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PHOTOVOLTAIC SYSTEMS

UL Classification File Number E247515

Category #QHZQ

Guide Specification

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Engineering and drafting of production documents, including structural calculations of the entire photovoltaic skylight system. (BIPV Skylight System–Building Integrated Photovoltaic)
- B. Fabrication and erection of skylight frames.
- C. Fabrication and erection of the aluminum gutter system including, when applicable, insulation and pitched liners.
- D. Applied finish of aluminum extrusions and sheet.
- E. Photovoltaic modules and glazing.
- F. Skylight related flashings.

1.02 RELATED SECTIONS

- A. Structural Steel: *Division 05*
- B. Metal Fabrications: *Division 05*
- C. Flashing and Sheet Metal: *Division 07*
- D. Photovoltaic Panels: *Division 26*
- E. Roofing: *Division 07*
- F. Sealants: *Division 07*

1.03 REFERENCES

- A. Aluminum Association Incorporated (AA):SAS-30 Specifications for Aluminum Structures.
- B. American Architectural Manufacturers Association (AAMA):
 - 1. 501.1: Standard Test Method for Metal Curtain Walls for Water Penetration Using Dynamic Pressure.
 - 2. 501.2: Field Check of Metal Curtain Walls for Water Leakage.
 - 3. 501.3: Field Check of Water Penetration Through Installed Exterior Windows, Curtain Walls and Doors by Uniform Air Pressure Difference.
 - 4. 603.8: Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.
 - 5. 605.2: Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.

6. 606.1: Voluntary Guide Specification and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.
7. 607.1: Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum.
- C. American National Standards Institute (ANSI): Z 97.1 -1984- Safety Glazing Materials Used in Buildings -Safety Performance Specifications and Methods of Test.
- D. American Society for Testing and Materials (ASTM):
 1. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
 2. A307: Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 3. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 4. B211: Specification for Aluminum-Alloy Bar, Rod and Wire.
 5. B221: Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
 6. B316: Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods.
 7. C719: Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cycle Movement.
 8. C794: Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants.
 9. C1036: Specification for Flat Glass.
 10. C1048: Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
 11. D395: Test Methods for Rubber Property -Compression Set.
 12. D412: Test Methods for Rubber Properties in Tension.
 13. D1171: Test Method for Rubber Deterioration -Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens).
 14. D2240: Test Method for Rubber Property -Durometer Hardness.
 15. E283: Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors.
 16. E330: Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
 17. E331: Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
 18. E773: Test Method for Seal Durability of Sealed Insulating Glass Units.
 19. E774: Specification for Sealed Insulating Glass Units.
 20. E783: Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
- E. Consumer Product Safety Commission (CPSC): 16CFR 1202 - Architectural Glazing Standards and Related Material.
- F. Flat Glass Manufacturers Association (FGMA): Glazing Manual.
- G. Insulating Glass Certification Council (IGCC): Classification of Insulating Glass Units.
- H. UL Standard QHZQ for Building Integrated Photovoltaic Mounting System.
- I. National Electrical Code.

1.04 SYSTEM DESCRIPTION

- A. Design Requirements:
 1. Extruded aluminum members with a system of alternate serrations for attachment of exterior glass retainers with 1/4-in. x 20 stainless steel screws and snap-on beauty caps.
 2. Condensation guttering system integral with skylight framing members for positive drainage of condensation.
 3. Flush glazed exterior horizontal joints with field applied structural silicone.
 4. Full silicone wet seals along both sides of all exterior glass retainers.
 5. Optional aluminum rain gutters, with insulation and pitched liners, when applicable.
- B. Performance Requirements:
 1. Structural Members: Of sufficient sizes to support design loads as prescribed by governing building codes.
 2. The deflection of the framing member in a direction normal to the plane of glass when subjected to a uniform load deflection test in accordance with ASTM E330, and per the above specified loads, shall not exceed L/175, up to 1-in. maximum, for clear spans under 20-ft., or L/240 for clear spans greater than 20-ft.

