

## SECTION 133460 - PHOTOVOLTAIC CURTAIN WALL

This section specifies photovoltaic curtain wall assemblies manufactured by Focus Materials, Inc., consisting of the following:

- Conventionally glazed aluminum framed curtain walls.
- Solar energy harvesting system consisting of photovoltaic modules (glazed panels and grid panels), and an energy conversion system connected to the building's electrical grid.

This section does not specify photovoltaic structural-sealant-glazed curtain wall assemblies, or photovoltaic sloped glazing assemblies, also manufactured by Focus Materials, Inc., but can be modified for specifying these assemblies.

This section is formatted according to the Construction Specifications Institute's latest guidelines for Section Format and the MasterFormat 2004 numbering system. LEED references are for LEED version 3 – Building Design + Construction.

Information in this section was obtained from the latest information published by the manufacturers of the system components in January of 2010. Possible changes might occur in later publications.

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. Section includes: Photovoltaic integrated glazed aluminum curtain wall assembly, including BiPV Curtain Wall, BiPV Rainscreen, BiPV Sunscreen and BiPV Retrofit, as follows:
1. The assembly consists of a conventionally glazed aluminum curtain wall with photovoltaic modules at the spandrel locations **[and where indicated on the Drawings.]**
  2. The solar energy captured by the photovoltaic modules is converted to regular AC current and incorporated into the building's electrical system.
  3. The assembly includes a monitoring system for energy management.
- B. Related Requirements:

[<Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.>](#)

1. Division 07 Section "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls **[and for sealants to the extent not specified in this Section]**.
2. Division 08 Section "Structural-Sealant-Glazed Curtain Walls" for structural-sealant-glazed curtain walls.
3. Division 08 Section "Sloped Glazing Assemblies" for sloped glazing **[installed with glazed aluminum curtain walls]**.
4. Division 08 Section "Louvers and Vents" for units installed with glazed aluminum curtain walls.
5. Division 08 Curtain Wall
6. Division 08 Doors and Hardware
7. Division 08 Glazing
8. Division 08 Aluminum Entrances and Storefront
9. Division 17 Skylights
10. Division 16 Electrical

1.3 ALLOWANCES

<Retain this article if testing is paid for by Contractor under an allowance.>

- A. Provide **[preconstruction]** **[field quality-control]** testing as part of testing and inspecting allowance.

1.4 ASSEMBLY DESCRIPTION

1.5 PREINSTALLATION MEETINGS

<Insert below the list of participants required to attend (suggested participants include: owner, architect, structural engineer, electrical engineer, general contractor, subcontractor). Delete this article if no pre-installation conference is required.>

1. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for curtain wall components.
2. For energy harvesting components. Include system description, ratings, capacities, and performance characteristics.

- B. Shop Drawings: Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, BiPV Curtain Wall, BiPV Rainscreen, BiPV Sunscreen and BiPV Retrofit, showing the following:
  - a. Joinery, including concealed welds.
  - b. Anchorage.
  - c. Expansion provisions.
  - d. Glazing.
  - e. Flashing and drainage.
3. Include details of energy harvesting equipment components. Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location of each field connection.
4. Include diagrams for power and control wiring.

- C. Structural Calculations.

- D. Samples for Verification:

1. For each type of exposed finish required, in manufacturer's standard sizes.
  - a. Where normal texture or color variations are expected, submit a set of minimum five samples illustrating the range of variation.
2. Structural glazing gaskets in 12-inch lengths.
3. Sealants for color selection.
4. PV Panels samples

- E. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

<Subparagraphs below apply to LEED-NC, -CI, and -CS.>

F. LEED Submittals:

1. Credit EA 2:
  - a. Product Data for specified photovoltaic curtain wall.
  - b. Calculations of anticipated energy generated by photovoltaic curtain wall.
2. Credit IEQ 4.1: Product Data for glazing sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

<Subparagraph below applies to LEED for Schools.>

- a. Include Laboratory Test Reports for glazing sealants used inside the weatherproofing system, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Credit MR 4: Product Data for products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

<Retain paragraph below if location project is within 500 miles of Focus Materials, Inc.>

4. Credit MR 5: Product Certificates for products and materials required to comply with requirements for regional materials, certificates indicating location of photovoltaic curtain wall manufacturer. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer [and preconstruction testing agency] [and testing agency].

