SECTION 084433 - SLOPED GLAZING ASSEMBLIES

Revise this Section by deleting and inserting text to meet Project-specific requirements.

1. GENERAL
	* + 1. SUMMARY
				1. Section Includes:

Sloped glazing assemblies.

Refer to sections listed below for cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections. Sections listed below are for spec editor’s and design team coordination and are to remain as Editor’s Notes. Remove referenced specification sections within the body of the specification if not applicable to the project.

Section 084413 "Glazed Aluminum Curtain Walls" for vertical curtain walls.

Section 088000 "Glazing" for glass requirements.

* + - 1. ALLOWANCES

Retain paragraph below if testing is paid for by Contractor under an allowance.

* + - * 1. [**Preconstruction laboratory mockup**] [**Source quality-control**] [**and**] [**field quality-control**] testing is part of testing and inspecting allowance.
			1. PREINSTALLATION MEETINGS

Retain "Preinstallation Conference" paragraph below if Work of this Section is extensive or complex enough to justify a conference.

* + - * 1. Preinstallation Conference: Conduct conference at Project site.
			1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Provide Qualification Data from Quality Control Submittals prior to submitting the remaining submittals in order specified below.

Submit Product Data, Shop Drawings, Samples for Initial Selection, [**and**] [**Delegated Design**] submittals as one package.

Submit remaining Quality Controls Submittals.

Submit remaining submittals Sample for Verification, [**Fabrication Samples**], [**and**] [**Sustainable Design Submittals**].

Contract Closeout Submittals.

* + - * 1. Quality Control Submittals:

Energy Performance Certificates: For sloped glazing assemblies, accessories, and components from manufacturer.

Basis for Certification: NFRC-certified energy performance values for each sloped glazing assembly.

Product Test Reports: For sloped glazing assemblies, for tests performed by [**manufacturer and witnessed by a qualified testing agency**] [**a qualified testing agency]**.

Retain "Quality-Control Program" paragraph below if Project includes structural glazing. ASTM C1401 recommends establishing a written quality-control program for fabrication, installation, and post-construction maintenance of structural-sealant-glazed units.

Quality-Control Program: Developed specifically for Project, including fabrication and installation, in accordance with recommendations in ASTM C1401. Include periodic quality-control reports.

Source quality-control reports.

Retain "Mockup Testing Submittals" paragraph below if specifying Project-specific preconstruction testing in Part 1 "Preconstruction Testing" Article as Contractor's responsibility.

Mockup Testing Submittals:

Testing Program: Developed specifically for Project.

Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.

Record Drawings: As-built drawings of preconstruction laboratory mockups, showing changes made during preconstruction laboratory mockup testing.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

Field quality-control reports.

Sample Warranties: For special warranties.

* + - * 1. Product Data: For each type of product.

Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

Include manufacturer’s installation instructions.

* + - * 1. Shop Drawings: For sloped glazing assemblies. Include plans, elevations, sections, full-size details, and attachments to other work.

Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.

Include full-size isometric details of each type of vertical-to-horizontal intersection of sloped glazing assemblies, showing the following:

Joinery, including concealed welds.

Anchorage.

Expansion provisions.

Glazing.

Flashing and drainage.

Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

Retain "Samples for Initial Selection" and "Samples for Verification" paragraphs below for two-stage Samples.

* + - * 1. Samples for Initial Selection: For units with factory-applied color finishes.
				2. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

Retain "Fabrication Sample" paragraph below to verify details of assembly.

* + - * 1. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:

Joinery, including concealed welds.

Anchorage.

Expansion provisions.

Glazing.

Flashing and drainage.

Retain "Delegated-Design Submittal" paragraph below if design services have been delegated to Contractor.

* + - * 1. Delegated-Design Submittal: For sloped glazing assemblies, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
				2. Sustainable Design Submittals:
				3. Contract Closeout Submittals:

Maintenance Data: For sloped glazing assemblies to include in maintenance manuals.

Retain "Maintenance Data for Structural Sealant" paragraph below if Project includes structural glazing.

Maintenance Data for Structural Sealant: For sloped glazing assemblies with structural glazing, to include in maintenance manuals. Include ASTM C1401 recommendations for post installation-phase quality-control program.