3. 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.
4. Water Penetration: No water penetration shall occur when the system is tested in accordance with ASTM E331 using a differential static pressure of (20% of the inward acting design wind load pressure, but not less than 12 psf). Water penetration is defined as the appearance of uncontrolled water other than condensation on the interior surface of any part of the skylight.
 - a. Drain water penetrating at joints, as well as condensation occurring within the system to exterior face of the work.
5. Thermal Movement: Provide for expansion and contraction of component materials as will be caused by an exterior surface temperature range of (+/-) 85 °F, ranging from -20 °F to 150 °F, and an interior surface temperature range of (+/-) 40 °F, ranging from 40 °F to 120 °F. Adjustments in the exterior and interior temperature ranges should be made, based on specific project locations and conditions. The skylight system should allow for thermal movements without buckling, sealant failure, undue material stress, and other detrimental affects.
6. Where permitted by code, a 1/3 increase in allowable stress for wind or seismic load shall be acceptable, but not in combination with any reduction applied to combined loads. In no case shall allowable values exceed the yield stress.
7. 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.
8. Skylight framing is designed to be self-supporting between the support construction. The skylight(s) will impose reactions to the support construction. All adjacent and support construction must support the transfer of all loads including horizontal and vertical, exerted by the skylight(s). Design or structural engineering services for the supporting structure or building components not included in the skylight scope are not included under this section.
9. The 4 Element UL Classification Mark to be provided at a location readily visible after installation on a major system component, such as a rafter.
10. *Optional* limited reaction design: The skylight framing is to be designed to exert no horizontal reactions under vertical gravity type loads, (dead, snow, live). Unbalanced live loads, (wind, seismic, etc.), acting upon the skylight will produce horizontal reactions that cannot be controlled by the skylights, but must be resisted by the support structure.
11. *Optional* Balance of System (BOS): Design of photovoltaic array, including electrical paths, wiring, and specification for the balance of system components (combiner boxes, junction boxes, inverters, wiring to Data Acquisition System (DAS), and/or grid core.

1.05 SUBMITTALS

- A. Submit [____] copies of shop drawings showing plans, elevations and sections as required to fully describe the skylight construction for the Architect's approval prior to starting fabrication.
- B. Submit structural calculations prepared in accordance with the Aluminum Association's Specifications for Aluminum Structures (SAS30) by a [civil] [____] engineer qualified in the design of self-supporting sloped glazed systems licensed in (state where skylight is to be installed) [____].
- C. With regard to structural silicone joinery, submit, only if specifically requested:
 1. Certification that adhesion of sealant to samples of metal and glass is adequate when tested in accordance with ASTM C794.
 2. Certification that materials in contact with sealant are compatible with sealant after being exposed to 2,000-4,000 micro watt ultra-violet radiation for twenty-one (21) days.
 3. Statement that stress on each detailed sealant joint will not exceed design stress of sealant when exposed to specified wind loads.
- D. Submit [____] 12-in. x 12-in. samples of each type of glass.
- E. Submit [____] manufacturer's samples of each type of sealant.
- F. Submit [____] 6-in. long samples of extrusions (with appropriate finish).
- G. Submit [____] sets of as-built drawings and cleaning and maintenance manuals upon completion of skylight installation.

- H. Certification that insulating glass units will withstand specified design loads.
- I. Instruction manual containing:
 - 1. Photovoltaic laminate ratings:
 - a. Open-circuit voltage.
 - b. Short-circuit voltage.
 - c. Maximum power.
 - d. Operating voltage.
 - e. Current voltage.
 - f. Current at operating voltage.
 - g. Maximum allowed series fuse.
 - h. The fire resistance rating for the PV modules, or a statement that the PV modules are not fire rated.
 - 2. Electrical ratings.
 - 3. Module field replacement instructions: replacement of the photovoltaic laminates used in an array is limited to the same manufacturers type and model to maintain conformance with the UL Listing requirements.

1.06 QUALITY ASSURANCE

- A. Work of this Section, including design, engineering, fabrication, finishing, preparation at the jobsite, erection and glazing of the skylight system shall be the responsibility of the skylight manufacturer. The manufacturer shall be regularly engaged in the preceding phases of construction of skylights and able to demonstrate that he has performed successfully on comparably sized projects and of comparable design complexity over at least the previous ten (10) years.
- B. Commissioning of the photovoltaic array to be supervised by the designer.

