

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2017

SECTION 08 44 00

CURTAIN WALL AND GLAZED ASSEMBLIES 08/11

NOTE: This guide specification covers the requirements for complete glazed curtain wall system exclusive of doors, entrances, and store fronts, commercial aluminum curtain walls designed to accommodate fixed-glass lights, window sashes, panels, louvers, and other curtain-wall accessories. Curtain-wall systems may be classified by visual characteristics as follows:

Adhere to <u>UFC 1-300-02</u> Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a <u>Criteria Change Request (CCR)</u>.

Curtain-wall systems may be classified by visual characteristics as follows:

1. Mullion type has dominant vertical lines. Vertical mullions are usually 45 millimeter (1-3/4 inches) or more wide and usually extend 100 millimeter (4 inches) or more beyond the exterior face of the curtain wall. Mullions are usually not more than 1525 millimeter (5 feet) on center.

2. Grid type has equally dominant vertical and horizontal lines. Vertical and horizontal mullions

are usually 45 millimeter (1-3/4 inches) or more wide and usually extend 100 millimeter (4 inches) or more beyond the exterior face of the curtain wall. The area enclosed by the mullions is usually not more than 3 square meter (32 square feet).

3. Spandrel type has dominant horizontal lines, and the supports are not a primary element of expression. The sheathed type has a nonlinear pattern, and the supports are not a primary element of expression.

Related work specified in this section as required by the project includes:

1. Field-applied thermal insulation, glass and glazing, and field-applied joint sealing and expansion joints.

2. Methods of securing framing to structure and details of fastenings, anchors, and auxiliary shapes,

3. Openings to be glazed with double-glazing units.

Drawings must include a complete schedule of system types and sizes and all window units for the work to be performed and must indicate the following::

1. Arrangement of curtain-wall framing showing all dimensions, shapes, and sizes of the members, floor elevations, connections, and the relation of the curtain-wall framing to other building components

2. Windows showing types, sizes, ventilators, dimensions, shapes, and sizes of members, and the relationship of each window sash to the curtain-wall system

3. Insect screens showing locations, dimensions, shapes, and sizes of members; shade screens and baffles showing locations, dimensions, shapes, and sizes of members; location of window cleaners' bolts

4. Panels showing all dimensions, edge detail, and the relationship of panels to the curtain-wall system, openings to be glazed with double-glazing units

5. Doors and frames showing the door size, thickness, and hand. Arrangement of frames including dimensions, shapes, and sizes of members and connections; and the relationship of doors and frames to the curtain-wall system

6. Metal accessories, such as aluminum sills at the bottom of curtain walls, aluminum coping at the top of curtain walls, and exterior architectural louvers showing all dimensions, shapes, and sizes of members, connections, and the relationship of each metal accessory item to the curtain-wall system

7. Field-applied thermal-insulation systems showing the location, method of attachment, nominal thickness, and name of insulation

8 Joints to be sealed with field-applied sealing compound showing the kind of materials that will be in contact with the sealing compound; locations, dimensions of joints, name of backup material, and name of sealing compound, for each type of sealing compound

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA	ADM	(2015)	Aluminum Design Manual
AA	ASD1	(2017)	Aluminum Standards and Data
AA	DAF45	(2003; for Alu	Reaffirmed 2009) Designation System uminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501.1 (2005) Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure

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- AAMA 501.4 & 501.6 (2009) Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts & Recommended Dynamic Test Method for Determining the Seismic Drift Causing Glass Fallout from a Wall System
- AAMA 609 & 610 (2015) Cleaning and Maintenance Guide for Architecturally Finished Aluminum
- AAMA 611 (2014) Voluntary Specification for Anodized Architectural Aluminum
- AAMA 800 (2010) Voluntary Specifications and Test Methods for Sealants
- AAMA CW-10 (2015) Care and Handling of Architectural Aluminum from Shop to Site

AAMA MCWM-1 (1989) Metal Curtain Wall Manual

AAMA/WDMA/CSA 101/I.S.2/A440 (2011; Update 1 2014) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (1995; R 2004) Basic Hardboard

AMERICAN IRON AND STEEL INSTITUTE (AISI)

