

DIVISION 13 -- SPECIAL CONSTRUCTION

SECTION 13 34 12.13 (or 13123)

GREENHOUSES

Items in blue indicate specification comments or choices to be selected, deleted or filled in as appropriate.

I. GENERAL

A. Work Included:

1. Single source factory fabricated and installed aluminum clear span pre-engineered greenhouse structure with framework, glass and glazing, sill cap flashing and other required flashings, (edit the following equipment list) automatic roof and wall sash, door, windows, exterior and interior ventilating fans, motorized dampers, screens, anchorages, irrigation systems, shading, evaporative cooling, natural gas unit heater, ornamental ironwork, planting benches, programmable climate controller, sealant, attachments and other equipment as described herein for a complete watertight installation.
2. Engineering and drafting of production documents, including structural design calculations.
3. Shop drawing submittals.
4. When shown on the drawings, fabrication and erection of the aluminum gutter system including insulation and pitched liners.
5. Applied finish to aluminum extrusions and flashings.

B. Related Work Not Included:

1. Section 05120: Structural Steel.
2. Section 05160: Space Frames.
3. Section 05500: Metal Fabrications.
4. Section 07600: Flashing and Sheet Metal.
5. Section 08800: Glazing.
6. Section 08900: Glazed Curtain Walls.
7. Section xxxxx: Roofing.
8. Section xxxxx: Sealants.

C. Standards:

1. Comply with the standards that are applicable to the work of this Section except as otherwise indicated. Provide assembly that is weather tight, airtight and in compliance with the Building Code for the state where the project is located.
2. Aluminum Association Incorporated (AA):SAS-30 Specifications for Aluminum Structures.
3. American Architectural Manufacturers Association (AAMA):
 - i. 501.1: Standard Test Method for Metal Curtain Walls for Water Penetration Using Dynamic Pressure.
 - ii. 501.2: Field Check of Metal Curtain Walls for Water Leakage.

- iii. 501.3: Field Check of Water Penetration Through Installed Exterior Windows, Curtain Walls and Doors by Uniform Air Pressure Difference.
 - iv. 603.8: Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.
 - v. 605.2: Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
 - vi. 606.1: Voluntary Guide Specification and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.
 - vii. 607.1: Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum.
4. American National Standards Institute (ANSI): Z 97.1 -1984- Safety Glazing Materials Used in Buildings -Safety Performance Specifications and Methods of Test.
 5. American Society for Testing and Materials (ASTM):
 - i. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
 - ii. A307: Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - iii. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - iv. B211: Specification for Aluminum-Alloy Bar, Rod and Wire.
 - v. B221: Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
 - vi. B316: Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods.
 - vii. C719: Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cycle Movement.
 - viii. C794: Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants.
 - ix. C1036: Specification for Flat Glass.
 - x. C1048: Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
 - xi. D395: Test Methods for Rubber Property -Compression Set.
 - xii. D412: Test Methods for Rubber Properties in Tension.
 - xiii. D1171: Test Method for Rubber Deterioration -Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens).
 - xiv. D2240: Test Method for Rubber Property -Durometer Hardness.
 - xv. E283: Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors.
 - xvi. E330: Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
 - xvii. E331: Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
 - xviii. E773: Test Method for Seal Durability of Sealed Insulating Glass Units.
 - xix. E774: Specification for Sealed Insulating Glass Units.
 - xx. E783: Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
 6. Consumer Product Safety Commission (CPSC): 16CFR 1202 - Architectural Glazing Standards and Related Material.
 7. Flat Glass Manufacturers Association (FGMA): Glazing Manual.
 8. Insulating Glass Certification Council (IGCC): Classification of Insulating Glass Units.

D. Submittals:

1. Submit shop drawings to include manufacturers' product specifications, test results showing compliance with performance criteria described below. Indicate pertinent dimensioning, general construction, component connections and locations, anchorage methods, locations and installation details.
2. Provide pairs of samples for initial color selection on 6" long sections of extrusions or formed shapes. Where normal color variations are anticipated, include two or more units in each set indicating limits of color variations.
3. Submit structural calculations prepared in accordance with the Aluminum Association's Specifications for Aluminum Structures (SAS30) by a structural engineer qualified in the design of self-supporting sloped glazed systems and licensed to practice in the state where the greenhouse is manufactured.
4. Submit only if specifically requested:
 - a. (2) 12-in. x 12-in. samples of each type of glass.
 - b. (2) manufacturer's samples of each type of sealant.
 - c. (3) sets of as-built drawings and operation and maintenance manuals
 - d. Certification that insulating glass units will withstand specified design loads.