1.07 WARRANTY

- A. Submit manufacturer's warranty certifying that skylight work was furnished and installed in accordance with the Contract Documents.
- B. Certify that skylight frame is free of defects in design, material, and construction for a period of ten (10) years from the Date of Skylight Completion.
- C. Warrant photovoltaic panels against defective materials, delamination, seal failure, and defects in manufacture per the glass manufacturer's standard warranties. Glass breakage is not warranted.
- D. Warrant structural sealant for a period of ten (10) years per sealant manufacturer's standard warranty of merchantable quality. Warranty shall certify that cured sealant:
 - 1. Will not become brittle or crack due to weathering or normal expansion and contraction of adjacent surfaces.
 - 2. Will not harden beyond a Shore A durometer of 50, nor soften below a minimum of 10 points.
 - 3. Will not change color significantly when used with compatible back-up materials.
 - 4. Will not bleed significantly.
- E. Warrant finish per the manufacturer's standard warranties.
- F. Optional extended warranties may be available on some products at an additional cost.
- G. Warranty service becomes effective only following payment in full for the contract amount.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Contract documents are based on products manufactured by Super Sky Products, Inc.; 10301 N. Enterprise Drive; Mequon, WI 53092; Phone (800) 558-0457, (262) 242-2000; Fax (262) 242-7409; www.supersky.com.
 - 1. UL Classification file number E247515 for Category #QHZQ.

- B. Other manufacturers will be considered when the following conditions have been met.
 - 1. Optional manufacturers must pre-qualify to bid not less than fourteen (14) days prior to the bid closing date.
 - 2. Complete details are submitted for review by the Architect showing compliance to the drawings and Contract Documents.
 - 3. Structural calculations, showing sizes of framing members and loads applied to the support structure, based on the design loads of this specification are submitted for review.
- 4. Prospective manufacturers submit notarized certification that they have successfully performed in the phases of design, manufacture and installation of skylight projects comparable in nature over at least the previous ten (10) years.

2.02 MATERIALS

- A. Framework:
 - 1. Principal Supporting Members: .125-in. minimum thickness extruded aluminum, alloy 6005-T5 or 6061-T6 per ASTM B221. Sizes, shapes and profiles (as per Super Sky Products' standard components) (as indicated on the Contract Drawings).
 - 2. Snap-on Covers and Miscellaneous Non-supporting Trim: .062-in. minimum thickness extruded aluminum, alloy 6063-T5 per ASTM B221.
 - 3. Raised aluminum screw slot for separation of mechanical fastener and wiring.
 - 4. Supporting aluminum gutters: thickness as prescribed by skylight engineer, based on skylight reactions and applied design loads.
 - 5. Principal Formed Metal Members: .125-in. minimum thickness aluminum, alloy [5052] [6061-T6] per ASTM B209.
- B. Glazing Strips:
 - 1. Extruded EDPM rubber designed to comply with the following specifications:
 - a. Hardness: ASTM D2240, Type A: Durometer 50 (+/-5).
 - b. Tensile Strength: ASTM D412. 800 psi (min.).
 - c. Elongation: 300% (min.).
 - d. Color: Black.
 - 2. Compression Set: ASTM D395 Method B, 22 hours @ 212 °F: 25% (max.).
 - 3. Heat Aging Characteristics:
 - a. 70 hours @ 212 °F.
 - b. Hardness: ASTM D2240, Type A: Durometer 50 (+/-5).
 - c. Tensile Change: ASTM D412. -10%.
 - d. Elongation Change: ASTM D412: -20%.
 - 4. ASTM D1171 Weather Resistance at 1 Part Ozone per Million, 500 hours at 20% Elongation: No cracks.
 - 5. No visual checks, cracks or breaks after completion of tests.
- C. Setting Blocks:
 - 1. Extruded Type II silicone rubber designed to permit adhesion and comply with the following specifications:
 - a. Hardness: ASTM D2240, Type A: Durometer 80 (+/-5).
 - b. Color: Black.
- D. Fasteners:
 - 1. For Exterior Cap Retainers: ASTM A193 B8 300 series stainless steel screws.
 - 2. For Framework Connections: ASTM B211 2024-T4 aluminum, ASTM A193 B8 300 series stainless steel, and ASTM B316 aluminum rivets, as required by connection.
 - 3. For Anchoring Skylight to Support Structure: ASTM A307 zinc plated steel fasteners.
 - 4. Exposed stainless steel truss head mechanical fasteners are utilized in accordance with standard connection details.
 - 5. Internal wiring miscellaneous components: 1001 Bridgeport anti-short bushing, 5/8-in. diameter grommet, and 1-1/4-in. Crouse-Hinds LNR4 non-metallic conduit liner.
- E. Flashing:
 - 1. [5005 H34 Aluminum] [Copper][Stainless Steel], [.040-in.][_____] minimum thickness.