<Retain first paragraph below if welding is required.>

B. **[Welding certificates.]**

- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified preconstruction testing agency, for photovoltaic curtain walls, indicating compliance with performance requirements.

<Retain paragraph below if Contractor is responsible for field quality-control testing and inspecting.>

- D. Warranties: Sample of special warranties.

- E. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For BiPV Curtain Wall, BiPV Rainscreen, BiPV Sunscreen and BiPV Retrofit, components to include in maintenance manuals.

- B. Operation and Maintenance Data: For energy harvesting components to include in operation, and maintenance manuals.

1. Include instructions for accessing and navigating the monitoring and reporting website information.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized personnel trained and approved for installation of units required for this Project.

- B. Delegated-Design Quality Requirements:

1. Engineering Responsibility: Preparation of data for aluminum-framed systems including Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.

<Retain first paragraph below if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article.>

- C. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

<Retain first paragraph below if welding is required and select applicable subparagraphs. >

- E. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- F. Mockups: (If required) Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

<Retain first subparagraph below for large-scale mockup. Indicate portion of wall represented by mockup on Drawings or draw mockup as separate element.>

1. Build mockup of typical wall area as shown on Drawings.

<Retain first subparagraph below if subjecting mockup to field testing.>

2. Field testing shall be performed on mockups according to requirements in "Field Quality Control" Article.

<Retain first subparagraph below if mockups are not only for establishing appearance factors.>

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

<Retain subparagraph below if applicable.>

4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- G. Preinstallation Conference: Conduct conference at [**Project site**] <Insert location>.
- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  1. Comply with NFPA 70.

#### 1.10 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls, BiPV Curtain Wall, BiPV Rainscreen, BiPV Sunscreen and BiPV Retrofit, by field measurements before fabrication and indicate measurements on Shop Drawings.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces to prevent damage.

1. Do not use adhesive papers or sprayed coatings, which become firmly bonded when exposed to sun.
2. Do not leave coating residue on surfaces.

1.12 WARRANTY

A. Curtain Wall Assembly Warranty: Standard form in which Focus Materials Inc. agrees to repair or replace components of glazed aluminum curtain walls that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Structural failures including, but not limited to, excessive deflection.
  - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - c. Water penetration through fixed glazing and framing areas
  - d. Failure of operating components.
2. Warranty Period: One year from date of Substantial Completion but commencing not later than six months from date of acceptance of curtain wall installation.

<Retain first subparagraph below for factory-painted finishes.>

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
  - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
  - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
  - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Warranty Period: 10 years from date of Substantial Completion.

<Select warranties below according to type of photovoltaic modules selected. >

C. Energy Harvesting Components:

1. Photovoltaic Glass Panel Modules: Standard form in which the manufacturer agrees to compensate the Owner for the lack of performance of the panels either by the supply of additional modules, by rectification of the module in question, by replacement of the module, or by refund at current market value.
  - a. Warranty Period: 10 years from the date of Substantial Completion if the module's performance is less than 90 percent of the minimum output specified in the product description.
  - b. Warranty Period: 20 years from the date of Substantial Completion if the module's performance is less than 80 percent of the minimum output specified in the product description.
2. Photovoltaic Metal Grill Panels:
  - a. Manufacturer's standard 25 year limited power warranty.
  - b. Manufacturer's standard 5 year limited product warranty.
3. Photovoltaic Silicone Coated Panels: Manufacturer's standard 20 year limited product warranty.

<First warranty below if for Enphase products, second one is for Sunny Boy. >

4. Energy Micro-Inverter System:
  - a. Microinverter Warranty Period: 5 years from the date of Substantial Completion.
  - b. Information Collector Warranty Period: One year from the date of Substantial Completion.