* + - 1. QUALITY ASSURANCE

If retaining "Installer Qualifications" paragraph below, verify with prospective installers that they can comply with certification requirements referenced.

* + - * 1. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors[**and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program**].

Retain "Laboratory Mockup Testing Agency Qualifications" paragraph below if Project-specific preconstruction mockup testing is specified in "Preconstruction Testing" Article. Delete if specifying preconstruction laboratory mockup testing in Section 014339 "Mockups."

* + - * 1. Laboratory Mockup Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

Retain "Testing Agency Qualifications" paragraph below if Contractor selects testing agency or if Contractor is required to provide services of a qualified testing agency in Part 3 "Field Quality Control" Article.

* + - * 1. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**] and acceptable to Owner and Director’s Representative.
				2. 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.

Retain subparagraph below or revise to suit Project.

Do not change intended aesthetic effects, as judged solely by Director’s Representative, except with Director’s Representative's approval. If changes are proposed, submit comprehensive explanatory data to Director’s Representative for review.

Retain "Structural-Sealant Glazing" paragraph below if Project includes structural glazing.

* + - * 1. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of structural-sealant-glazed sloped glazing assemblies.
			1. BENCHMARKS
				1. Build benchmarks 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 benchmark. Indicate portion of sloped glazing assembly represented by benchmark on Drawings, or draw benchmark as separate element. Coordinate requirements with those in other Sections specifying glazing and cladding materials installed with sloped glazing assemblies.

Build benchmark of typical sloped glazing area, as shown on Drawings.

Retain first subparagraph below if subjecting benchmark to field testing.

Testing shall be performed on benchmarks in accordance with requirements in Part 3 "Field Quality Control" Article.

Retain first subparagraph below if benchmarks are not only for establishing appearance factors.

Approval of benchmarks does not constitute approval of deviations from the Contract Documents contained in benchmarks unless Director’s Representative specifically approves such deviations in writing.

* + - 1. PRECONSTRUCTION TESTING

Project-specific preconstruction testing of assemblies can be expensive but may be the best means of proving that performance requirements are met. Retain this Article for preconstruction laboratory mockup or preconstruction adhesive and compatibility testing.

Retain "Preconstruction Testing Service" paragraph below if required.

* + - * 1. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on laboratory mockups.

Build preconstruction laboratory mockups at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.

Usually indicate size and other details of preconstruction laboratory mockups on Drawings. ASTM E2099 includes recommendations for minimum sizes and configurations.

Size and Configuration: As indicated on Drawings.

Retain subparagraph below if required for Project.

Notify Director’s Representative [**seven**] <**Insert number**> days in advance of the dates and times when preconstruction laboratory mockups will be constructed and tested.

Retain "Preconstruction Laboratory Mockup Testing" paragraph below if required.

* + - * 1. Preconstruction Laboratory Mockup Testing: Test preconstruction laboratory mockups in accordance with requirements in Part 2 "Performance Requirements" Article. Perform the following tests in the following order:

Subparagraphs below list example test methods and sequence of tests based on AAMA 501 and ASTM E2099. Revise to suit Project. Coordinate with performance requirements in "Performance Requirements" Article. See AAMA 501 and ASTM E2099, and consult testing laboratories default testing methods and sequences. Consult manufacturers and testing agencies for guidance on appropriate requirements for Project.

Structural, 50 percent: ASTM E330 at 50 percent of positive test load.

Air Leakage: ASTM E283.

Water Penetration under Static Pressure: ASTM E331.

Water Penetration under Dynamic Pressure: AAMA 501.1.

Interstory Drift, 100 percent: AAMA 501.4 at 100 percent of design displacement. Repeat the following:

Air Leakage: ASTM E283.

Water Penetration under Static Pressure: ASTM E331.

Vertical Interstory Movement: AAMA 501.7 at 100 percent of design displacement. Repeat the following:

Air Leakage: ASTM E283.

Water Penetration under Static Pressure: ASTM E331.

Thermal Cycling: AAMA 501.5. Repeat the following:

Air Leakage: ASTM E283.

Water Penetration under Static Pressure: ASTM E331.