- AISC/AISI 121 (2004) Standard Definitions for Use in the Design of Steel Structures
- AISI SG03-3 (2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7 (2017) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

- AWS A5.1/A5.1M (2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
- AWS A5.10/A5.10M (2017) Welding Consumables Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys - Classification
- AWS D1.1/D1.1M (2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M (2016) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

ASTM A1011/A1011M (2017) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

- ASTM A123/A123M (2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM A153/A153M (2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- ASTM A242/A242M (2013) Standard Specification for High-Strength Low-Alloy Structural Steel
- ASTM A27/A27M (2017) Standard Specification for Steel Castings, Carbon, for General Application
- ASTM A283/A283M (2013) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
- ASTM A36/A36M (2014) Standard Specification for Carbon Structural Steel
- ASTM A424/A424M (2009a; R 2016) Standard Specification for Steel Sheet for Porcelain Enameling
- ASTM A47/A47M (1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings
- ASTM A501/A501M (2014) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

ASTM A572/A572M (2015) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A588/A588M (2015) Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance

ASTM A606/A606M (2009a) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance

ASTM A653/A653M	(2015; E 2016) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B108/B108M	(2015) Standard Specification for Aluminum- Alloy Permanent Mold Castings
ASTM B136	(1984; R 2013) Standard Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum
ASTM B137	(1995; R 2014) Standard Test Method for Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminum
ASTM B152/B152M	(2013) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B211	(2012) Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B211M	(2012; E 2012) Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire (Metric)
ASTM B221	(2014) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM B244	(2009; R 2014) Standard Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments
ASTM B26/B26M	(2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B316/B316M	(2010) Standard Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods
ASTM B85/B85M	(2014) Standard Specification for Aluminum- Alloy Die Castings
ASTM C1036	(2016) Standard Specification for Flat Glass
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ASTM C1048	(2012; E 2012) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM C1363	(2011) Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
ASTM C220	(1991; R 2015) Standard Specification for Flat Asbestos-Cement Sheets
ASTM C481	(1999; R 2011) Standard Test Method Laboratory Aging of Sandwich Constructions
ASTM C542	(2005; R 2017) Standard Specification for Lock-Strip Gaskets
ASTM C547	(2017) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2016a) Standard Specification for Cellular Glass Thermal Insulation
ASTM C553	(2013) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C578	(2017a) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C591	(2017) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C592	(2016) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C610	(2015) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C612	(2014) Mineral Fiber Block and Board Thermal Insulation
ASTM C665	(2017) Standard Specification for Mineral- Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C864	(2005; R 2015) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C920	(2014a) Standard Specification for Elastomeric Joint Sealants

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ASTM	D1037	(2012) Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM	D1730	(2009; R 2014) Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting
ASTM	D3656/D3656M	(2013) Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM	E119	(2016a) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM	E136	(2016) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C
ASTM	E283	(2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM	E330/E330M	(2014) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM	E331	(2000; R 2016) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM	E34	(2011; E 2012) Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM	E546	(2014) Frost Point of Sealed Insulating Glass Units
ASTM	E576	(2014) Frost Point of Sealed Insulating Glass Units in the Vertical Position
ASTM	E774	(1997) Classification of the Durability of Sealed Insulating Glass Units
ASTM	E84	(2017) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM	E90	(2009) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
	NATIONAL ASSOCIATION OF	ARCHITECTURAL METAL MANUFACTURERS (NAAMM)
NAAMM	AMP 500	(2006) Metal Finishes Manual

PORCELAIN ENAMEL INSTITUTE (PEI)

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PEI 1001 (1996) Specification for Architectural Porcelain Enamel (ALS-100)

PEI CG-3 (2005) Color Guide for Architectural Porcelain Enamel

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC	7/NACE No.4	(2007;	E 2004)	Brush-Off	Blast	Cleaning
SSPC	SP 1	(2015)	Solvent	Cleaning		
SSPC	SP 3	(1982;	E 2004)	Power Tool	l Clear	ning

STEEL WINDOW INSTITUTE (SWI)

SWI AGSW (2002) Architect's Guide to Steel Windows

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety	Standard	for	Architectural	Glazing
	Materia	als			

1.2 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Glazed Curtain Wall System

Submit for curtain wall system, accessories, and mock-up. [Tentative approval of drawings must be received before fabrication of mock-up. Final approval of drawings will be deferred pending approval of mock-up and accessories.] Drawings must indicate in detail all system parts including elevations, full-size sections, framing, jointing, panels, types and thickness of metal, flashing and coping details, field connections, weep and drainage system, finishes, sealing methods, glazing, glass sizes and details, firestopping insulation materials, and erection details.

