SECTION 085113 - ALUMINUM WINDOWS

1. GENERAL
   * + 1. SUMMARY
          1. Section includes aluminum windows for exterior locations.

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 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.

* + - 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.

Retain subparagraphs below if required. If retaining, revise to include product-specific requirements.

Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.

Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.

Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.

Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

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

Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.

Include manufacturer’s installation instructions.

* + - * 1. Shop Drawings: For aluminum windows.

Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

Retain “Samples” below for typical sample requirements. Delete if retaining next “Samples” paragraph for larger projects.

* + - * 1. Samples: Corner section for each type of window unit and for each color specified, 8 by 8 inches in size.

Include as part of corner section: frame, sash, and insect screen.

Provide manufacturer’s standard color finishes for selection.

Retain “Samples” below for large projects or for projects where window appearance is very important. If a full window sample is required.

* + - * 1. Samples: One full size unit, including insect screen and hardware.

Provide manufacturer’s standard color finishes for selection.

* + - * 1. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.
        2. Quality Control Submittals:

Qualification Data: For manufacturer and Installer.

Names and address of 3 similar projects that Installer has worked on during the past 5 years.

Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.

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 manufacturer's warranties.

* + - 1. QUALITY ASSURANCE
         1. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
         2. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project and have a minimum three years’ experience.
         3. Label: each window unit shall have a AAMA or WDMA Certification label affixed to it.

Retain “Benchmark” for large projects requiring a benchmark(s) window installation for approval by the Director’s Representative.

* + - * 1. Benchmark: Build benchmark to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

Indicate portion of wall represented by benchmark on Drawings or draw benchmark as separate element.

Build benchmark of typical wall area as shown on Drawings.

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

Subject to compliance with requirements, approved benchmarks may become part of the completed Work if undisturbed at time of Substantial Completion.

Insert "Field Conditions" Article and requirements for field measurements for existing construction that requires custom-fabricated window replacements.

* + - 1. WARRANTY

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

* + - * 1. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

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

Failure to meet performance requirements.

Structural failures including excessive deflection, water leakage, condensation, and air infiltration.

Faulty operation of movable sash and hardware.

Deterioration of materials and finishes beyond normal weathering.

Failure of insulating glass.

Verify available warranties and warranty periods for units and components. Some manufacturers might insist that warranty periods begin on date of manufacture or sale.

Warranty Period:

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

Warranty period for glazing units varies by type.

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

Warranty period for aluminum finish depends on type. Baked-on enamel finishes often have 10-year warranties; high-performance fluoropolymer finishes often have 20-year warranties.

Aluminum Finish: [**10**] [**20**] <**Insert number**> years from date of Substantial Completion.

1. PRODUCTS
   * + 1. MANUFACTURERS
          1. Source Limitations: Obtain aluminum windows from single source from single manufacturer.
       2. WINDOW PERFORMANCE REQUIREMENTS

See the Evaluations for discussions of performance requirements. Coordinate performance requirements with types of window operation (for example, casement or double hung), glass type, and other variables. If performance requirements vary among types of windows, insert language to differentiate requirements among window types or show requirements in a schedule on Drawings.

* + - * 1. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

Retain requirements for AAMA certification and labeling if needed. Not all manufacturers that test products according to AAMA/WDMA/CSA 101/I.S.2/A440 requirements participate in AAMA's third-party certification program for listing and labeling aluminum windows.

Window Certification: AAMA certified with label attached to each window.

* + - * 1. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

Performance class abbreviations: Per Fenestration & Glazing Industry Alliance, [FGIA - Performance Class Overview | AAMA Standards & Ballots (fgiaonline.org)](https://fgiaonline.org/pages/performance-class-overview)

15 psf for R class (commonly used in one- and two-family dwellings)

25 psf for LC class (commonly used for low- and mid-rise multifamily dwellings and other buildings where larger sizes and higher loading requirements are expected)

30 psf for the new CW class (commonly used in low- and mid-rise buildings where larger sizes, higher loading requirements, limits on deflection and heavier use are expected)

40 psf for the AW class (commonly used in high-rise and mid-rise buildings to meet increased loading requirements and limits on deflection and in buildings where frequent and extreme use of the fenestration products is expected)

Minimum Performance Class: [**R**] [**LC**] [**CW**] [**AW**] [**As indicated on Drawings**] <**Insert class**>.

AAMA/WDMA/CSA 101/I.S.2/A440 establishes a gateway Performance Grade for windows to qualify for each Performance Class. The gateway Performance Grade is 15 for Class R, 25 for Class LC, 30 for Class CW, and 40 for Class AW. For a particular project, the minimum Performance Grade for windows is typically based on the design pressure.