Structural, 100 percent: ASTM E330 at 100 percent of positive and negative test loads. Repeat the following:

Air Leakage: ASTM E283.

Water Penetration under Static Pressure: ASTM E331.

Water Penetration under Dynamic Pressure: AAMA 501.1.

Structural, 150 percent: ASTM E330 at 150 percent of positive and negative test loads.

Interstory Drift, 150 percent: AAMA 501.4 at 150 percent of design displacement.

Retain "Preconstruction Adhesion and Compatibility Testing" paragraph below if Project includes structural glazing. Adhesion and compatibility testing is essential and usually performed by sealant manufacturer.

Tests require many Samples, and some tests require four weeks to complete. If retaining paragraph below, also retain "Mockup Testing Submittals" paragraph in "Quality Control Submittals."

* + - * 1. Preconstruction Adhesion and Compatibility Testing: Submit to structural glazing sealant manufacturer, for testing indicated below, Samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that is in close proximity to or is touching the structural or nonstructural sealants of a structural glazed system.

Compatibility: Test materials or components using ASTM C1087.

Adhesion: Test for adhesion or lack of adhesion of a structural sealant to the surface of another material or component using ASTM C1135.

Submit no fewer than [**eight**] <**Insert number**> pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.

Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

Retain subparagraph below if testing is not required.

Testing will not be required if data based on previous testing of current sealant products match those submitted.

* + - 1. WARRANTY

When warranties are required, verify with Director’s Representative that special warranties stated in this article are not less than remedies available to the Facility under prevailing local laws.

* + - * 1. Special Assembly Warranty: [**Manufacturer**] [**Installer**] agrees to repair or replace components of sloped glazing assemblies that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

Failures include, but are not limited to, the following:

Structural failures, including, but not limited to, excessive deflection.

Noise or vibration created by wind and thermal and structural movements.

Delete option in first subparagraph below if retaining separate finish warranties.

Deterioration of metals[**, metal finishes,**] and other materials beyond normal weathering.

Water penetration through fixed glazing and framing areas.

Failure of operating components.

Verify available warranties and warranty periods for sloped glazing assemblies.

Warranty Period: [**Two**] [**Five**] [**10**] <**Insert number**> years from date of Substantial Completion.

* + - * 1. Special Finish Warranty, Factory-Applied Finishes: 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.

Retain first subparagraph below for factory-painted finishes. Coordinate color fading and chalking limits with finishes retained in Part 2.

Deterioration includes, but is not limited to, the following:

Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.

Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.

Cracking, checking, peeling, or failure of paint to adhere to bare metal.

Coordinate "Warranty Period" subparagraph below with Part 2 "Aluminum Finishes" Article. AAMA 2604 is intended to represent five years of performance; AAMA 2605 is intended to represent 10 years of performance. Verify available warranties and warranty periods for finishes.

Warranty Period: [**Five**] [**10**] [**20**] <**Insert number**> years from date of Substantial Completion.

* + - * 1. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

Retain first subparagraph below for anodized finishes. Coordinate color fading and chalking limits with finishes retained in Part 2.

Deterioration includes, but is not limited to, the following:

Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.

Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.

Cracking, peeling, or chipping.

Coordinate "Warranty Period" subparagraph below with Part 2 "Aluminum Finishes" Article. Five years is standard for Class I anodized finishes, although a few manufacturers offer a 10- or 20-year warranty. Class II anodized finishes often carry less than a five-year warranty. Verify available warranties and warranty periods for finishes.

Warranty Period: [**Five**] [**10**] <**Insert number**> years from date of Substantial Completion.

1. PRODUCTS

Manufacturers and products listed in this Section are neither recommended nor endorsed by the AIA or Deltek. Before selecting manufacturers and products, verify availability, suitability for intended applications, and compliance with minimum performance requirements.

Product options commonly available from manufacturers are included in square brackets throughout the Section Text. Not every manufacturer listed can provide every option offered; verify availability with manufacturers.

* + - 1. PERFORMANCE REQUIREMENTS
				1. General Performance: Comply with performance requirements specified, as determined by testing of sloped glazing assemblies representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

Sloped glazing assemblies shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.