Installation Drawings

Shop-Painting Aluminum

Shop-Painting Steel

SD-03 Product Data

Glazed Curtain Wall System

Include descriptive literature, detailed specifications, and available performance test data.

Preventive Maintenance and Inspection

Metals For Fabrication

Nonskinning Sealing Compound

Metal Accessories

Curtain-Wall Framing Members

Aluminum Doors and Frames

Curtain Wall Frame

Panels

Thermal Insulation Materials

Sealants and Caulkings

Curtain-Wall Installation Materials

Masonry Anchorage Devices

[Recycled Content of Aluminum Doors and Frames; S

][Recycled Content of Aluminum Curtain-Wall Framing Members; S

][Recycled Content of Aluminum Windows; S

]Sample Warranties

SD-05 Design Data

Calculations

Finish

Exposed-to-View Aluminum Finish

Porcelain-Enamel

Seismic Calculations

SD-08 Manufacturer's Instructions

Glazed Curtain Wall System

Insulating Glass

SD-11 Closeout Submittals

[Recycled Content of Aluminum Doors and Frames; S

[Recycled Content of Aluminum Curtain-Wall Framing Members; S

[Recycled Content of Aluminum Windows; S

-WARRANTY

1.3 REQUIREMENT FOR DESIGN DATA

Submit structural and thermal calculations for complete wall assembly.

1.4 QUALITY ASSURANCE

1.4.1 Testing Requirements

The components listed below must be tested in accordance with the requirements below, and meet performance requirements specified.

- a. Joint and Glazing Sealants: Perform tests as required by applicable publications referenced.
- b. Preformed Compression Gaskets and Seals: ASTM C864.
- c. Preformed Lock-strip Gaskets: ASTM C542, modified as follows: Heat age specimens seven days at 70 degrees C (158 degrees F), in zipped or locked position under full design compression. Unzip, cool for one hour, re-zip, and test lip seal pressure, which must be minimum 0.045 kilograms per linear millimeter (2.5 pounds per linear inch) on any extruded or corner specimen.
- d. Spandrel Glass: Fallout resistance test, ASTM C1048.
- e. Porcelain Enamel: Acid resistance, color retention, and spall resistance tests, PEI 1001.
- f. Anodized Finishes: Stain resistance, coating weight, and coating thickness tests, ASTM B136, ASTM B137, and ASTM B244, respectively.
- g. Insulating Glass: ASTM E546 or ASTM E576 at [minus 29 degrees C (20 degrees F)] [], no frost or dew point.

1.4.2 Mockup

NOTE: Size of project and system specified will determine whether mock-ups are necessary. Complete information should be given concerning extent, details, and purpose of mock-ups. Where mock-ups have been previously tested for another project or for commercial production, they may serve the purpose. When testing of a mock-up is required, the unit should be erected at a testing laboratory or other location where adequate testing equipment is available.

1.4.2.1 Construction

Construct at [job site] [manufacturer's plant] [approved testing laboratory] full size typical wall unit which incorporates horizontal and vertical joints, framing, window units, panels, glazing, and other accessories as

detailed and specified. Mock-up wall unit size and design must be as indicated.

1.4.2.2 Performance Test

Conduct after approval of visual aspects has been obtained. Finished work must match approved mock-up.

1.4.2.3 Approved Mock-Up

After completion and approval of test results [[transport mock-up to job site and] install, where directed, for reference during construction.] [Approved mock-up must remain property of the Contractor.]

1.4.3 Factory Tests

NOTE: The overall performance requirements and tests will vary with the design and geographical location of the building as well as with the type of construction and components specified. Only those tests which are necessary to establish compliance with specifications should be included in the project specification. Refer to AAMA Curtain Wall Manual for detailed testing methods and the recommended minimum performance requirements and safety factors.