5. Energy Micro-Inverter Warranty Period: 5 years from the date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

#### A. Acceptable Manufacturers:

1. The products described below are the Basis of Design Products. Basis of Design Products establish the standards of type, function, dimension, in-service performance, physical properties, appearance, warranty, cost, and other characteristics required by the Project. The Project's design is based on the Basis-of-Design Products specified.
2. Subject to the requirements of Division 01, products of manufacturers not listed may be proposed for substitution, provided they are comparable to the products specified.

#### B. Photovoltaic Curtain Wall Assembly:

1. Basis of Design Assembly Manufacturer: **Focus Materials Inc.**, 2750 Redding Ave, Sacramento, CA 95820, (916) 837-1134.
2. Assembly is tested and compliant with the requirements of the following:
  - a. NFPA 70, National Electrical Code, 2008 Edition.
  - b. UL 1703 Standard for Safety Flat-Plate Photovoltaic Modules and Panels.
  - c. UL 1741 Standard for Safety Inverters, Converters, and Controllers for use in Independent Power.

#### C. PV Rainscreen Assembly:

#### D. PV Retrofit Cladding Assembly:

### 2.2 PERFORMANCE REQUIREMENTS

<Modify paragraph below if preconstruction testing of a mock-up or custom design is required. >

- #### A. Curtain Wall General Performance: Comply with performance requirements specified, as determined by testing of manufacturer's standard glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls shall withstand movements of supporting structure[ **indicated on Drawings**] including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:
  - a. Thermal stresses transferring to building structure.
  - b. Glass breakage.
  - c. Loosening or weakening of fasteners, attachments, and other components.
  - d. Failure of operating units.

<Retain first paragraph below if Contractor is required to assume responsibility for design.>

- #### B. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

<Data below are determined by the Project's Structural Engineer.>

#### C. Structural Loads:

1. Wind Loads:[**As indicated on Drawings**] <Insert loads>.
2. Seismic Loads:[**As indicated on Drawings**] <Insert loads>.

3. Periodic Maintenance-Equipment Loads: **[As indicated on Drawings] <Insert loads>**.

D. Structural-Test Performance: Test according to ASTM E 330 as follows:

Uniform Load: A static air Design Load of 30 psf shall be applied in the positive and negative direction in accordance with ASTM E330. Deflection shall be less than L/175 of the span of any framing member. When tested at 1.5 times the Design Load, there shall be no glass breakage and no permanent set in the framing members.

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

E. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.

First option in first subparagraph below is based on typical deflection criteria for glass. Second option is based on GANA's "Glazing Manual."

2. Deflection Parallel to Glazing Plane: Limited to **[L/360 of clear span or 1/8 inch, whichever is smaller] [amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch]**.

<Delete first subparagraph below if no operable windows or doors.>

- a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

<Retain subparagraph below for parapets and similar components.>

3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.

<Data below are determined by the Project's Structural Engineer.>

F. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to **[SEI/ASCE 7] [California Building Code]**.

1. Component Importance Factor is **[1.5] [1.0] <Insert factor>**.

<Retain first paragraph below if required by Project. Wind and earthquake events may create overturning moments that cause differential lateral displacement (deflection) of multistory buildings.>

G. Story Drift: Accommodate design displacement of adjacent stories indicated.

1. Design Displacement: **[As indicated on Drawings] <Insert design displacement>**.

Revise subparagraph below to suit Project.

2. Test Performance: Meeting criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement **[and 1.5 times the design displacement]**.

<Retain first paragraph below for static-pressure method, which is most frequently specified. >

Limit water infiltration to zero at when tested at 8 psf differential air pressure using ASTM E331.

- H. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than [6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>.

Framing system shall allow for expansion and contraction within system components caused by cycling temperature range of 100 degrees F without causing detrimental effects to system or components.

- I. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
  2. Test Interior Ambient-Air Temperature: 75 deg F.