Failure also includes the following:

Thermal stresses transferring to building structure.

Glass breakage.

Noise or vibration created by wind and thermal and structural movements.

Loosening or weakening of fasteners, attachments, and other components.

* + - * 1. Structural Loads:

Usually indicate on Drawings design loads determined by Project's Structural Engineer. Verify requirements of authorities having jurisdiction. See the Evaluations for additional information.

Wind Loads: As indicated on Drawings.

Other Design Loads: [**As indicated on Drawings**] <**Insert loads**>.

* + - * 1. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

Based on Project conditions, more stringent deflection criteria than specified in "Deflection Normal to Wall Plane" and "Deflection Parallel to Glazing Plane" subparagraphs below may be required; see "Seismic Performance" Article in the Evaluations.

Deflection Normal to Wall Plane: Limited to [**1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans of greater than 13 feet 6 inches**] <**Insert deflection limit**>.

Deflection criteria in "Deflection Parallel to Glazing Plane" subparagraph below is based on the "GANA Glazing Manual."

Deflection Parallel to Glazing Plane: Limited to [**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**] <**Insert deflection limit**>.

Retain "Cantilever Deflection" subparagraph below if required.

Cantilever Deflection: Limited to 2l/175 at unsupported cantilevers.

ASTM E 330 test method evaluates structural performance of sloped glazing assemblies and not structural performance of contiguous construction.

* + - * 1. Structural: Test in accordance with ASTM E330 as follows:

When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.

When tested at [**150**] <**Insert number**> percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding [**0.2**] <**Insert number**> percent of span.

Minimum test duration in accordance with ASTM E330 is 10 seconds, which is historically U.S. practice.

Test Durations: As required by design wind velocity, but not less than [**10**] <**Insert number**> seconds.

Retain "Water Penetration under Static Pressure" paragraph below for static-pressure method, which is most frequently specified. For water-penetration tests, AAMA 501 states that a static-air-pressure differential of 20 percent of wind-load design pressure provides satisfactory performance in most parts of the United States. Locations where high winds and heavy rains occur simultaneously require higher test-pressure differences.

* + - * 1. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

No evidence of water penetration through fixed glazing and framing areas when tested in accordance with 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**>.

Retain "Water Penetration under Dynamic Pressure" paragraph below if required for preconstruction laboratory mockup testing; most manufacturers do not include test data in product literature for dynamic-pressure testing. This test may be available in some areas for field quality-control testing; verify with qualified testing agency.

* + - * 1. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 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**>.

AAMA 501.1's definition of water leakage allows up to 1/2 oz. of water to accumulate on an interior stop or stool integral to assembly in a 15-minute period.

Maximum Water Leakage: [**In accordance with AAMA 501.1**] [**No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation**]. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

Retain "Interstory Drift" paragraph below if required by Project. Wind and seismic events may create overturning moments that cause differential lateral displacement (deflection) of multistory buildings. See the Evaluations for further information.

* + - * 1. Interstory Drift: Accommodate design displacement of adjacent stories indicated.

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

Revise "Test Performance" subparagraph below to suit Project.

Test Performance: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.4 at design displacement[**and 1.5 times the design displacement**].

Retain "Seismic Performance" paragraph below for projects requiring seismic design. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: Sloped glazing assemblies shall withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>.

AAMA 501.6 in "Seismic Drift Causing Glass Fallout" subparagraph below is a dynamic racking test method focusing on seismic safety (glass fallout).

Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.6 at design displacement[**and 1.5 times the design displacement**].

AAMA 501.7 in "Vertical Interstory Movement" subparagraph below focuses on changes in serviceability resulting from vertical displacement.

Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.7 at design displacement[**and 1.5 times the design displacement**].

The ECCNYS and ASHRAE/IES 90.1 require that all fenestration be certified and labeled by manufacturer for energy performance for thermal transmittance (U-factor), solar heat gain coefficient (SHGC), air leakage, and visible transmittance (VT). Energy performance for fenestration products is typically determined for the whole fenestration product or system, which includes the framing, glazing, and spacer. Coordinate the values selected for energy performance with the glazing selections in Section 088000 "Glazing," and confirm manufacturer can meet the specified energy performance and can provide certification and labelling. Verify requirements of authorities having jurisdiction.