Perform the following tests except that where a curtain wall system or component of similar type, size, and design as specified for this project has been previously tested, under the conditions specified herein, the resulting test reports may be submitted in lieu of testing the components listed below:

- a. [____]
- b. [___]
- c. []

1.4.3.1 Deflection and Structural Tests

No curtain wall framing member shall deflect, in a direction normal to the plane of the wall, more than 1/175 of its clear span or 20 mm (3/4 inch), whichever is less, when tested in accordance with ASTM E330/E330M, except that when a plastered surface will be affected the deflection mustl not exceed 1/360 of the span. No framing member shall have a permanent deformation in excess of 0.2 percent of its clear span when tested in accordance with ASTM E330/E330M for a minimum test period of 10 seconds at 1.5 times the design wind pressures specified.

1.4.3.2 Water Penetration Test

difference. When testing under dynamic conditions is required, AAMA Specification 501.1 should be referenced. The availability of facilities for conducting dynamic testing is very limited and should be checked before specifying this type of test.

No water penetration shall occur when the wall is tested in accordance with ASTM E331 at a differential static test pressure of 20 percent of the inward acting design wind pressure as specified, but not less than 0.19 kPa (4 psf). Make provision in the wall construction for adequate drainage to the outside of water leakage or condensation that occurs within the outer face of the wall. Leave drainage and weep openings in members and wall open during test.

1.4.3.3 Air Infiltration Test

Air infiltration through the wall, when tested in accordance with ASTM E283, must not exceed 0.005 cms per sq. m (0.06 cfm per square foot) of fixed wall area, plus the permissible allowance specified for operable windows within the test area.

1.4.3.4 Delamination Test

Adhesively bonded metal-faced [[____] faced] panels must show no evidence of delamination, warpage or other deterioration or damage when subjected to the six "Accelerated Aging Cycles" specified in ASTM D1037.

1.4.3.5 Thermal Conductance Tests

The thermal transmittance of opaque panels must not exceed specified Uvalue, when tested in accordance with ASTM C1363. The average calculated thermal transmittance of the complete wall assembly including panels, windows, and all other components must not exceed a U-value of [____]. Determine U-values of components in accordance with ASTM C1363.

1.4.3.6 Window Tests

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.

Windows must meet the requirements specified in [____] except where the requirements of this section differ, this section governs. Provide windows that meet the same requirements for deflection and structural adequacy as specified for framing members when tested in accordance with ASTM E330/E330M, except permanent deformation must not exceed 0.4 percent; there must be no glass breakage, and no permanent damage to fasteners, anchors, hardware, or operating devices. Provide windows that have no water penetration when tested in accordance with ASTM E331.

1.4.3.7 Fire Resistance Tests

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to hospitals and confinement (correctional) facilities; insulation for these facilities must have a smoke developed rating not exceeding 150.

Insulation [provided in the curtain wall system] [field applied in conjunction with the curtain wall system] must have a flame spread rating not exceeding 75 and a smoke developed rating not exceeding 150 when tested in accordance with ASTM E84, except as specified otherwise herein.

- a. Insulation: Insulation [contained entirely within panel assemblies which meets the flame spread and smoke developed ratings of 75 and 150 respectively] [isolated from the building interior by masonry walls, masonry cavity walls, or encased in masonry cores] is not required to comply with the flame spread and smoke developed ratings specified.
- b. Curtain Wall Systems: Material for firestopping the opening between the edge of the floor slab and back of the curtain wall system, must not have less than the flame spread and smoke developed ratings specified for insulation which is neither isolated from the building interior nor encased in masonry cores.
- c. Curtain Wall Panels: Provide panels for fire resistive curtain walls that have a fire resistive rating of [___] hours when tested in accordance with ASTM E119.
- d. Firestopping Materials and Devices: Firestopping material and attachment devices must be an effective barrier against the spread of fire, smoke, and gases for a period of [____] hours when exposed to the conditions of the standard ASTM Ell9time-temperature curve for a period equivalent to the fire rating of the floor system and must also be rated noncombustible when tested in accordance with ASTM El36.

