soil temperature adjacent to the ground heat exchanger. Solar energy can be used to recharge the ground loop when appropriate or even reduce the length of the loop, thereby reducing the installation cost [7].

There exists no "standard" solar-assisted heat pump configuration. Many types have been tested with varied results. In general, the use of both solar thermal energy and a heat pump should strive to achieve the following objectives: 1) to increase the energy efficiency of the heating system

and/or the heat pump itself relative to a conventional design; and 2) to increase the efficiency of the solar thermal collection via a reduction in the supply temperature to the collectors.

[1] Jordan, R.C. and J.L. Threlkeld. (1954). *Design and economics of solar energy heat pump systems.* ASME Journal Section, Heating Piping, and Air Conditioning, 26, 122-130.

[2] Freeman, T. L., Mitchell, J. W., & Audit, T. E. (1979). *Performance of combined solar-heat pump systems.* Solar Energy, 22(2), 125-135.

[3] Kuang, Y. H., Wang, R. Z., & Yu, L. Q. (2003). *Experimental study on solar assisted heat pump system for heat supply.* Energy Conversion and Management, 44(7), 1089-1098.

[4] Ozgener, O., & Hepbasli, A. (2007). *Modeling and performance evaluation of ground source (geothermal) heat pump systems.* Energy and Buildings, 39, 66-75.

[5] Bi, Y., Guo, T., Zhang, L., & Chen, L. (2004). *Solar and ground source heat-pump system.* Applied Energy, 78, 231-245.

[6] Chandrashekar, M., Le, N.T., Sullivan, H.F. & Hollands, G.T. (1982). *A comparative study of solar assisted heat pump systems for Canadian locations.* Solar Energy, 28(3), 217-226.

[7] Trillat-Berdal, V., Souyri, B. & Achard, G. (2007) *Coupling of geothermal heat pumps with thermal solar collectors.* Applied Thermal Engineering, 27, 1750-1755.

Introduction and Design Approach

Lighting considerations for the SolAbode are taken from a holistic perspective on the use and affect of electric light and daylight. This perspective includes necessary functions, tasks, energy efficiency and the impact of the electric lighting and daylight in the interior and exterior areas of the home. Specifically the design seeks to:

- Locate glazings to provide adequate light levels during the day to avoid the use of electric light
- Use electric lighting to highlight visual focal points within the space and provide adequate ambient light levels
- Provide adequate task lighting in the kitchen and on counter surfaces
- Lighting should instill feelings of comfort within the general living space

Required lighting levels for interior spaces were developed using IESNA standards using area calculations and rated lumen outputs designed to meet the recommended footcandle/lux levels. Additioinally, a lighting lighting simulation using AGI32 was developed for the main living area (kitchen, northwest hallway and living room). The results of this simulation are shown throughout the Lighting Narrative. For this space, the focal points and intended illuminance ratios are shown below in Table 1.

Table 1: Summary of visual focal points

Element in space (e.g., object, surface)	Status (e.g., primary, secondary – see note)	Intended illuminance ratio	Comment
Artwork at Entrance	Primary	10:1	First lighting feature visible when entering from front door (not shown in simulation)
Island	Primary	10:1	Task surface, dominates the space
Counter/Sink Area	Primary	10:1	Task surface, will house custom cabinetry and glasswork made by students
Post/Beams	Secondary	3:1	Expresses structure of home

Windows and Daylighting

Windows placements allow daylight to enter the home from morning to night, providing the homeowners with a connection to the changing light throughout the entire day. Windows on the east, north, and west have interior blinds that provide privacy, glare reduction, UV reduction and light control. North facing clerestory windows bring diffuse light deep into the living room space during the day.

Daylight is controlled on the south face of the home with exterior perforated aluminum blinds. Figure 1 below shows that without exterior solar control uncomfortable glare conditions result.