* + - * 1. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:

Energy performance requirements below are based on the ECCNYS and ASHRAE/IES 90.1 requirements for vertical fenestration, based on glazing sloped at an angle of no greater than 30 degrees from vertical. If glazing is sloped at an angle of greater than 30 degrees from vertical, revise requirements below to comply with the ECCNYS and ASHRAE/IES 90.1 energy performance requirements for skylights

Options in subparagraphs below are examples only; revise values to suit climate zone of building envelope as defined by the ECCNYS. Testing for visible light transmittance (VT) is specified in Section 088000 "Glazing."

Thermal Transmittance (U-factor):

Fixed Glazing and Framing Areas: U-factor for the system of not more than [**0.29 Btu/sq. ft. x h x deg F**] [**0.36 Btu/sq. ft. x h x deg F**] [**0.38 Btu/sq. ft. x h x deg F**] [**0.41 Btu/sq. ft. x h x deg F**] [**0.46 Btu/sq. ft. x h x deg F**] [**0.50 Btu/sq. ft. x h x deg F**] <**Insert value**> as determined in accordance with NFRC 100.

Solar Heat Gain Coefficient (SHGC):

Fixed Glazing and Framing Areas: SHGC for the system of not more than [**0.25**] [**0.30**] [**0.40**] [**0.45**] <**Insert value**> as determined in accordance with NFRC 200.

Air Leakage:

Retain first option in "Fixed Glazing and Framing Areas" subparagraph below for maximum air-leakage rate based on ASHRAE/IES 90.1 requirements. Static-air-pressure differential of 1.57 lbf/sq. ft. in second option, equivalent to a 25-mph wind, is ASHRAE/IES 90.1 minimum, which is adequate for many buildings. Air-pressure differential in third option is equivalent to a 50-mph wind and is recommended for buildings in which greater control of air quality or humidity is required.

Fixed Glazing and Framing Areas: Air leakage for the system of not more than [**0.06 cfm/sq. ft.**] <**Insert value**> at a static-air-pressure differential of [**1.57 lbf/sq. ft.**] [**6.24 lbf/sq. ft.**] <**Insert value**> when tested in accordance with ASTM E283.

Condensation Resistance Factor (CRF):

Fixed Glazing and Framing Areas: CRF for the system of not less than [**29**] [**55**] [**65**] [**80**] <**Insert value**> as determined in accordance with AAMA 1503.

Retain "Noise Reduction" paragraph below if required for Project.

* + - * 1. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows:

Ratings in "Outdoor-Indoor Transmission Class" subparagraph below represent noise reductions based on a sound spectrum with frequencies weighted to correlate with transportation sources (aircraft takeoff, freeway, and railroad passby). The higher the OITC, the more effective the noise reduction.

Outdoor-Indoor Transmission Class (OITC): Minimum [**26**] [**30**] [**34**] <**Insert number**>.

Sound Transmission Class (STC): Minimum [**31**] [**34**] [**37**] [**40**] <**Insert number**>.

If blast resistance is required by Project, insert the requirements here using other Sections as a guide. Blast-resistant sloped glazing assemblies are not typically offered by manufacturers and will have to be custom manufactured, tested and rated.

If windborne-debris impact resistance is required by Project, insert the requirements here using other Sections as a guide. Windborne-debris impact-resistant sloped glazing assemblies are not typically offered by manufacturers and will have to be custom manufactured, tested, and rated.

* + - * 1. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

Differential values in "Temperature Change" subparagraph below (for aluminum in particular) are suitable for most of the United States.

Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

Retain "Thermal Cycling" subparagraph below if testing is required for Project. Standard systems are usually not tested in accordance with AAMA 501.5. Manufacturers often rely on calculations and in-service performance to verify thermal-movement capabilities.

Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.

High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of [**180 deg F**] <**Insert temperature**>.

Low Exterior Ambient-Air Temperature: [**0 deg F**] <**Insert temperature**>.

Retain "Structural-Sealant Joints" paragraph below if Project includes structural glazing.