1.4.3.8 Sound Transmission Loss Test

Sound transmission loss (TL) of the wall must be less than [____] db, when tested in accordance with ASTM E90 for the frequency range from [125] [] to [400] [] Hz.

1.5 GLAZED CURTAIN WALL SYSTEM REQUIREMENTS

NOTE: This specification is intended for use with glazed curtain walls for low rise buildings and multi-story buildings. Since aluminum shapes are usually extruded and most other metal shapes are rolled-formed or brake-formed, the project drawings and details must show the materials and shapes desired. Requests to the Contractor for alternate bids is not allowed. The Contractor is not allowed to substitute one metal for another unless complete details are shown for each type of metal components permitted.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within

UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including misture control, thermal performance, fenestrations and glazing.

For further guidance and information on the design of Curtain Walls for moisture control, thermal comfort, energy savings, and sustainability, see the "Whole Building Design Guide, Building Envelope Design Guide - Curtain Walls".

Provide system complete with framing, mullions, trim, [framed pre-assembled units,] panels, windows, glass, glazing, sealants, insulation, fasteners, anchors, accessories, concealed auxiliary members, and attachment devices for securing the wall to the structure as specified or indicated.

1.5.1 Source

Furnish curtain wall system components by one manufacturer or fabricator; however, all components need not be products of the same manufacturer.

1.5.2 Design

NOTE: Refer to AAMA Curtain Wall Design Guide Manual "Testing, Types and Systems" for an explanation of the various curtain wall systems. The systems included in this guide specification are the standard architectural type as opposed to custom type. Generally the custom type of system is more expensive and should only be considered for special projects. When a system other than those listed is required this paragraph must be adjusted accordingly.

[Stick system] [Unit system] [Unit and mullion system] [[____] system] with [mullions,] [horizontal rails,] [panels,] [window units,] [screens] [framed pre-assembled units with [integral] [nonintegral] spandrel panels [____]]. Fully coordinate system accessories directly incorporated, and adjacent to contiguous related work and insure materials compatibility, deflection limitations, thermal movements, and clearances and tolerances as indicated or specified.

1.5.3 Thermal Movement

Fabricate, assemble, and erect system with adequate allowances for expansion and contraction of components and fastenings to prevent buckling damage, joint seal failure, glass breakage, undue stress on fastenings or other detrimental effects. For design purposes, base provisions for thermal movement on assumed ambient temperature range of from [___] degrees C (F) to [___] degrees C (F).

1.5.4 Tolerances

Design and erect wall system to accommodate tolerances in building frame and other contiguous work as indicated or specified. Provide with the following tolerances:

- a. Maximum variation from plane or location shown on approved shop drawings: one millimeter per 12 meters (1/8 inch per 12 feet) of length up to not more than 13 mm (1/2 inch) in any total length.
- b. Maximum offset from true alignment between two identical members abutting end to end in line: 2 mm (1/16 inch).

1.5.5 Structural Requirements

Members may not deflect in a direction parallel to the plane of the wall, when carrying its full design load, more than an amount which will reduce the edge cover or glass bite below 75 percent of the design dimension. After deflection under full design load, members may not have a clearance between itself and the top of the panel, glass, sash, or other part immediately below it less than 3 mm (1/8 inch). The clearance between the member and an operable window or door must be minimum 2 mm (1/16 inch). [Design system members serving as guide rails for window cleaning equipment to carry mid-span concentrated load of [___] kilograms (pounds) normal to plane of wall and [___] kilograms (pounds) applied horizontally, parallel to wall plane without deflection which would affect adjacent surfaces.] Design entire system to withstand the indicated wind and concentrated loads, and the following wind loads acting normal to the plane of the wall:

- a. On the first [____] stories above grade [____] kPa (psf) acting inward, and the same load acting outward.
- b. On the next [____] stories above grade [____] kPa (psf) acting inward, and the same load acting outward.

c. On corner areas, extending [____] meters (feet) from the building corners on the [____] stories, on all facades, the outward-acting (negative) design load must be increased to [____] kilopascals (pounds per square foot).