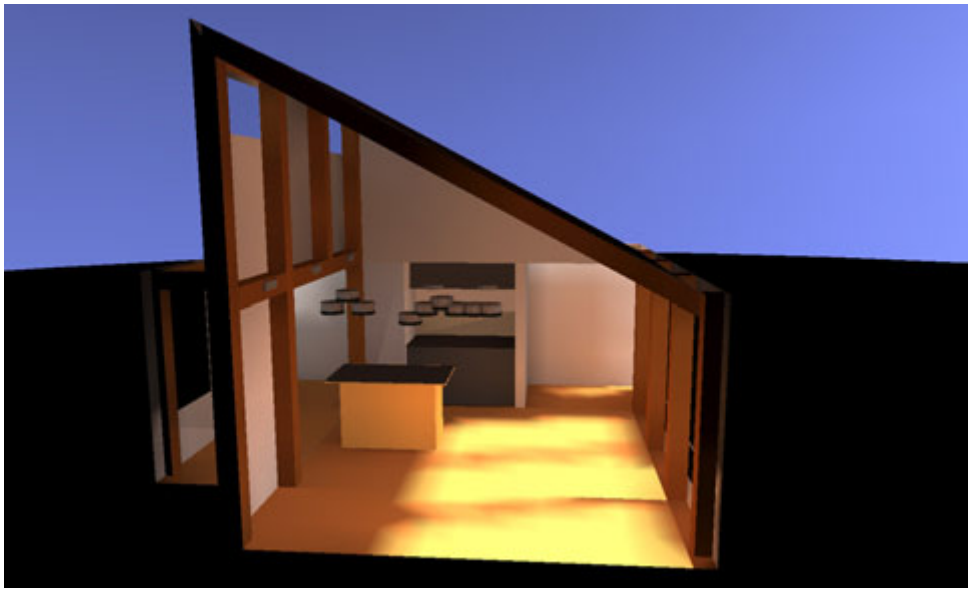


Figure 1: Daylighting simulation in Calgary without external solar control (March 21, 11:00)

The exterior blinds are motorized and controlled through the home automation system to operate on different schedules seasonally. The blinds also have a manual override. The louvers are 3” wide and can be adjusted from a horizontal position to a vertical (i.e., letting no light through). The interior and exterior blinds selected for the home also reduce the potential harm daylight, specifically ultraviolet radiation, can have on interior material finishes as well as artwork. When fully closed glare is reduced entirely except from the keyway (as seen in the back right corner of the space), as shown below in Figure 2. The intense light through the keyway is an intentional architectural feature.

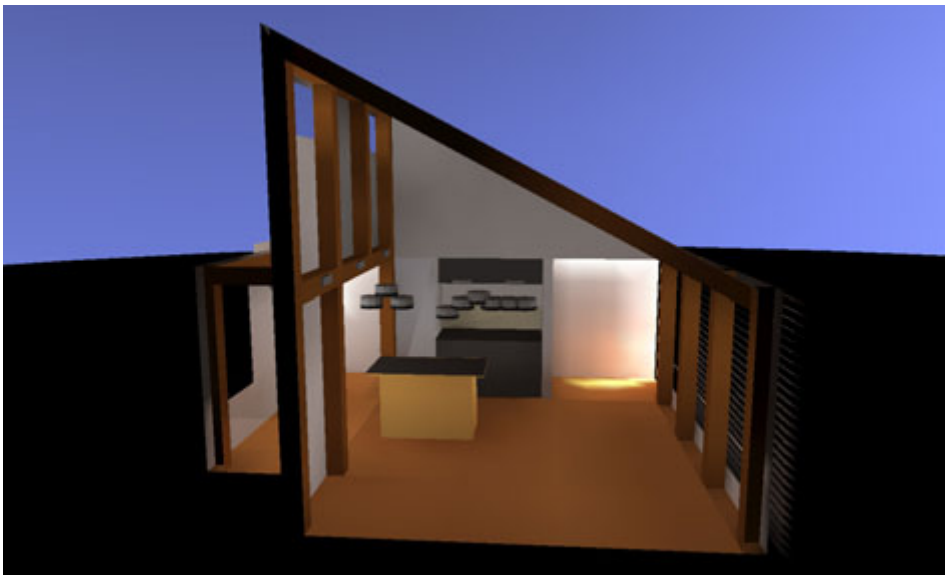


Figure 2: Daylighting simulation in Calgary with external solar control (March 21, 11:00)

The two north facing clerestories do not have much impact in the simulation shown in Figure 2. However, later in the year, when the sun tracks further north, these apertures bring light deeper into the space as shown below in Figure 3. A perforated cladding was later added which will decrease the overall daylighting potential of these windows but will add an interesting interior and exterior visual effect.