Minimum Performance Grade: [**15**] [**20**] [**25**] [**30**] [**35**] [**40**] [**45**] [**50**] [**As indicated on Drawings**] <**Insert grade**>.

Retain "Thermal Transmittance" paragraph below if required to comply with requirements of authorities having jurisdiction. Options below are per NY State Energy Conservation Code 2020 Table R402.1.2. Revise as necessary for applicable fenestration criteria First option is for Climate Zone 4,, second is for Climate Zone 5 or 6 Option 1, and third is for Climate Zone 6 Option 2.

* + - * 1. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of [**0.32 Btu/sq. ft. x h x deg F**] [**0.30 Btu/sq. ft. x h x deg F**] [**0.28 Btu/sq. ft. x h x deg F**] .

Options in "Solar Heat-Gain Coefficient (SHGC)" Options below are per NY State Energy Conservation Code 2020 Table R402.1.2. Revise as necessary for applicable fenestration criteria. Value listed below is for Climate Zone 4,, Climate Zone 5 and 6 do not have a maximum SHGC.

* + - * 1. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.40.

CRFs are typically between 45 and 75. First option in "Condensation-Resistance Factor (CRF)" paragraph below is suitable for most of the United States at 25 percent relative humidity where outdoor design temperature is below 0 deg F; second option is suitable for same relative humidity at minus 10 deg F. In northern states where winter outdoor design temperature is lower, increase factor. If buildings have mechanically controlled humidification, coordinate CRF with design conditions for humidity level. See AAMA 1503.

* + - * 1. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of [**45**] [**52**] <**Insert value**>.
        2. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

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

Retain "Sound Transmission Class (STC)" and "Outside-Inside Transmission Class (OITC)" paragraphs below after verifying availability of test data. STC evaluates construction subject to interior sound frequencies, while OITC evaluates an expanded sound-frequency range more representative of conditions to which the building envelope is subject, such as road, rail, and airplane traffic noise. OITC is generally the preferred evaluation method for exterior windows.

* + - * 1. Sound Transmission Class (STC): Rated for not less than [**26**] [**30**] <**Insert rating**> STC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.
        2. Outside-Inside Transmission Class (OITC): Rated for not less than [**22**] [**26**] [**30**] <**Insert rating**> OITC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.

Retain "Windborne-Debris Impact Resistance" paragraph below to suit Project. The BCNYS establishes criteria for buildings in hurricane-prone locations. In paragraph, "enhanced" option applies to essential facilities and has additional requirements. Verify requirements of authorities having jurisdiction. Verify which manufacturers have tested products and can demonstrate compliance. New York State is located in Wind Zone 2 and in a hurricane susceptible region.

* + - * 1. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone  2 for [**basic**] [**enhanced**] protection.

Insert increased heights if different from those in "Large-Missile Test" and "Small-Missile Test" subparagraphs below. For enhanced protection, delete "Small-Missile Test" subparagraph.

Large-Missile Test: For glazing located within [**30 feet**] <**Insert dimension**> of grade.

Small-Missile Test: For glazing located between 30 feet and [**60 feet**] <**Insert dimension**> above grade.

* + - 1. ALUMINUM WINDOWS
         1. Types: Provide the following types in locations indicated on Drawings:

Casement: [**Outswing**] [**Inswing**].

Projected, awning.

Projected, hopper.

Single hung.

Double hung.

Horizontal sliding.

Fixed.

AAMA/WDMA/CSA 101/I.S.2/A440 includes requirements for aluminum, thermal breaks, and other materials and window components. If more stringent requirements apply, insert them in this article.

* + - * 1. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.

Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

Retain "Glass," "Windborne-Debris-Impact-Resistant Laminated Glass," "Insulating-Glass Units," or "Windborne-Debris-Impact-Resistant Insulating-Glass Units" paragraph below to suit Project, or revise if other type of glazing unit is necessary.

* + - * 1. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

Codes require fully tempered or laminated labeled safety glass in areas subject to human impact.

Kind: Fully tempered [**where indicated on Drawings**] <**Insert requirements**>.

Retain "Windborne-Debris-Impact-Resistant Laminated Glass" paragraph below with "Windborne-Debris-Impact Resistance" paragraph in "Window Performance Requirements" Article.

* + - * 1. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C1172 with two plies of float glass.

Float Glass: [**Annealed**] [**Heat strengthened**] [**Fully tempered**] [**As required by performance requirements indicated**].

Inner Ply: Clear.