The 2003 IECC and ASHRAE/IESNA 90.1 require that all fenestration be certified and labeled by the manufacturer for energy performance, based on ratings established by NFRC. Verify which manufacturers have tested glazed aluminum curtain walls and can demonstrate compliance with NFRC. Verify requirements of authorities having jurisdiction.

ASTM E 283 requires using a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) unless otherwise indicated, which is equivalent to a 25-mph (40-km/h) wind. A static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa) is equivalent to a 50-mph (80-km/h) wind. Maximum air leakage rate is based on the 2003 IECC; insert other value as applicable.

Air Infiltration: maximum 0.06 cfm per square foot of window area when tested at 6.24 psf static air pressure difference using ASTM E283.

- J. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of [0.30 cfm/sq. ft.] <Insert value> of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft. <Insert value>.
- K. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than [15] [25] [35] [45] <Insert value> as determined according to NFRC 500.
- L. Sound Transmission: Provide glazed aluminum curtain walls with fixed glazing and framing areas having the following sound-transmission characteristics:

Revise subparagraph below for exterior (airport or highway) noise sources; options are examples only.

1. Outdoor-Indoor Transmission Class: Minimum [26] [30] [34] <Insert number> when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

## 2.3 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: ASTM B 209.
  2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
  3. Extruded Structural Pipe and Tubes: ASTM B 429.
  4. Structural Profiles: ASTM B 308/B 308M.

<Retain subparagraph below for welding.>

5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

<Retain paragraph below for internal steel reinforcement of aluminum framing members; revise to suit Project.>

- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.



1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

## 2.4 FRAMING

- A. Framing Members: **Manufacturer's standard extruded aluminum, ASTM B 221, or 6063-T5 and 6063-T6 alloy and temper** and thickness required and reinforced as required to support imposed loads.

1. Construction: **[Nonthermal] [Thermally improved] [Thermally broken] <Insert description>**.
2. Glazing System: Retained mechanically with gaskets on four sides.
3. Glazing Plane: Front.

- B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.

<Retain subparagraph below for exposed fasteners if any.>

3. Use exposed fasteners with countersunk Phillips screw heads[, **finished to match framing system**] [, **fabricated from 300 series stainless steel**].

- D. Anchors: Three-way adjustable anchors with minimum adjustment of [**1 inch**] **<Insert dimension>** that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

Retain subparagraph below if applicable or revise to suit Project.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

- E. Concealed Flashing: [Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials] [ASTM A 240/A 240M of type recommended by manufacturer].

- F. Framing Sealants: Manufacturer's standard sealants.

## 2.5 GLAZING

- A. Vision Glass: Comply with Division 08 Section "Glazing."

**Gaskets: Glazing gaskets shall comply with ASTM C 864 and be extruded of a silicone compatible EPDM rubber that provides for silicone adhesion.**

- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black glazing gaskets fabricated of extruded EPDM, compatible with silicone, setting blocks, and shims or spacers.

- C. Weatherproof Sealants:

1. Weatherproof Sealants: As specified in Division 07 Section "Sealants".

<Retain first subparagraph below if required for LEED-NC, LEED-CI, or LEED-CS Credit IEQ 4.1.>

2. Sealants used inside the weatherproofing system shall have a VOC content of [250] <Insert value> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

<Retain subparagraph below if required for LEED for Schools Credit IEQ 4.>

3. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.6 OPERABLE UNITS

- A. Doors: Comply with Division 08 Section "Aluminum-Framed Entrances and Storefronts."

## 2.7 ENERGY HARVESTING COMPONENTS

- A. Solar Photovoltaic Modules:

1. Photovoltaic Laminated Glass Panel Modules:
  - a. Basis of Design Product: SCG-HV-L frameless laminated panels by Sulfurcell Solartechnik, [www.sulfurcell.de](http://www.sulfurcell.de).
    - 1) Rated Power: [50 W.] [52.5 W.] [55 W.] [57.5 W.][60 W.]
  - b. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified.
  - c. Front Panel: Copper-Indium-Sulfide (CIS)-coated glass, ASTM C 1048, Condition C, Type I, Quality-Q3, High Transmission, fully tempered.
    - 1) Thickness: 5 mm.
    - 2) CIS Coating Color: [As selected by Architect from manufacturer's full range] [Blue] [Blue-green] [Bronze] [Green] [Gray].
  - d. Back Panel: Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) or Class II (tinted).
    - 1) Thickness: 2 mm.
2. Photovoltaic Metal Grill Panels:
  - a. Basis of Design Product: Solyndra Photovoltaic Systems, Solyndra, Inc. [www.solyndra.com](http://www.solyndra.com).
  - b. Panels assembled with cylindrical metal rods with proprietary photovoltaic thin-film coating.

Provide required hardware for installation.
3. Photovoltaic Silicone Cell Panels:
  - a. Basis of Design Product: SP Series Solar Module SP200 by Solar Power Inc., [www.solarpowerinc.net](http://www.solarpowerinc.net).
  - b. Panel consisting of white backing sheet with proprietary 6 inch by 6 inch multi-crystalline silicone cells.
  - c. Panel Thickness: ¼ inch.
  - d. Panel Size: 58.03 inches by 39.17 inches.

- B. Grid-Connected Inverter Systems:

1. Basis of Design Manufacturer: Enphase Microinverter System, [www.enphaseenergy.com](http://www.enphaseenergy.com), (707) 763-4784.
  - a. MicroInverter: [M190 Microinverter] [M210 Microinverter] by Enphase.
    - 1) Standard: CSA Listed per UL1741.
    - 2) Performance: Capable of withstanding surges of up to 6kV.
    - 3) Function: Units are independently connected to each solar module and individually track the amount of energy harvested by each solar module to maximize energy harvested at all times.
    - 4) Efficiency:
      - a) Peak Inverter Efficiency: 95.5%.
      - b) CEC Weighted Efficiency: 95.0%
      - c) Nominal MPP Tracking: 99.6 %
  - b. Information Collector: Envoy by Enphase:

- 1) Standard: UL 60950, EN 60950
- 2) Function: Unit collects performance information from each photovoltaic module.
- 3) Performance: Units work with AC standard current and no special wiring is required.
- 4) Enclosure: NEMA 1, Interior.
- c. Transmitting Unit: The Enlighten by Enphase.
  - 1) Function: Unit transmits the performance information using broadband Ethernet protocols to a monitoring and analysis website for immediate access by system users.

<Select inverter below for light commercial applications.>

2. Basis of Design Product: Sunny Boy **[3000US] [4000US]** by SMA Solar Technology, www.sma-america.com.
  - a. Standard: UL 1741/ IEEE 1547.
  - b. Maximum Photovoltaic Power: **[3750 W.] [4375 W @ 208 V / 5000 W @ 240 V.]**
  - c. Maximum voltage: **[500 V.] [600 V.]**
  - d. Efficiency:
    - 1) Peak Inverter Efficiency: **[96.5%.] [96.8%.]**
    - 2) CEC Weighted Efficiency: **[95.0 % @ 208 V, 95.5 % @ 240 V.] [95.5 % @ 208 V, 96.0 % @ 240 V.]**

## 2.8 ACCESSORY MATERIALS

- A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

## 2.9 CURTAIN WALL COMPONENTS FABRICATION

- A. Form or extrude aluminum shapes before finishing.

<Retain first paragraph below for welding.>

- B. **[Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.]**

- C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.

<Revise first subparagraph below to suit Project. Most glazed aluminum curtain walls are glazed from the exterior.>

5. Provisions for field replacement of glazing from **[exterior] [interior] [interior for vision glass and exterior for spandrel glazing or metal panels].**

<System in first subparagraph below uses internal drainage method to protect against both water leakage and excessive air infiltration.>

6. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

<Retain first paragraph below if a particular assembly method is required.>

- D. Curtain-Wall Framing: Fabricate components for assembly using **[shear-block system] [screw-spline system] [head-and-sill-receptor system with shear blocks at intermediate horizontal members]** <Insert description>.