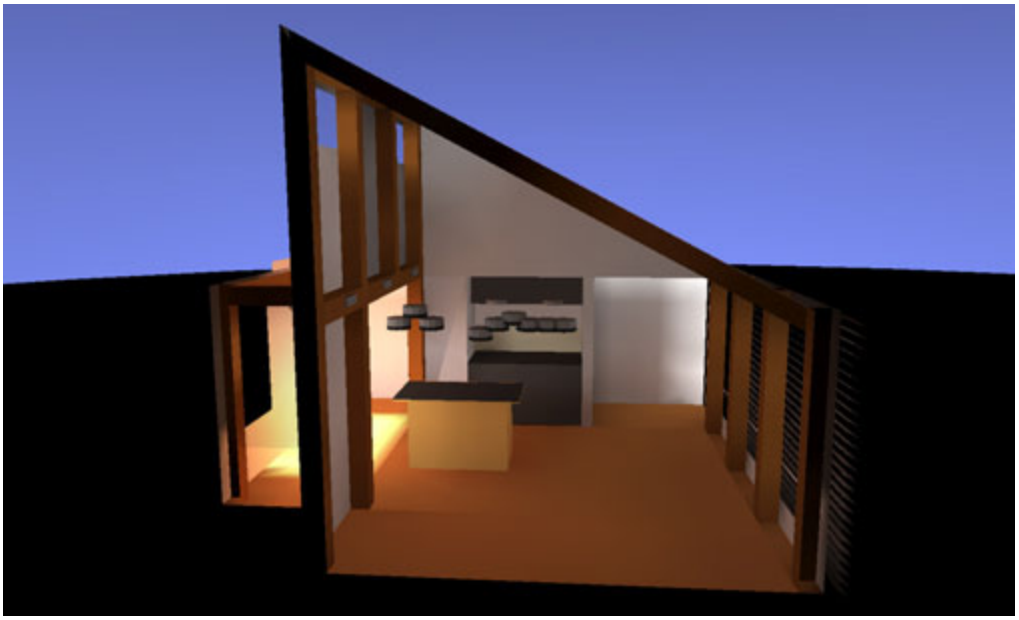


Figure 3: Daylighting simulation in Calgary with external solar control (June 21, 20:00)

Figure 4 shows the lux levels during a daylight scenario. It shows that daylighting has the potential to adequately illuminate the critical surfaces (i.e., the counters).

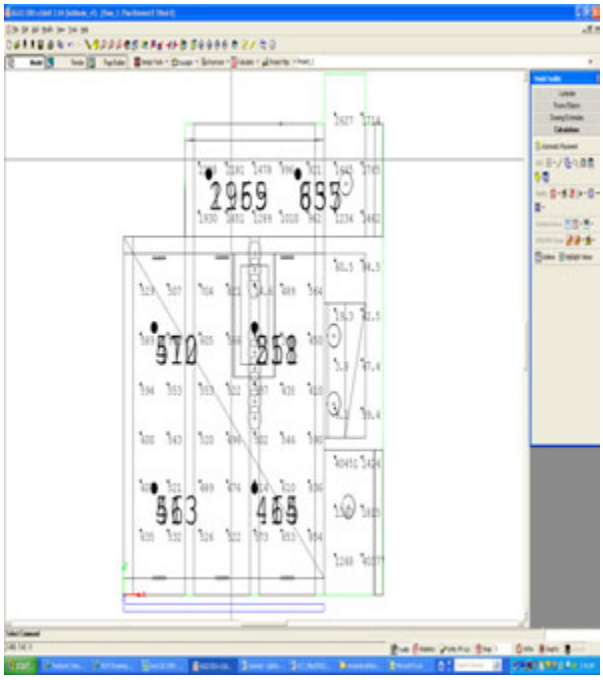


Figure 4: Daylighting lux levels with no electric light in Calgary (March 21, 11:00)

An additional positive result is that daylighting can be used in the main living space in lieu of electric light during the competition (i.e., during public tours and objective contests), as shown below in Figure 5.