Interlayer: [**0.090 inch**] [**As required by performance requirements indicated**] <**Insert requirements**>.

Outer Ply: [**Clear**] [**Gray**] [**Bronze**] [**Green**] <**Insert tint**>.

Low-E Coating: [**Pyrolytic on second surface**] [**Sputtered on second surface**] [**Sputtered on third surface**] [**Sputtered on second or third surface**] <**Insert coating**>.

* + - * 1. Insulating-Glass Units: ASTM E2190.

Glass: ASTM C1036, Type 1, Class 1, q3.

Tint: [**Clear**] [**Gray**] [**Bronze**] [**Green**] <**Insert tint**>.

Kind: Fully tempered [**where indicated on Drawings**] <**Insert requirements**>.

Lites: [**Two**] [**Three**].

Filling: Fill space between glass lites with [**air**] [**argon**].

Low-E Coating: [**Pyrolytic on second surface**] [**Sputtered on second surface**] [**Sputtered on third surface**] [**Sputtered on second or third surface**] <**Insert coating**>.

Retain "Integral Louver Blinds" subparagraph below if required. Verify availability with manufacturers.

Integral Louver Blinds: Glass manufacturer's standard, horizontal louver blinds with aluminum slats and polyester fiber cords, located in space between glass lites, and operated by hardware located on inside face of sash.

Operation: [**Tilt only**] [**Tilt, raising, and lowering**].

Color: [**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**>.

Retain "Windborne-Debris-Impact-Resistant Insulating-Glass Units" paragraph below with "Windborne-Debris-Impact Resistance" paragraph in "Window Performance Requirements" Article.

* + - * 1. Windborne-Debris-Impact-Resistant Insulating-Glass Units: ASTM E2190 with two lites and complying with impact-resistance requirements in "Window Performance Requirements" Article.

Exterior Lite: ASTM C1036, Type 1, Class 1, q3.

Tint: [**Clear**] [**Gray**] [**Bronze**] [**Green**] <**Insert tint**>.

Kind: [**Heat strengthened**] [**Fully tempered**].

Interior Lite: ASTM C1172 clear laminated glass with two plies of float glass.

Float Glass: [**Annealed**] [**Heat strengthened**] [**Fully tempered**] [**As required by performance requirements indicated**].

Interlayer Thickness: [**0.090 inch**] [**As required by performance requirements indicated**] <**Insert requirements**>.

Filling: Fill space between glass lites with [**air**] [**argon**].

Low-E Coating: [**Pyrolytic on second surface**] [**Sputtered on second surface**] [**Sputtered on third surface**] [**Sputtered on second or third surface**] <**Insert coating**>.

"Glazing System" paragraph below refers to the method by which the glazing unit (glass) is retained within the window sash or frame.

* + - * 1. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

If retaining "Dual Glazing System" subparagraph below, verify availability with manufacturers.

Dual Glazing System:

Interior Lite: [**Glass**] <**Insert type**>.

Exterior Lite: [**Glass**] [**Insulating-glass unit**] <**Insert type**>.

Nonmagnetic stainless steel, Series 300, or superior corrosion-resistant-coated metal hardware may be required to meet specific customer or regional needs and for protection against corrosive environments, such as in urban, coastal, or industrial areas.

* + - * 1. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

Exposed Hardware Color and Finish: [**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 finish**>.

* + - * 1. [**Casement**] [**and**] [**Projected**] Window Hardware:

Gear-Type Rotary Operators: Complying with AAMA 901 when tested according to ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

Type and Style: [**Match Director’s Representative's sample**] [**As selected by Director’s Representative from manufacturer's full range of types and styles**] <**Insert type and style**>.

Hinges: [**Non-friction type, not less than two per sash**] <**Insert requirements**>.

Lock: [**Lift-type throw, cam-action lock with keeper**] [**Lever handle and cam-action lock with keeper**] [**Dual lever handles, tie rod, and cam-action lock with keepers**] [**Key-operated custodial lock with keeper and removable handle**] [**Concealed multipoint lock operated by single lever handle or lift-type throw**] <**Insert requirements**>.

Retain one option in "Limit Devices" subparagraph below if limit devices are required. They restrict sash opening for safety. Indicate locations of windows with limit devices on Drawings or in schedules, and coordinate with code requirements for windows for emergency escape and rescue.

Limit Devices: [**Concealed friction adjustor, adjustable stay bar**] [**Concealed support arms with adjustable, limited, hold-open**] <**Insert type**> limit devices designed to restrict sash opening.

Limit clear opening to [**4 inches**] <**Insert dimension**> for ventilation; with custodial key release.