<Retain first paragraph below for unitized system or unit-and-mullion system assembly. Revise to suit Project.>

E. **[Factory-Assembled Frame Units:**

1. **Rigidly secure nonmovement joints.**
2. **Seal joints watertight unless otherwise indicated.**
3. **Install glazing to comply with requirements in Division 08 Section "Glazing."**

F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

A. Finish products after assembly.

B. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

C. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: **[Light bronze] [Medium bronze] [Dark bronze] [Champagne] [Black] <Insert color>.**

<Select one of the two high-performance organic products below.>

D. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.**
2. Basis of Design Product: Fluropon® by Valspar Spray Applied Architectural Coatings.

E. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>.**
2. Basis of Design Product: Fluropon Classic® by Valspar Spray Applied Architectural Coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine **[substrates] [supporting framing] [and] [conditions], with Installer present,** for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine assembly components before installation. Reject components that are wet, bended, moisture damaged, or otherwise damaged.

C. Examine roughing-in for electrical work to verify actual locations of electrical connections before electrical units are installed.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

### 3.2 INSTALLATION

#### A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

[Retain first subparagraph below for field welding of components.](#)

**6. [Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.]**

7. Seal joints watertight unless otherwise indicated.

#### B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

#### C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

#### D. Install components plumb and true in alignment with established lines and grades.

[Retain first paragraph below for operable units.](#)

#### E. [Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.]

[Retain paragraph below if glazed aluminum curtain walls are not factory glazed.](#)

#### F. Install glazing as specified in Division 08 Section "Glazing."

### 3.3 ERECTION TOLERANCES

#### A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:

[Erection tolerances in subparagraphs below are examples only that are based on various AAMA references. Coordinate with tolerances for support systems and revise to suit Project.](#)

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:
  - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
  - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
  - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

### 3.4 ENERGY HARVESTING COMPONENTS INSTALLATION

- A. Comply with NECA 1. See Div. 16 Specification.
- B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[ **and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.

[Retain first subparagraph below if retaining unenclosed wiring method option in "Wiring Method" Paragraph above.](#)

- 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements for cable trays specified in Division 26 Section "Cable Trays for Electrical Systems."
  - 3. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceways and Boxes for Electrical Systems."
- C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Energy Micro-Inverter System:
  - 1. Comply with manufacturer's installation specifications.
  - 2. Install a micro-inverter unit in the back each individual photovoltaic unit, connected to the central unit.
  - 3. Connect data collector and transmitter unit to central unit.

### 3.5 FIELD QUALITY CONTROL

[Retain first paragraph below to identify who shall perform tests and inspections. If retaining second option, retain "Field quality-control reports" Paragraph in "Informational Submittals" Article. See the "Field Testing" Article in the Evaluations for discussion on field testing.](#)

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
  - 1. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
    - a. Test Area: **[A minimum area of 12 feet by one story of glazed aluminum curtain wall]** **<Insert requirements>**.
- C. Testing and Inspecting of the Energy Harvesting Components: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Photovoltaic glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

2. <Insert startup steps if any>.

3.7 ADJUSTING

- A. Adjust **[hardware] [moving parts] [Insert operable component]** to function smoothly, and lubricate as recommended by manufacturer.
- B. Occupancy Adjustments: When requested within **[12] <Insert number>** months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **[two] <Insert number>** visits to Project during other-than-normal occupancy hours for this purpose.

[Insert "Cleaning" Article for specific requirements for cleaning the completed Work so it functions and performs properly.](#)

3.8 PROTECTION

[Paragraph below is for products and materials that are subject to mold.](#)

- A. Remove and replace **<Insert products or materials>** that are wet, moisture damaged, or mold damaged.

3.9 MAINTENANCE SERVICE

[Verify with Owner that maintenance service is required for Project.](#)

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include **[three] [six] [nine] [12]** months' full maintenance by **[skilled employees of systems and equipment Installer] [manufacturer's authorized service representative]**. Include **[monthly] [quarterly] [semiannual] [annual]** preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain energy harvesting components.

END OF SECTION 133460