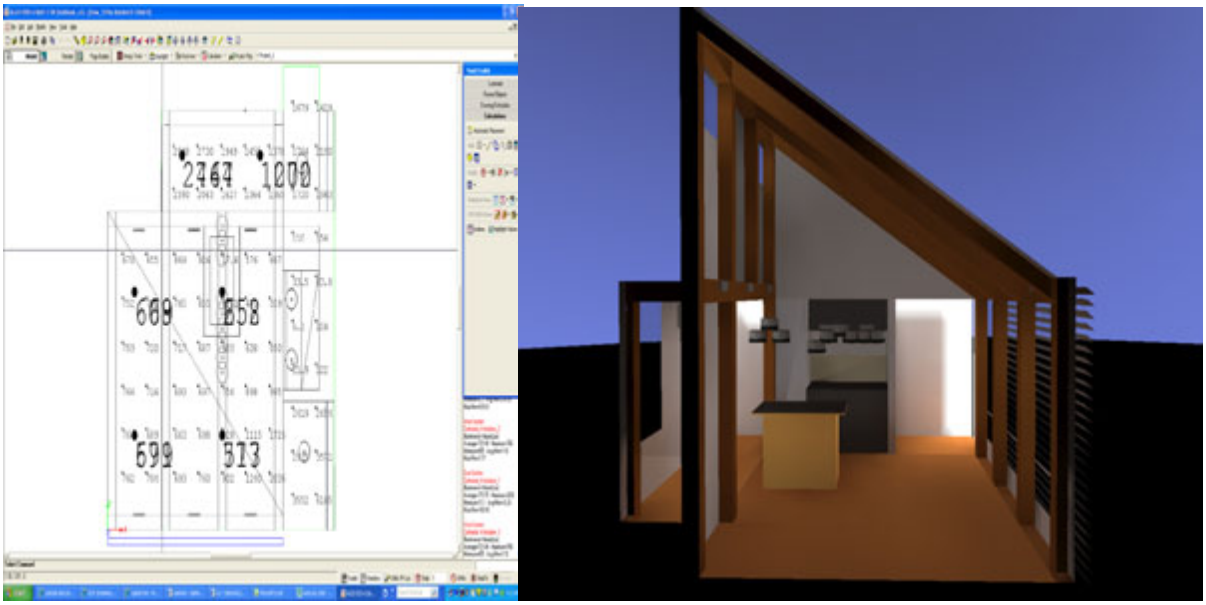


Figure 5: Daylighting lux levels and rendering for competition (Washington, DC, mid-October, 14:00)

Electric Lighting

We are fortunate to have a local manufacturer of high quality LED lighting in Calgary, Nemalux. Nemalux uses new LED technology in all of their luminaries. They incorporate appropriate and effective thermal management while providing bright, high luminous efficacy lights with superior longevity. Cool white LED lighting was selected due to their low energy use while providing adequate illumination. Additionally, they were chosen for the quality of light. The light is in the blue-white range (approx. 4000 degrees Kelvin) and is close to natural daylight at noon. This range of light provides good color rendering (CRI of 80+) which appropriately illuminates the materials chosen in the home. In addition, research currently being conducted is finding that this blue-white range has a positive affect on people by increasing serotonin levels. Increased serotonin levels have been shown to elevate moods and improve sleep patterns, as long as these lights are not on during sleep[].

Table 2 shows the interior electric lighting and summarizes the installed lighting power density. It is also shown with a 15% conversion loss, expected from the AC to DC conversion to run the LED circuits.

Table 2: Interior Lighting Schedule

CODE	DESCRIPTION	LAMPS			QTY	INSTALLED WATTS
		TYPE	VOLTS	WATTS		
L1	DIRECTI/INDIRECT HORIZONTAL STRIP LED (1-1'SECTIONS)	COOL WHITE LED	12VDC	3.85W	2	7.7
L2	HORIZONTAL STRIP LED (2-1' SECTIONS 3.85W/+1-6" JUMPER)	COOL WHITE LED	12VDC	7.7W	5	38.5
L3	VERTICAL STRING LED (W JUMPERS & DRIVERS AS REQUIRED)	COOL WHITE LED	12VDC	7.5W	2	15
L4	HORIZONTAL STRIP LED (W/JUMPERS & DRIVERS AS REQUIRED)	COOL WHITE LED	12VDC	3.85W	17	65.45
L5	HORIZONTAL LED	COOL WHITE LED	12VDC	23.1W	1	23.1
L6	RECESSED POTLIGHT	COOL WHITE LED	12VDC	7.7W	11	84.7
L7	6" MICRO TITAN PENDANT (#1 SUBSCRIPT - 12" LENGTH)	WHITE 5500K	12VDC	1W	9	9
L8	WATERPROOF CLG WOUNT	COOL WHITE LED	12VDC	7.7W	1	7.7
L9	Z-BAR MINI TASK LAMP	COOL WHITE LED	120V AC	6.5W	1	6.5
L14	VERTICAL STRIP LED (W JUMPERS & DRIVERS AS REQUIRED)	COOL WHITE LED	12VDC	3.85W	6	23.1
L15	ADJUSTABLE SPOT LIGHT	COOL WHITE LED	12VDC	7.7W	1	7.7