* + - * 1. Structural-Sealant Joints:

Retain subparagraph below if dead-load support by structural sealant is acceptable.

Designed to carry gravity loads of glazing.

Retain "Structural Sealant" paragraph below if Project includes structural glazing.

* + - * 1. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by sloped glazing assemblies without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.

Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

* + - 1. SOURCE LIMITATIONS
				1. Obtain all components of sloped glazing assemblies[**and glazed aluminum curtain walls**], including framing and accessories, from single manufacturer.
			2. SLOPED GLAZING ASSEMBLIES

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=45) Subject to compliance with requirements, provide products by one of the following:

[EFCO Corporation](http://www.specagent.com/Lookup?uid=123457191618).

[Kawneer North America, an Arconic company](http://www.specagent.com/Lookup?uid=123457191620).

[U.S. Aluminum; a brand of C.R. Laurence](http://www.specagent.com/Lookup?uid=123457191627).

[Wausau Window and Wall Systems; Apogee Wausau Group, Inc](http://www.specagent.com/Lookup?uid=123457191632).

[YKK AP America Inc](http://www.specagent.com/Lookup?uid=123457191633).

Or equal.

* + - * 1. Framing Members: Manufacturer's standard, formed- or extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.

Construction: [**Thermally broken**] [**Thermally improved**] [**Nonthermal**] <**Insert description**>.

Framing-Member Type: [**Self-supporting**] [**Skin type, supported by structural-steel members indicated**].

Glazing System: [**Field-installed pressure caps on four sides**] [**Field-installed structural sealant at horizontal members (purlins) and pressure caps at rafters**].

Finish: [**Clear anodic finish**] [**Color anodic finish**] [**Baked-enamel or powder-coat finish**] [**High-performance organic finish**] [**Superior-performance organic finish**].

Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

Steel Reinforcement: As required by manufacturer.

* + - * 1. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.

Include snap-on aluminum trim that conceals fasteners.

* + - * 1. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
			1. GLAZING
				1. Comply with Section 088000 "Glazing."

For gaskets in continuous contact with structural silicone, use extruded silicone or compatible material. Silicone glazing gaskets are available in custom colors from some manufacturers.

* + - * 1. Glazing Gaskets:

Retain one of two subparagraphs below.

ASTM C509 or ASTM C864. [**Manufacturer's standard**] [**Compression-type, replaceable EPDM**] [**Extruded silicone**] <**Insert type**>.

Color: [**Black**] <**Insert color**>.

Comply with Section 088000 "Glazing."

* + - * 1. Glazing Sealants:

Retain first subparagraph below for products based on manufacturer's standard systems, or retain second subparagraph and specify sealants for glazing systems in Section 088000 "Glazing."

As recommended by manufacturer.

Comply with Section 088000 "Glazing."

Retain "Structural Glazing Sealants" and "Weatherseal Sealants" paragraphs below if Project includes structural glazing.

* + - * 1. Structural Glazing Sealants: ASTM C1184, chemically curing silicone formulation that is compatible with system components with which it comes into contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in sloped glazing assembly indicated.

Color: [**Black**] [**Gray**] [**As selected by Director’s Representative from manufacturer's full range of colors**] <**Insert color**>.

Weatherseal sealants in "Weatherseal Sealants" paragraph below provide weather resistance for structural-glazed sealants. Delete if not required or where structural sealant is also weatherseal sealant.

* + - * 1. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes into contact; recommended by structural-sealant, weatherseal-sealant, and sloped glazing assembly manufacturers for this use.

Color: Match structural sealant.

* + - 1. MATERIALS
				1. Sheet and Plate: ASTM B209.
				2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
				3. Structural Profiles: ASTM B308.

Retain "Steel Reinforcement" and "Steel Reinforcement Primer" paragraphs below for internal steel reinforcement of aluminum framing members; revise to suit Project.

* + - * 1. Steel Reinforcement:

Structural Shapes, Plates, and Bars: ASTM A36.

Cold-Rolled Sheet and Strip: ASTM A1008.

Hot-Rolled Sheet and Strip: ASTM A1011.

* + - * 1. Steel Reinforcement Primer: 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 in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.
			1. ACCESSORIES
				1. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.