2. Sheet metal flashings/closures/claddings are to be furnished shop formed to profile in min. 10-ft. lengths. When lengths exceed 10-ft., field trimming of the flashing and field forming the ends is necessary to suit as-built conditions. Sheet metal ends are to overlap 6-in. to 8-in. minimum, set in a full bed of sealant and riveted if required.
- F. Exposed metal finish [interior and exterior] [interior] [exterior] to comply with the following:

The following is a listing of all types of finishes that can be specified, therefore, only those finishes that apply should be used in an individual specification.

1. High Performance Pigmented Organic Coatings: AAMA 2605-05 [2-coat] [3-coat] [4-coat] min. 70% PVDF fluropolymers [standard] [custom] [mica] [exotic] [metallic].
 2. Pigmented Organic Coatings: AAMA 2604-05 [2-coat] min. 50% PVDF fluropolymers [standard] [custom] [mica].
 3. Anodized Coatings:
 - a. AAMA 611-98 Architectural Class I clear anodized Type AA-M10C22A41: **215-R1**.
 - b. AAMA 611-98 Architectural Class I electrolytically deposited color anodized Type AA-M10C22A44: [light bronze] [medium bronze] [dark bronze] [black].
- G. Photovoltaic Glazing:
1. Standard Certification Requirements:
 - a. UL Listed Panel [poly-crystalline, mono-crystalline, thin-film].
 - b. Heat Treated Glass: ASTM C1048, with surface stress of 5,000 (+/-) 1500 psi.
 - c. Laminated Glass: Two lites interleaved with polyvinyl butyral (PVB). Units must meet criteria of ANSI Z97.1- 1984 and CPSC 16 CFR 1201 for safety glazing. Provide PVB layer of 0.030-in. for all glass units unless a coating is applied to the inside face of the laminate thereby necessitating a 0.060-in. PVB layer.
 - d. Insulating Glass: CBA rated by the Insulating Glass Certification Council (IGCC) when tested in accordance with ASTM E773 and ASTM E774. Dual edge seals with the secondary seal being silicone. Exterior lite of [heat strengthened] [fully tempered] glass and interior lite of laminated glass.
 2. Performance Requirements:
 - a. Probability of breakage not to exceed 8/1000 for vertical glass and 1/1000 for sloped glass upon first application of design wind and live load pressures. For glass selection, design wind pressure for a one minute duration. For loads of longer duration use standard engineering practices for glass selection.
 - b. Probability of breakage due to anticipated thermal stress not to exceed 8/1000 for vertical glass and 1/1000 for sloped glass.
 3. Photovoltaic Unit Composition:
 - a. Sloped glass units are to be [____].
 - b. Vertical glass units are to be [____].

Specifier should consult Photovoltaic Panel Specification, for glazing make-up, sizes and compositions. Composition breakdown goes here.

4. Design of electrical array, balance of system (BOM), and data acquisition system (DAS) are not included.
- H. Sealants:
1. Structural Flush Glazed Joints: High performance silicone sealant applied in accordance with manufacturer's recommendations.
 2. Non-structural Flush Glazed Joints and Weather Seal Joints: Silicone sealants applied in accordance with manufacturer's recommendations.
 3. Structural silicone sealant performance requirements:
 - a. Hardness: ASTM D2240 Type A, 30 durometer.
 - b. Ultimate Tensile Strength: ASTM D412, 170 psi.
 - c. Tensile at 150% Elongation: ASTM D412, 80 psi.
 - d. Joint Movement Capability after 14 Day Cure: ASTM C719, (+/-) 50%.
 - e. Peel Strength [aluminum, glass, concrete] after 21 Day Cure: ASTM C794, 50 ppi.
 4. Structural silicone shall not be used to support dead weight of vertical glass or panels.