Retain "Pole Operators" subparagraph below if Project includes manually operated windows more than 72 inches above floor. Electric operators are also available; if needed, insert requirements.

Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches above floor; one pole operator and pole hanger per room that has operable windows more than 72 inches above floor.

* + - * 1. Hung Window Hardware:

Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.

Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide key-operated custodial locks.**]

Tilt Latch: Releasing latch allows sash to pivot about horizontal axis to facilitate cleaning exterior surfaces from the interior.

* + - * 1. Horizontal-Sliding Window Hardware:

Sill Cap/Track: [**Extruded-aluminum track with natural anodized finish**] [**Manufacturer's standard**] <**Insert track material and finish**> of dimensions and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.

Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.[**Provide key-operated custodial locks.**]

Roller Assemblies: Low-friction design.

* + - * 1. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
        2. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

Generally, retain "Exposed Fasteners" subparagraph below. Revise if exposed fasteners are permitted.

Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

* + - 1. ACCESSORIES
         1. Integral Ventilating System/Device: Where indicated, provide weather-stripped, adjustable, horizontal fresh-air vent, with a free airflow slot, full width of window sash by approximately [**1 inch**] [**3 inches**] when open, complying with AAMA/WDMA/CSA 101/I.S.2/A440. Equip vent bar with an integral insect screen, removable for cleaning.

Retain "Dividers (False Muntins)" paragraph below if dividers are required. Indicate divider patterns on Drawings or insert requirements.

* + - * 1. Dividers (False Muntins): Provide extruded-aluminum divider grilles in designs indicated for each sash lite.

Type: [**Permanently located at exterior lite**] [**Permanently located between insulating-glass lites**] <**Insert type**>.

Pattern: [**As indicated on Drawings**] <**Insert pattern**>.

Profile: [**As selected by Director’s Representative from manufacturer's full range**] <**Insert profile**>.

For dual-glazing systems, retain "Horizontal Louver Blinds" paragraph below for blinds located between glazing units. Verify availability with manufacturers.

* + - * 1. Horizontal Louver Blinds: Provide manufacturer's standard, removable, horizontal louver blinds with aluminum slats and polyester fiber cords that are operated by hardware located on inside face of sash.

Operation: [**Tilt only**] [**Tilt, raising, and lowering**].

Color: [**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**>.

* + - * 1. Subsills: [**Thermally broken**] [**Nonthermal**], extruded-aluminum subsills in configurations indicated on Drawings.
        2. Column Covers: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
        3. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
        4. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
        5. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place.

Insert other accessories, such as nail fins, if required.

* + - 1. INSECT SCREENS
         1. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

Type and Location: [**Full, inside for outswing**] [**Full, inside for projected, awning**] [**Full, outside for inswing**] [**Full, outside for projected, hopper**] [**Full, outside for double-hung**] [**Half, outside for single-hung**] [**Full, outside for sliding**] [**Half, outside for sliding**] sashes.

* + - * 1. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.

Retain "Glass-Fiber Mesh Fabric" or "Aluminum Wire Fabric" paragraph below or insert another. Usually, retain first option in "Glass-Fiber Mesh Fabric" paragraph. Second option is suitable for areas plagued by small insects such as no-see-ums and is also suitable for use as a solar screen that blocks up to 65 percent of incident solar heat and glare.

* + - * 1. Glass-Fiber Mesh Fabric: [**18-by-14 or 18-by-16**] [**20-by-20 or 20-by-30**] <**Insert type**> mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656.

Mesh Color: [**Manufacturer's standard**] <**Insert color**>.

* + - * 1. Aluminum Wire Fabric: 18-by-16 mesh of 0.011-inch-diameter, coated aluminum wire.

Wire-Fabric Finish: [**Natural bright**] [**Charcoal gray**] [**Black**] <**Insert finish**>.

* + - 1. FABRICATION
         1. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
         2. Glaze aluminum windows in the factory.
         3. Weather strip each operable sash to provide weathertight installation.
         4. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

Retain first paragraph below for lines where sash frames lap the wrong way to shed water.

* + - * 1. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

Retain "Mullions" paragraph below if required for Project.

* + - * 1. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.

Bow and bay window assemblies usually contain casement, double-hung, or fixed window units.

* + - * 1. [**Bow**] [**Bay**] Window Assemblies: Provide [**operating**] [**and**] [**fixed**] units in configuration indicated. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:

Angled mullion posts with interior and exterior trim.

Angled interior and exterior extension and trim.

Exterior head and sill casings and trim.