Reinforce members as required to receive fastener threads.

Retain subparagraph below for exposed fasteners if any.

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

* + - * 1. 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 "Concrete and Masonry Inserts" subparagraph below if applicable, or revise to suit Project.

Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123 or ASTM A153 requirements.

* + - * 1. Concealed Flashing: [**Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials**] [**Dead-soft, 0.018-inch-thick stainless steel, ASTM A240 of type recommended by manufacturer**].
				2. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.
			1. FABRICATION
				1. Form or extrude aluminum shapes before finishing.

Retain first paragraph below for welding.

* + - * 1. 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.
				2. Fabricate components that, when assembled, have the following characteristics:

Profiles that are sharp, straight, and free of defects or deformations.

Accurately fitted joints with ends coped or mitered.

Physical and thermal isolation of glazing from framing members.

Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.

Revise first subparagraph below to suit Project. Verify glazing requirements for sloped glazed assemblies with manufacturers listed in Part 2 articles.

Provisions for field replacement of glazing from [**exterior**] [**interior**].

Revise first subparagraph below for safety railings if any.

Provisions for safety railings mounted [**on interior face of mullions**] [**between mullions at interior**].

Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

Retain subparagraph below for curved components if any.

Components curved to indicated radii.

Retain "Structural-Sealant-Glazed Framing Members" paragraph below if Project includes structural glazing.

* + - * 1. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
				2. Fabricate components with internal guttering system or other means to drain water-passing joints, condensation occurring within framing members, and moisture migrating within sloped glazing assemblies to exterior.
				3. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.
			1. ALUMINUM FINISHES

Retain finishes in paragraphs below to suit Project. If retaining more than one, indicate location of each on Drawings or by inserts. Some aluminum-framing systems are available with dual finishes, allowing different interior and exterior color finishes. See "Aluminum Finishes" Article in the Evaluations for additional information.

Retain one of two options in "Clear Anodic Finish" paragraph below. Verify availability with manufacturers.

* + - * 1. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**] [**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

Retain one of two options in "Color Anodic Finish" paragraph below. Verify availability with manufacturers.

* + - * 1. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**] [**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

Options in "Color" subparagraph below are examples only and may vary in color range and availability among manufacturers.

Color: [**Light bronze**] [**Medium bronze**] [**Dark bronze**] [**Champagne**] [**Black**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from full range of industry colors and color densities**] <**Insert color**>.

"Baked-Enamel or Powder-Coat Finish" paragraph below references AAMA standard for pigmented organic coating on aluminum extrusions and panels.

* + - * 1. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range**] <**Insert color and gloss**>.

Retain "High-Performance Organic Finish, Two-Coat PVDF," "Superior-Performance Organic Finish, Three-Coat PVDF," "Superior-Performance Organic Finish, Four-Coat PVDF," "Superior-Performance Organic Finish, Single-Coat FEVE," or "Superior-Performance Organic Finish, Two-Coat FEVE" paragraph below; if more than one is required, indicate location of each system on Drawings, in schedules, or by inserts. Coordinate finish system selected with special finish warranty period specified in Part 1 "Warranty" Article.

In "High-Performance Organic Finish, Two-Coat PVDF" paragraph below, retain AAMA 2604 with 50 percent resin content by weight in color coat or AAMA 2605 with 70 percent resin content by weight in color coat for high-performance organic coatings on extrusions and panels. If specific products are required, name coating manufacturers and products.

* + - * 1. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with [**AAMA 2604**] [**AAMA 2605**] and containing not less than [**50**] [**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 [**for seacoast and severe environments**].

Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range**] <**Insert color and gloss**>.

* + - * 1. Superior-Performance Organic Finish, Three-Coat PVDF: 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 [**for seacoast and severe environments**].

Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range**] <**Insert color and gloss**>.

* + - * 1. Superior-Performance Organic Finish, Four-Coat PVDF: 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 [**for seacoast and severe environments**].

Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range**] <**Insert color and gloss**>.

"Superior-Performance Organic Finish, Single-Coat FEVE" paragraph below is not suitable for seacoast and severe environments.

* + - * 1. Superior-Performance Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range**] <**Insert color and gloss**>.