2.03 FABRICATION

- A. Construct skylight(s) using extruded aluminum members.
- B. Construct skylight(s) using a continuous aluminum curb with expansion joints as required.
- C. Insofar as practicable, fit and assemble work in the manufacturer's shop. Work which cannot be permanently assembled shall be shop-assembled, marked, and disassembled before shipment to the jobsite.
- D. Design rafter bars for slide-in type spline glazing strips.
- E. Design glass retainer fasteners to resist uplift loadings. Spacing to be determined by structural calculations, when applicable.
- F. Use snap-on beauty caps to conceal glass retainers and glass retainer fasteners.
- G. Shop locate drill and bolt, or weld aluminum clips to framing members.
- H. Set glass with interior and exterior EDPM glazing strips.
- I. Use silicone setting blocks to support glass and to provide edge clearances and glass bites as outlined below, in accordance with FGMA recommendations:
 - 1. Set blocks not less than 6-in. from edge of glass for support unit.
 - 2. Glass Bite: Not less than 1/2-in. nor more than 5/8-in. on any side of glass unit.
 - 3. Maintain 1/4-in. edge clearance between glass and adjacent metal framework.
 - 4. Use rubber spacers to maintain separation of glass and adjacent metal framework.
- J. Locate weepholes in curb to positively drain condensation to exterior of skylight at each rafter connection.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Upon arrival to the jobsite for installation of the specified work, the manufacturer's erector is to examine the structure and substrate to determine that they are properly prepared, dimensionally accurate, and ready to receive the skylight work included herein. Report any discrepancies to the General Contractor. Correction of faulty work to be at the expense of the responsible party/s. The skylight manufacturer is not responsible for faulty structure or substrate.

3.02 PREPARATION

- A. Contact between aluminum and dissimilar metals shall receive a protective coating of asphaltic paint for the prevention of electrolytic action and corrosion.
- B. Skylight manufacturer and manufacturer's erector excludes all field measuring, demolition, removal, replacement, or re-work of any existing material.

3.03 INSTALLATION

- A. Install skylight frame, glass and accessory items as needed in accordance with manufacturer's instructions.
- B. Install skylight system under the direction of the skylight manufacturer's designated erector.
- C. Erect system plumb and true, in proper alignment and relation to established lines and grades as shown on approved shop drawings.
- D. Anchor skylight to structure in strict accordance with approved shop drawings.
- E. Installation includes panel-to-panel hook-up only. All electrical wiring to the grid core and/or to the Balance of System (BOS) and/or to the Data Acquisition System (DAS) is by others.
- F. Use high performance silicone sealants to seal horizontal joints between glass panels and silicone sealant to wet seal joints between snap-on cap retainers and glass.
- G. Apply sealing materials in strict accordance with sealant manufacturer's instructions. Before application, remove mortar dirt, dust, moisture and other foreign matter from surfaces it will contact. Mask adjoining surfaces to maintain a clean and neat appearance. Tool sealing compounds to fill the joint and provide a smooth finish.

- H. Furnishing of temporary covering and weather-proofing of the skylight openings, if required by the General Contractor, and removal of the protective measures during and after the skylight installation is excluded by the manufacturer and the manufacturer's erector. ANY TEMPORARY COVERINGS THAT MAY BE REQUIRED ARE NOT TO OBSTRUCT OR INTERFERE WITH THE SKYLIGHT INSTALLATION IN ANYWAY.

3.04 TOLERANCES

- A. All parts of the work, when completed, shall be within the following tolerances:
 - 1. Maximum variation from plane or location shown on approved shop drawings: 1/8-in. per 12-ft. length, or 1/2-in. in total length.
 - 2. Maximum offset from true alignment between two members abutting end-to-end, edge-to-edge in line or separated by less than 3-in.: 1/32-in.

3.05 FIELD QUALITY CONTROL

- A. Water Leakage: Field check in accordance with AAMA 501.2 in proportionate areas. There shall be no uncontrolled water leakage as defined in AAMA 501.2. Water supply to the skylights, with adequate water pressure, is to be furnished by the General Contractor. Tests are to be conducted upon completion of the installation with no remobilization or down time included to accommodate either water supply availability or witness personnel schedules. Testing is to be performed by the manufacturer's authorized personnel with a maximum of five (5) man-hours for set-up, testing and clean-up. Independent laboratory testing and reports, if required, are to be ordered and directed by the Owner and/or General Contractor.

3.06 CLEANING

- A. Install skylight frame and associated metal to avoid soiling or smudging the finish.
- B. Clean glass and frame at time of installation. Final cleaning, if required, subsequent to completion of project, is not to be performed by the manufacturer.

3.07 PROTECTION

- A. The skylight manufacturer does not provide, nor does it include any temporary protection to the skylight and its materials after the installation is complete. Protection of the skylight from ongoing work by other trades shall be the responsibility of the General Contractor. The manufacturer is responsible only for the damage caused by the personnel under its control and responsibility.

END OF SECTION