* + - * 1. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.
      1. GENERAL FINISH REQUIREMENTS
         1. Comply with NAAMM's "Metal Finishes Manual" for recommendations for applying and designating finishes.
         2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
         3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
      2. ALUMINUM FINISHES
         1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

Retain finishes in this article to suit Project. If retaining more than one, indicate location of each on Drawings, in a window schedule, or by inserts. Verify availability with manufacturers.

OGS prefers Class I Anodic finish over Class II.

"Class II, Clear Anodic Finish" paragraph below is standard finish with many manufacturers. Finish has a minimum coating thickness of 0.4 mil.

* + - * 1. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

"Class I, Clear Anodic Finish" paragraph below is heavy-anodized finish. Finish has a minimum coating thickness of 0.7 mil.

* + - * 1. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

"Class II, Color Anodic Finish" paragraph below is standard finish with many manufacturers. Finish has a minimum coating thickness of 0.4 mil.

* + - * 1. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.

Retain one of two "Color" subparagraphs below. Options in first "Color" subparagraph are examples only and may vary in color range and availability among manufacturers.

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

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

"Class I, Color Anodic Finish" paragraph below is heavy-anodized finish. Finish has a minimum coating thickness of 0.7 mil.

* + - * 1. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

Retain one of two "Color" subparagraphs below. Options in first "Color" subparagraph below are examples only and may vary in color range and availability among manufacturers.

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

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

Revise "Baked-Enamel Finish" paragraph below if specific products are required, or revise to suit manufacturers' finishes such as siliconized acrylic or polyester enamels or powder coatings. Some powder-coating systems might comply with the more stringent requirements in AAMA 2604; consult manufacturers.

* + - * 1. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.

"Organic Coating" subparagraph below references AAMA standard for pigmented organic coating on extrusions and panels. AAMA 2603 allows a minimum 0.8-mil dry film thickness; AAMA 2604 and AAMA 2605 require 1.5 mils.

Organic Coating: Thermosetting, modified-acrylic or polyester enamel primer/topcoat system complying with AAMA 2603[**, except with a minimum dry film thickness of 1.5 mils**], medium gloss.

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

"High-Performance Organic Finish (Two-Coat Fluoropolymer)" paragraph below references AAMA standards for high-performance and superior performance organic coatings on extrusions and panels. Revise if specific products are required. Consult manufacturers for AAMA compliance and for percentage of polyvinylidene fluoride in their finishes.

* + - * 1. High-Performance Organic Finish (Two-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than [**50**] [**70**] percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with [**AAMA 2604**] [**AAMA 2605**] and 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 full range of industry colors and color densities**] <**Insert color and gloss**>.

"High-Performance Organic Finish (Three-Coat Fluoropolymer)" paragraph below references AAMA standard for superior performance organic coating on extrusions and panels. Revise if specific products are required.

* + - * 1. High-Performance Organic Finish (Three-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coatings; Organic Coating: manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and 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 full range of industry colors and color densities**] <**Insert color and gloss**>.

For exact finish, insert names of coating manufacturers and products.

1. EXECUTION
   * + 1. EXAMINATION
          1. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
          2. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
          3. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
          4. Proceed with installation only after unsatisfactory conditions have been corrected.
       2. INSTALLATION
          1. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
          2. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
          3. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
          4. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
       3. FIELD QUALITY CONTROL

Retain "Testing Agency" paragraph below to identify who shall perform tests and inspections. If retaining second option in paragraph, retain "Field quality-control reports" paragraph in "Informational Submittals" Article.

* + - * 1. Testing Agency: [**Director’s Representative will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

Revise "Testing Services" paragraph below if more stringent testing is required.

* + - * 1. Testing Services: Testing and inspecting of installed windows shall take place as follows:

Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.

Air-Infiltration Testing:

Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.

Allowable Air-Leakage Rate: [**1.5**] <**Insert number**> times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.

Water-Resistance Testing:

Test Pressure: [**Two-thirds**] <**Insert number**> times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.

Allowable Water Infiltration: No water penetration.

Testing Extent: [**Three**] [**Three benchmarks**] <**Insert number or description**> windows of each type as selected by Director’s Representative and a qualified independent testing and inspecting agency. Windows shall be tested after perimeter sealants have cured.

Test Reports: Prepared according to AAMA 502.

* + - * 1. Windows will be considered defective if they do not pass tests and inspections.
        2. Prepare test and inspection reports.
      1. ADJUSTING, CLEANING, AND PROTECTION
         1. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.
         2. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

Keep protective films and coverings in place until final cleaning.

* + - * 1. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
        2. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 085113