* + - * 1. Superior-Performance Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605.

Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range**] <**Insert color and gloss**>.

* + - 1. SOURCE QUALITY CONTROL

Retain this article if Project includes structural glazing.

* + - * 1. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.
1. EXECUTION
	* + 1. EXAMINATION
				1. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
				2. Proceed with installation only after unsatisfactory conditions have been corrected.
			2. INSTALLATION, 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.
				6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
				7. Seal joints watertight unless otherwise indicated.
				8. Metal Protection:

Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.

Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

* + - * 1. Install components to drain water-passing joints, condensation occurring within framing members, and moisture migrating within sloped glazing assemblies to exterior.
				2. Install components plumb and true in alignment with established lines and grades.
			1. INSTALLATION OF GLAZING
				1. Install glazing as specified in Section 088000 "Glazing."
			2. INSTALLATION OF STRUCTURAL GLAZING

Retain this article if Project includes structural glazing.

* + - * 1. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
				2. Set glazing into framing in accordance with sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
				3. Set glazing with proper orientation, so that coatings face exterior or interior as specified.
				4. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.
				5. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer and framing manufacturers written instructions and in compliance with local codes.
				6. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.
				7. Allow structural sealant to cure in accordance with manufacturer's recommendations.
				8. Clean and protect glass as indicated in Section 088000 "Glazing."
			1. INSTALLATION OF WEATHERSEAL SEALANT

Retain this article if Project includes structural glazing.

* + - * 1. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass, as recommended by sealant manufacturer.
				2. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.
			1. ERECTION TOLERANCES
				1. Install sloped glazing assemblies 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.

Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.

Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.

Alignment:

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.

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.

Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

* + - 1. FIELD QUALITY CONTROL

Retain this article for testing of sloped glazing assembly during installation or for testing of benchmarks.

* + - * 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
				2. Test Area: Perform tests on [**one bay at least 30 feet, by one story**] [**representative areas of sloped glazing assemblies**] [**benchmarks**] <**Insert requirements**>.
				3. Field Quality-Control Testing: Perform the following test on [**representative areas of sloped glazing assemblies**] [**benchmarks**] <**Insert requirements**>.

Inexpensive test in "Water-Spray Test" subparagraph below tests for deficiencies in workmanship only and is not representative of a wind-driven rain event.

Water-Spray Test: Before installation of interior finishes has begun, areas designated by Director’s Representative shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.

Retain one of first two subparagraphs below.

Perform a minimum of [**two**] [**three**] <**Insert number**> tests in areas as directed by Director’s Representative.

Perform tests in each test area, as directed by Director’s Representative. Perform at least three tests, prior to [**10, 35, and 70 percent completion**] <**Insert requirements**>.

AAMA 503 allows a prescribed test pressure for air leakage, depending on the location and wind exposure of the Project. Modify "Air Leakage" subparagraph below to use a prescribed test pressure.

Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in Part 2 "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.

Retain one of first two subparagraphs below.

Perform a minimum of [**two**] [**three**] <**Insert number**> tests in areas, as directed by Director’s Representative.

Perform tests in each test area, as directed by Director’s Representative. Perform at least three tests, prior to [**10, 35, and 70 percent completion**] <**Insert requirements**>.

When specifying test pressure, note that AAMA allows a one-third reduction in test pressures for field tests. 6.24 lbf/sq. ft. is industry standard minimum; however, AAMA 503 allows minimum test pressure of 4.18 lbf/sq. ft. Alternately, AAMA 503 allows a prescribed test pressure for water penetration, depending on the location and wind exposure of the project. Modify "Water Penetration" subparagraph below to use a prescribed test pressure.

Water Penetration: ASTM E1105 at a minimum [**uniform**] [**and**] [**cyclic**] static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in Part 2 "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.

Retain "Structural-Sealant Adhesion" paragraph below if Project includes structural glazing.

* + - * 1. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

Test a minimum of [**two**] [**four**] [**six**] <**Insert number**> areas on each building facade.

Repair installation areas damaged by testing.

* + - * 1. Sloped glazing assemblies will be considered defective if they do not pass tests and inspections.
				2. Prepare test and inspection reports.

END OF SECTION 084433