E. Quality Assurance:

1. Single Source Responsibility: The greenhouse installers must be permanent full-time employees of the greenhouse manufacturer.
2. Greenhouse manufacturer will assume undivided responsibility for all components, including structural design, engineering, fabrication, finishing, preparation at the job site, erection and glazing of the greenhouse system and the weatherproof integrity of the system in place.
3. The manufacturer shall be regularly engaged in the preceding phases of construction of greenhouses and able to demonstrate that he has performed successfully on comparably sized projects and of comparable design complexity over at least the previous ten years.
4. Comply with recommendations of Flat Glass Marketing Association (FGMA) "Glazing Manual" and "Sealant Manual" except where more stringent requirements are indicated. Refer to those publications for definitions of glass and glazing terms not otherwise defined in this Section or referenced standards.

F. Design Loading requirements:

1. Roof and snow live loads to comply with [the applicable building code requirements including drifted snow loads](#).
2. Wind live load [as appropriate for local code: 20 psf](#), exposure classification C (B) as applicable, stagnation pressure 17 psf.
3. Concentrated load of 250lb applied to any framing member at a location that will produce the most severe stress or deflection.
4. American National Standard "Minimum Design Loads for Buildings and Other Structures" ANSI A58.1 -- latest edition.
5. Design assembly to safely carry all dead, snow, wind, thermal and building movement loads, as well as any additional service and construction loads.
6. The deflection of a framing member in a direction parallel to the plane of glass, when carrying its full dead load, shall not exceed an amount which will reduce the glass or panel bite below 75% of the design dimension and the member shall have a 1/8-in. minimum clearance between itself and the edge of the fixed panel, glass, or component immediately adjacent, nor shall it impair the function of or damage any joint seals.

7. Deflection of members shall not exceed design span divided by 175 (L/175) or one (1) inch for clear spans under 20 ft., or L/240 for clear spans greater than 20 ft.

G. Performance:

1. When tested in accordance with ASTM E-283, air infiltration shall not exceed .06 cfm/sf of fixed area at a test pressure of 1.56 psf.
2. When tested in accordance with ASTM E-331, there shall be no uncontrolled water penetration at a test pressure of 6.24 psf.
3. When tested in accordance with NFRC 100-91/ASTM C 1199/ASTM E 1423, the thermal performance Condensation Resistance Factor (CRF) shall be 77 or higher.
4. The system shall perform to these criteria under a combined load as dictated by the state building codes for dead load and live load.
5. Thermal Movement: Provide for such expansion and contraction of component materials as will be caused by the ambient surface temperature range without buckling, stress on glass, failure of seals, undue stress on structural elements, reduction of performance or other detrimental effects.
6. Compression flanges of flexural members may be assumed to receive effective lateral bracing only from anchors to the building structure and horizontal glazing bars or interior trim which are in contact with 50% of the member's total depth.
7. The greenhouse framing is designed to be self-supporting between the supporting construction. The greenhouse will impose reactions to the support construction. All adjacent and support construction must support the transfer of all loads exerted by the greenhouse including horizontal and vertical. Design or structural engineering services for the supporting structure or building components are not included in the scope of this section.
8. Rigid frame design: ~~If this item is to be included, delete the item 7 immediately above.~~ The greenhouse framing will exert no horizontal reactions or thrust under vertical gravity type loads, (dead, snow, live). Only unbalanced live loads such as wind, seismic, etc., acting upon the greenhouse will produce horizontal reactions applied to the supporting structure.

H. Warranty:

1. Provide written warranty from the greenhouse manufacturer stating that all work of this Section will remain free from defects in materials and workmanship. The work shall remain free of leaks, defective design, defective materials and construction for one (1) year after the date of acceptance.
2. Provide written warranty stating that all insulating glass units will remain free of seal failure, delamination, discoloration and defects in manufacture for five (5) years after the date of acceptance.