[1.5.6 Seismic Calculations

When tested to AAMA 501.4 & 501.6, system must meet design displacement of 0.010 times the story height and ultimate displacement of 1.5 times the design displacement. Provide with the following tolerances:

- a. Phase I: 3 stroke cycles using .005 times the story height no damage or failure.
- b. Phase II: 3 stroke cycles using .010 times the story height no damage or failure.

]1.6 QUALIFICATION OF WELDERS

Welding must be performed by certified welders qualified in accordance with AWS D1.1/D1.1M using procedures, materials, and equipment of the type required for the work.

1.7 DELIVERY AND STORAGE

Inspect materials delivered to the site for damage; unload and store with a minimum of handling in accordance with recommendations contained in AAMA CW-10. Storage spaces must be dry locations with adequate ventilation, free from heavy dust, not subject to combustion products or sources of water, and must allow for easy access for inspection and handling. Deliver caulking and sealing compounds to the job site in sealed containers labeled to show the designated name, formula or specifications number; lot number; color; date of manufacturer; shelf life; and curing time when applicable.

1.7.1 Protective Covering

Prior to shipment from the factory, place knocked-down lineal members in cardboard containers and cover finished surfaces of [aluminum] [stainless steel] with protective covering of adhesive paper, waterproof tape, or strippable plastic. Covering must not chip, peel, or flake due to temperature or weather, must protect against discoloration and surface damage from transportation, and storage, and must be resistant to alkaline mortar and plaster. Do not cover [aluminum] [stainless steel] surfaces that will be in contact with sealants after installation.

1.7.2 Identification

Prior to delivery, mark wall components to correspond with shop and erection drawings placement location and erection.

1.8 WARRANTY

NOTE: The warranty clause in this guide specification has been approved by NAVFACENGCOMHQ in accordance with the requirements of Naval Facilities Acquisition Supplement (NFAS).

Guarantee insulating glass units not to develop material obstruction of vision as a result of dust or film formation on the inner glass surface caused by failure of the seal, other than through glass breakage, within a period of 5 years from date of acceptance of work by the Government. Replace units failing to comply with the terms of this guarantee with new units without additional cost to the Government. The Contractor must require the manufacturer to execute their warranties in writing directly to the Government.

1.8.1 Sample Warranties

Provide curtain wall and glazing assembly material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard membrane manufacturer warranty to comply with the specified requirements.

- a. Project Warranty: Refer to Section 01 11 00 SUMMARY OF WORK and Section 01 33 00 SUBMITTAL PROCEDURES for project warranty provisions.
- b. Manufacturer's Warranty: Submit, for Owner's acceptance, Manufacturer's standard warranty document executed by authorized company official manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.
- c. Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of steel fire-rated glazed curtain-wall systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
- d. Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering. Determine warranty on finish by type of finish selected.
- e. Beneficiary: Issue warranty in the legal name of the project Owner.
- f. Warranty Period: [____] years commencing on Date of Substantial Completion, covering complete curtain wall system for failure to meet specified requirements.
- g. Warranty Acceptance: Owner is sole authority who will determine acceptability of manufacturer's warranty documents.
- 1.9 INTERPRETATION OF AWS CODE

NOTE: If Section 05 05 23.16 STRUCTURAL WELDING is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.

Section 05 05 23.16 STRUCTURAL WELDING applies to work specified in this section.

AWS code, when referred to herein, shall mean AWS D1.1/D1.1M, "Structural Welding Code - Steel" with the following modification:

Revise AWS code Section 1, "General Provisions," Paragraph 1.1 as follows: References to the need for approval shall mean "Approval by the Contracting Officer" and references to the "Building Commissioner" shall mean the "Contracting Officer."

1.10 QUALIFICATIONS FOR THE CURTAIN-WALL INSTALLER

Submit a written description of the proposed curtain-wall system installer giving the name of the curtain-wall manufacturer, qualifications of personnel, years of concurrent contracting experience, lists of projects similar in scope to the specified work, and other information as may be required by the Contracting Officer.

1.11 PERFORMANCE REQUIREMENTS

1.11.1 Allowable Design Stresses

Aluminum-alloy framing member allowable design stresses must be in accordance with the requirements of AA ADM pertaining to building type structures made of the specified aluminum alloy.