L16	HORIZONTAL STRIP LED (W/JUMPERS & DRIVERS AS REQUIRED)	COOL WHITE LED	12VDC	1.9W	6	11.55
L17	VERTICAL LED	COOL WHITE LED	12VDC	11.5W	2	23
L18	HORIZONTAL LED	COOL WHITE LED	12VDC	7.7W	2	15.4
					TOTAL INTALLAED LIGHTING POWER (W)	338.4
					TOTAL INTALLAED LIGHTING POWER W/ 15% CONVERSION LOSS (W)	389.16
					TOTAL CONDITIONED FLOOR SPACE (FT)	674
					LIGHTING POWER DENSITY (W/FT)	0.50
					LIGHTING POWER DENSITE W/ 15% CONVERSION LOSS (W/FT)	0.58

Indirect & direct lighting techniques have been used in the home to enhance the quality of light as well as provide the required light levels through reflectance rather than increasing lumen output. In the main interior entry and living room area custom aluminum luminaires have been designed to accommodate stock LED strip lights. These were substituted in the AGI32 simulation with an equivalent (linear LED with similar lumen output and expected distribution) as no photometric data was available on the custom luminaire. The custom luminaires have been designed to provide indirect (reflected off the ceiling) and direct (through side perforations) illumination. The fixtures have an adjustable locking arm that allows the angle of light to be adjusted as required (refer to details in construction drawings). They have a white powder coat finish that allows the luminaire to integrate easily with the white walls and ceilings.

Pendent lights are located over the kitchen at varying heights. The initial luminaire selection resulted in a glare condition from a seated position on the couch, shown below in Figure 6.

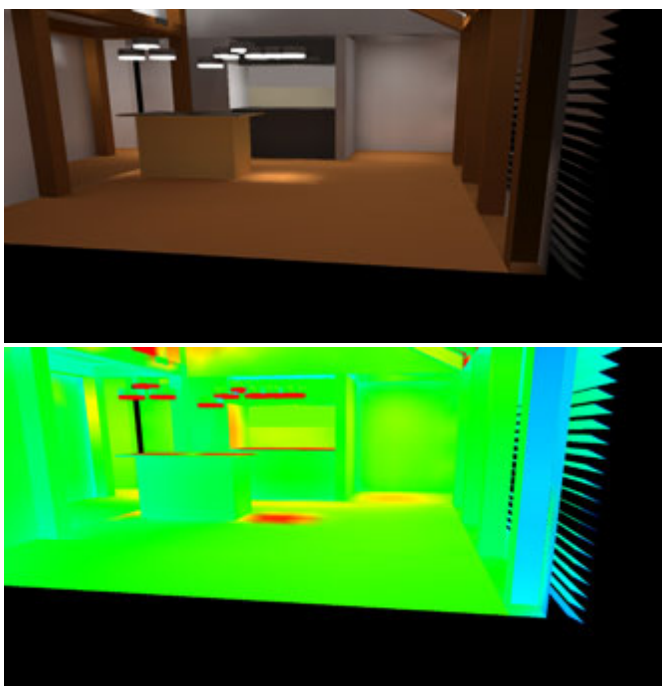


Figure 6: Pendent glare from couch position (right image shows RGB luminance rendering, left image shows pseudo color illuminance rendering)

The result of this simulation led the team to an alternate selection in order to avoid a glaring condition. Additionally, the viewing angle from the couch was calculated to ensure occupants seated there would not be subject to glare from kitchen lighting, shown below in Figure 7.