II. PRODUCTS

A. Manufacturers:

1. The specifications are based on the skylight products of Wisconsin Solar Design, Inc., www.wisconsinsolardesign.com.

2. [\[Complete or delete this item.\]](#) Acceptable manufacturers:
 - i. [\[Manufacturer #2\]](#)
 - ii. [\[Manufacturer #3\]](#)
3. Other manufacturers may bid this project provided they comply with all of the performance requirements of this specification and pre-qualify with the Architect per section 016000 Product Requirements, [\[optional, specify how many days, i.e., no less than # days\]](#) prior to bid date.

B. Greenhouse Structure [\(select from list below\)](#):

1. Extruded Aluminum Framing Members: ASTM B221 Alloy G.S. 10A-T6, 6063-T6 alloy and temper.
2. Fasteners: ASTM B221 2024-T4 aluminum or 300 series stainless steel with integral color coating to match finish of aluminum where exposed to view; cadmium plated steel for connections to supporting structure.
3. Aluminum sheet for Closures and Flashings: ASTM B209-86 3003-H14 with a minimum thickness of .040 inch, finish to match greenhouse.
4. All aluminum to receive an Architectural anodized finish conforming to Aluminum Association Standard AA-M21C22A42/A44 [\(select color\)](#). [\(or\)](#) All aluminum to receive an Architectural Grade factory applied, oven baked high performance two-step fluorocarbon painted finish [\(select color\)](#). [\(or\)](#) All aluminum to be mill finished free of water stains, scratches or abrasions. [Strike unused options](#).
5. Gaskets of extruded 60-70 durometer EPDM rubber conforming to ASTM D-2240.
6. Silicone sealants complying with Federal Specifications TTS-0023 OC and TTS-001543
7. Flat roof glass to be ¼” clear tempered over same [\(or 3/8” clear laminated\)](#), wall glass to be ¼” clear tempered over same, bent glass to be ¼” clear annealed over 3/8” clear laminated. All glass to be low-E with argon-filled air space, 1” overall thickness. [\(or\)](#) Glazing panels shall be 32mm colorless extruded five wall extruded polycarbonate structured panels (U=0.23 or better) manufactured by Lexan Thermoclear Products, Gallina USA or equal. Panels shall contain co-extruded UV protection and be furnished in continuous sections in each slope of the roof and in sidewall and gable areas. Full panel widths shall be used wherever possible. [Strike unused options](#).

C. Equipment [\(select from list below\)](#):

1. Shading systems: exterior roll-drop operable Phifertex fiberglass weave cloth shading system to cover roof and front wall by Thermal Designs, 303-442-3485. [\(or\)](#) Motorized interior Roman folding Phifertex fiberglass weave cloth shading system to cover roof and front wall by Thermal Designs, 303-442-3485. Owner’s choice from standard color chart. [\(or, for larger production or research facilities – please note reference to computer controller specified in this section\)](#) Svensson interior shading system as follows:
 - a. Acceptable manufacturers are:
 1. VRE Greenhouse Systems (system); Grassie, Ontario telephone 905 945-8863
 2. Ridder USA (tubular motors and system); Carpenteria, California, telephone 805 684-7715
 3. Cravo (system); Brantford, Ontario telephone 519 759-8226
 4. Ludvig Svensson (cloth only); Charlotte N.C. telephone 704 357-0460
 5. Elero USA (tubular motors only); Dallas, Texas telephone 800 752-8677
 6. Somfy Canada (tubular motors only); Mississauga, Ontario telephone 905 564-6446
 - b. System Requirements:

1. The system shall be designed so that all individual curtains can be opened and closed automatically through the greenhouse computer control system.
 2. Wall curtain systems shall be designed with center roll up configuration.
 3. Roof curtain system shall be designed so that the curtain fabric slides over supporting wires.
 4. Systems shall be designed so that, when fully open, the curtain stores in a tightly folded or rolled configuration with minimum shading.
 5. Systems shall be designed to provide a tight seal at all closures.
- c. Materials:
1. Fabric
 - a. Shading fabric consisting of aluminium and plastic strips held together with a strong yarn: Ludvig Svensson XLS 15 Revolux or pre-approved equivalent.
 - b. Shall be woven fabric of clear polyester (or uv resistant polyethylene - PEHD) and aluminum strips, providing 45% transmission.
 - c. Owner's choice from standard color chart.
 - d. Shall be warranted for 5 years against ultra violet degradation.
 - e. Shall be warranted against shrinkage: no more than 1 % over a temperature range between 10 and 70 degrees C.
 - f. Shall be warranted for 5 years against fraying.
 2. Tubular motors:
 - a. Shall have noiseless transmission and 2-pole asynchronous condenser motor.
 - b. Shall have instantaneous reversing capability.
 - c. Shall have built in limit switch system and internal overload protection.
 - d. Shall be warranted against oxidation or corrosion failure due to typical greenhouse conditions of high humidity, ultraviolet and chemical fumigant exposure.
 - e. Shall be sized appropriately for the weight and length of each shade curtain assembly.
 3. Other system components: drive cables, slide wires, clips, pulleys, sealing strips, etc. shall be selected to be compatible with the shade fabric.
2. Motorized roof sash, including gear motor, roller bearing pipe hangers, galvanized pipe, arm and rod linkage, open and close limit switches, screens, thermostat and other components as required for a complete operating system. Sash to be the full length of the greenhouse and a minimum of 2' wide. Inter-component wiring by greenhouse contractor; 110V power wiring to components by electrical.
 - a. Gear Motors--High-starting-torque, reversible, continuous-duty, Class A insulated, electric motors, complying with NEMA MG 1, with thermal-overload protection; sized to open and operate size and weight of roof sash without exceeding nameplate ratings or considering service factor, with the following specifications:
 1. Service Factor: According to NEMA MG 1, unless otherwise indicated.
 2. Enclosure: Open drip proof, unless otherwise indicated.
 3. Motors: Single phase, 110v, 60 Hz., 1/10hp.
 4. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop roof sash at open and closed positions.
 5. Emergency Release Mechanism: Quick disconnect-release of electric-motor drive system, permitting manual operation in the event of operating failure.
 3. Manual wall sash, aluminum awning vent windows, finished to match greenhouse, thermally broken, screens, manually operable by cam-lock latch, fully gasketed closure, extending the full length of the greenhouse and a minimum of 2'- 0" high. (or) Motorized wall sash, including gear motor, roller bearing pipe hangers, galvanized pipe,

- arm and rod linkage, open and close limit switches, screens, thermostat and other components as required for a complete operating system. Sash to be the full length of the greenhouse and a minimum of 2' wide. Inter-component wiring by greenhouse contractor; 110V power wiring to components by electrical.
4. Computerized climate controller, Growmaster Procom System by Microgrow, Temecula, CA, 909-695-7280 or Argus Control Systems Ltd., British Columbia, Canada V4B 3Y9, 800-667-2090, complete with relays, contactors, temperature and humidity sensors, solar k-lux sensor and outdoor temperature sensor. Provide control of all greenhouse and heating/cooling equipment specified herein including an alarm dialer for automatic notification when room temperature falls below prescribed setting. Testing: check the computerized climate controller, adjust equipment and computer for proper operation and demonstrate operation to owner's designated representatives. Provide (5) computer manuals with programming instructions and system electrical wiring schematics.
 5. Exhaust fans – American Coolair or equal, xx", x/x hp single (triple) phase, single (double) speed where shown on the drawings.
 6. Internal fans – Schaefer, xx", x/x hp, horizontal air flow (HAF) or equal.
 7. Wall ventilators – American Coolair or equal motorized air inlet shutters where shown on the drawings.
 8. Door and hardware - narrow stile aluminum, manufacturer's standard pivots (1½ pair), lockset, thumbturn, closer, push-pull, weather-strip and sweep. Cylinder by others.
 9. Aluminum Wire Insect Screens: 18 x 16 fine mesh screening in 3/4" x 3/8" mill screen framing. Provide at all vent locations. Install gasketed closure to vent operating linkage.
 10. Modine HD xx xx,xxx Btu/Hr power exhaust sealed combustion direct vent natural gas unit heater with low voltage thermostat and solid state ignition. Design for a minimum temperature differential of $\Delta T = 55^\circ$. Installation of unit by this section, gas and electrical hookups by others.
 11. Benches:
 - a. Benches shall be constructed entirely of sustainably forested solid.
 - b. Benches shall be completely sanded and finished with teak oil with waxed end grains.
 - c. The table height shall be 30".
 - d. Corners posts shall be 2 1/2" square (finished size), sides 5 1/2" x 1", tabletop 5 1/2" x 3/4".
 - e. Bench feet shall consist of 3/8" diameter leveling mounts with nylon glides and t-bolt receptors (or for rolling benches, lockable casters).
 - f. Benches shall be joined with stainless steel cross-dowel recessed corner connectors.
 12. Misting system comprised of strainer, couplings, solenoid valves, nozzles, pvc pipe, drain valve, 24 hr. and 12 minute timers and transformer. Requires 110V electrical receptacle and hose bibb by others.
 13. Grow light: Sun System or equal 400 Watt High Pressure Sodium (bulb included).
 14. Evaporative Cooler. Size and location as shown on the drawings. Furnish with:
 - a. Fan, multi-speed motor, thermostat, water pads, pump, drain pan and casing. Use centrifugal type fans, statically and dynamically balanced for operation without objectionable noise and vibration. Mount fan assembly on rubber isolators
 - b. Motors are to be permanent split capacitor type with built-in thermal overload protection.
 - c. Provide a manual disconnect switch inside cabinet.
 - d. Provide with louvered air inlet and outlet duct collar.
 - e. Provide access doors in cabinet to allow maintenance of internal mechanical and electrical devices.