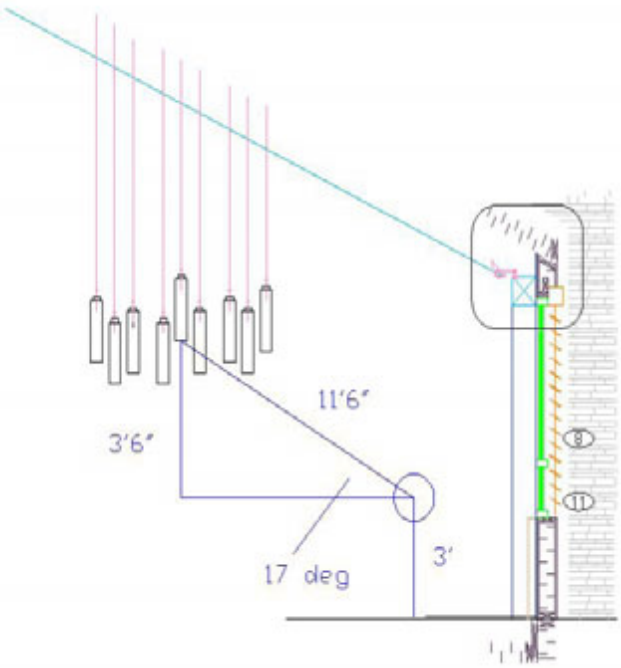


Figure 7: Cutoff angle to eliminate pendant glare from seated position on the couch (not to scale)

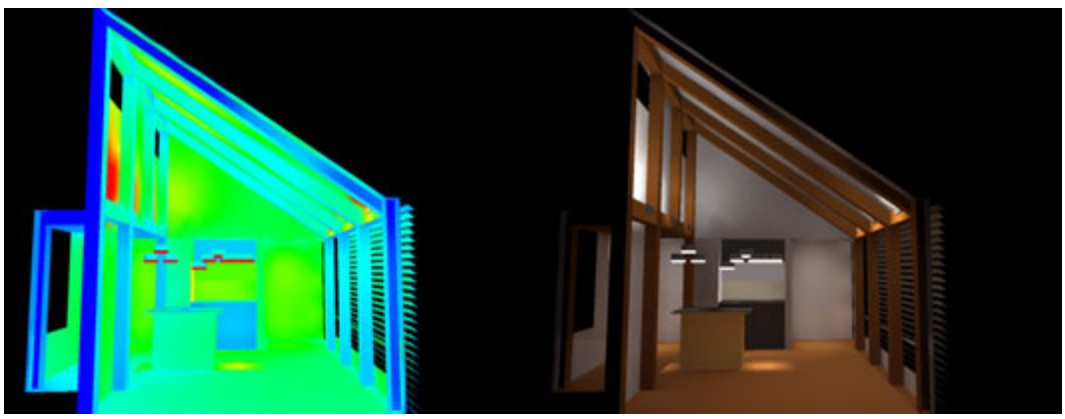
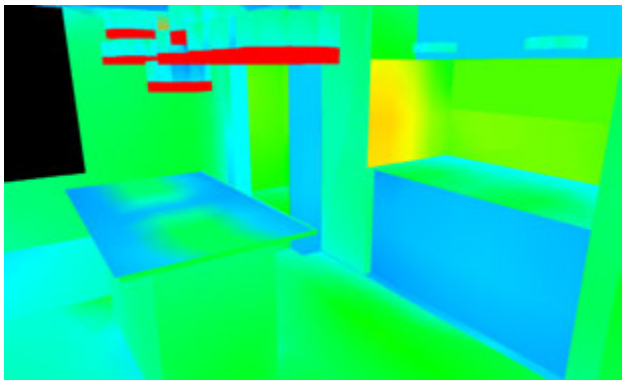


Figure 8: Pseudo Color and RGB renderings with all installed electric lighting on

Figure 8 shows variety in the lighting, particularly where the direct-indirect luminaires illuminate the ceiling and timber structure. This is effective in creating focus on the structure of the home and providing ambient light

The counter is a focal point in the room. It is not only a surface for cooking and preparing food, but is also a function piece of industrial design (it will fold out and expand to create additional surface space for eating). Use of a dark surface (black marble) mutes this element in the space. Figure 9 shows pseudo color rendering of the contrast between using a dark surface (right) and a more reflective one (left). The team utilized this information when choosing interior finishes.