- f. Units in exposed locations are to have an 18 gauge steel cabinet with baked enamel finish in one of the manufacturer's standard colors, selected by architect.
 - g. Provide with packaged controls. Unit provided with all required fan, pump and valve relays to integrate with thermostatic control.
15. (Other materials may include CO2 generation, bedding tables, blackout coverings and additional ventilation equipment. Please contact Wisconsin Solar Design for specifications.)

III. EXECUTION

A. Delivery:

1. Deliver fabricated units and component parts to the jobsite completely identified with labels corresponding to the erection drawings. Protect surfaces from damage during shipping. Inspect materials for damage upon delivery to the jobsite. Touch-up or replace items with minor defects or scratches with the appropriate material.

B. Pre-installation:

1. The furnishing of temporary covering, weatherproofing and protection of the greenhouse area before and after the greenhouse installation are excluded from the work of this section.

C. Installation:

1. Prior to the installation of the greenhouse system, arrange for the representative of the greenhouse manufacturer to examine the structure and substrate to determine that they are properly prepared, sized and ready to receive the greenhouse work specified herein.
2. Assist general contractor to coordinate installation with adjacent work such as roofing, sheet metal and other work to ensure a complete weatherproof assembly.
3. Contact between aluminum and dissimilar metals shall receive a protective coating at asphalt paint for the prevention of electrolytic action and corrosion.
4. Install greenhouse frame, glass and accessory items as needed in accordance with the manufacturer's printed instructions matching profiles, sizes and spacing indicated on approved shop drawings.
5. During installation, remove labels, part number markings, sealant smears, handprints, and construction dirt from all components. Touch-up damaged coatings and finishes and repair minor damage to eliminate all evidence of repair. Remove and replace work that cannot be satisfactorily repaired.
6. Anchor work securely to supporting structure, but allow for differential and thermal movement.
7. Erect system plumb and true and in proper alignment and relation to established lines and grades as shown on the approved shop drawings.
8. Handle glass in accordance with the recommendations of the FNMA, latest edition. Use rubber spacers to maintain separation of glass and adjacent metal framework.
9. Touch-up areas damaged during installation.
10. Locate weep holes in sill to positively drain condensation to exterior of greenhouse at each rafter connection.
11. Sealants to be installed per sealant manufacturers' instructions. Do not perform structural silicone sealant work when the metal temperature is below that recommended by the sealant manufacturer.

12. Before application, remove mortar dirt, dust moisture and other foreign matter from surfaces sealant will contact. Apply sealant in a tooled and uniform manner to completely fill joint. Remove excess sealant to leave uniform smooth edge.

D. Site Tolerances:

1. All supporting and adjacent construction will be held to within + ½” of theoretical.
2. Tolerances for the installation of related products: Refer to the sections noted in the “Related Work Not Included” paragraph above for specified tolerances for adjoining construction.

E. Cleaning:

1. Remove any temporary greenhouse coverings and protection of adjacent work areas at the completion of greenhouse installation. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.
2. The greenhouse subcontractor is required to leave glass and metal surfaces clean at the conclusion of the installation. Final cleaning is to be performed by the general contractor, not the greenhouse subcontractor, just prior to acceptance of the project by the owner.

END OF SECTION 13 34 12.13

(Notes to specifier: Portions of this greenhouse specification may not apply to your project. Items in blue indicate choices and require editing. Technical assistance is available from WSD engineering staff at 608-831-2112.)