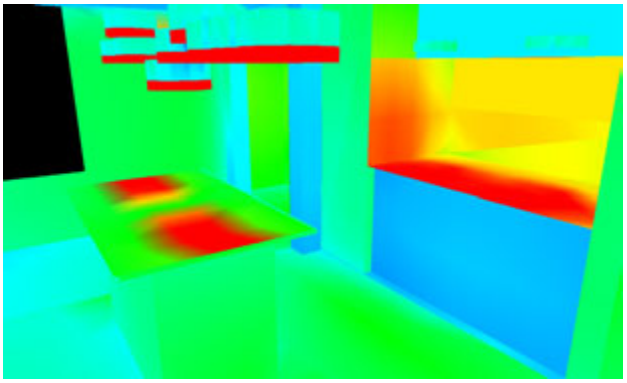


Figure 9: Psuedo color rendering of kitchen with dark, absorptive counters (right) and light, reflective counters (left)

Other unique lighting considerations have been given to areas in the entrance, bathroom, Murphy bed, stone wall, and desk area. At the kitchen sink a concealed LED luminaire is being used to provide counter task light as well as provide lighting for a small herb garden. LEDs have been used to backlight the glass shower partition, adjacent glass shelves, and the sink mirror. The edges of the shower partition and the glass shelves have been frosted to allow the edge to glow from the LEDs.

The most significant architectural feature of the home is the keyway that bisects the home from north to south allowing daylight to enter the home. This feature is reinforced at night or on cloudy days by a recessed LED cove light detail that runs the length of the keyway inside the home. Through this LED cove light the keyway is made visible at night from the exterior.

In the bedroom, the Murphy bed has a backlit frosted glass panel that acts as a reading light in bed. The wall across from the Murphy bed has recessed LED cove lighting that highlights the bottom of the Douglas fir beam in the ceiling and grazes the dark stone wall facing. The desk/workspace area has LED strip light set under the overhead cabinets to provide basic task light. Task illumination at the desk area is suplemented by a moveable LED task light when higher footcandle/lux levels are desired.

LED lighting is used in the home exterior with a few recessed LED deck up-lights around the perimeter to provide accent lighting on the home at night. Vertical recessed LED luminaires are set flush in step risers in the main deck and the roof top deck, providing safety lighting at night. The roof top area of the home has vertical LED lights to provide safety lighting at night at steps and walkways. The overall exterior lighting intent was to provide soft accent and task lighting to provide safety lighting and accentuate home details. One area that provides an interesting feature at night is the perforated metal panels at the roof deck on the north side. Behind these panels are interior opening hopper windows. At night, lighting from the interior of the home is softly filtered through these perforations to the exterior.

Lighting Controls Narrative

The lighting is tied into a Control4 home control system, which communicates with the SolAbode's Schneider Modicon M340 programmable logic controller (PLC) that serves as the central brain for all lighting, mechanical, plumbing, home theater, and networking for the home. This setup allows the homeowner to interact with and customize the lighting design to suit their tastes and preferences. Additionally, many of the LEDs are on 1-10V dimmable circuits and automated. This capability is uncommon in today's residential LED market and represents a significant advancement in solid-state illumination.

Scenes can be programmed into the system so that lighting is optimized for a range of individual activities that an occupant would encounter in daily life. From cooking, to watching movies, to keeping the bathroom light levels comfortable for that half-sleeping, late night visit, the system can be controlled through virtual switches much the same as standard wallswitches, as well as through interactive touch screens, remotes, iPhones or iTouches, and television displays. A scene appropriate for movie watching is illustrated below in Figure 10.

Figure 10: Scene with L2 and kitchen sink luminaires on

These lighting scenes not only allow appropriate lighting for different tasks, but they also serve to improve the overall efficiency of use of the home lighting. By reducing the amount of wall switches an occupant must operate to move from activity to activity, the system can reduce the amount of forgotten lighting. Beyond that the lighting system can be accessed securely via the internet, so a homeowner, knowing they might be home late and concerned that the house may appear to be unoccupied, can log in and turn a fixture or two on for security.

Another aspect of lighting control that improves the user experience in the home are the Nysan exterior solar control blinds. These are also controlled through the PLC and can adjust their shading based on both daylighting and heat gain optimization. Through this balance of lighting, the house is able to ensure a well lit, but quite comfortable environment during sunny parts of the day, while also providing privacy when needed. User overrides are provided for all the lighting scenes and blinds, so that homeowners are not held hostage by their control systems.

Overall the lighting and controls design of the SolAbode result in interesting visual scenes, occupant comfort, adequate illumination for tasks and flexible control options at the least possible energy cost.