Hot-rolled structural-steel member allowable design stresses and design rules must be in accordance with the requirements of AISC/AISI 121pertaining to the specified structural steel.

Cold-formed light-gage steel structural member allowable design stresses and design rules must be in accordance with the requirements of AISI SG03-3SG570 pertaining to structural members formed from the specified structural-steel sheet or strip.

1.11.2 Design Wind Load

NOTE: First measurement in the following paragraph specifies the design windload recommended in the American Insurance Association AIA CO-1 "National Building Code," Appendix K, for areas subject to severe winds and for height zones of 9140 to 14900 millimeters (30 to 49 feet).

The second measurement specifies the design windload recommended in ANSI A58.1, "Minimum Design Loads for Buildings and Other Structures," for 160 kilometer per hour (100 miles per hour) wind velocity, for unprotected locations in flat, open country or near shorelines of large bodies of water and fully exposed to a long fetch of wind, and for a height zone of 12200 millimeters (40 feet).

The third measurement specifies the design windload recommended in ANSI A58.1, "Minimum Design Loads for Buildings and Other Structures," for 160 kilometer per hour (100 miles per hour) wind velocity, and for a height zone of 9100 millimeters (30 feet) and under.

The fourth measurement specifies the design windload recommended in the American Insurance Association's AIA CO-1 "National Building Code," Appendix K, for areas subject to severe winds and for a height zone of less than 9100 millimeters (30 feet).

The fifth measurement specifies the design windload recommended in ANSI A58.1, "Minimum Design Loads for Buildings and Other Structures," for the Langley field area, and for a height zone of less than 9100 millimeters (30 feet).

Design windload must be [2155] [1963] [1819] [1676] [1436] [718] pascal ([45] [41] [38] [35] [30] [15] pounds per square foot). Design windload must be in accordance with ASCE 7.

1.11.3 Structural Capacity

Design curtain-wall system, including framing members, windows, doors and frames, metal accessories, panels, and glazing to withstand the specified design windload acting normal to the plane of the curtain wall and acting either inward or outward.

Deflection of any metal framing member in a direction normal to the plane of the curtain wall, when subjected to the test of structural performance, using the specified windload in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, must not exceed 1/175 of the clear span of the member or 20 millimeter (3/4 inch), whichever value is less.

Deflection of any metal member in a direction parallel to the plane of the curtain wall, when the metal member is carrying its full design load, must not exceed 75 percent of the design clearance dimension between that member and the glass, sash, panels, or other part immediately below it.

1.11.4 Provisions for Thermal Movement

Design curtain-wall systems, including framing members, windows, doors and frames, metal accessories, and other components incorporated into the curtain wall, to allow for expansion and contraction of the component parts at an ambient temperature of 38 degrees C (100 degrees F) without causing

buckling, opening of joints, overstressing of fasteners, or other harmful effects.

1.12 DRAWINGS

Installation Drawings must include the following information for curtain wall assemblies.

Curtain-wall locations in building, layout and elevations, dimensions, shapes and sizes of members, thickness of metals, types and locations of shop and field connections, details of anchorage to building construction, glazing provisions, and other pertinent construction and erection details.

Location and details of anchorage devices that are to be cast-in-place in concrete and masonry construction.

Panel dimensions, thicknesses and kinds of materials, edge details, details of installation in curtain-wall framing, and other pertinent construction and erection details.

1.13 MANUFACTURER'S INFORMATION

Preventive Maintenance and Inspection must consist of the aluminum manufacturer's recommended cleaning materials and application methods, including detrimental effects to the aluminum finish when improperly applied.

PART 2 PRODUCTS

12.1 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

[2.1.1 Recycled content of Aluminum Doors and Frames

Provide aluminum doors and frames meeting the recycled content requirements as stated within this section and provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph RECYCLED CONTENT.

][2.1.2 Recycled content of Aluminum Curtain-wall Framing Members

Provide aluminum curtain-wall framing members meeting the recycled content requirements as stated within this section and provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph RECYCLED CONTENT.

][2.1.3 Recycled Content of Aluminum Windows

Provide aluminum windows meeting the recycled content requirements as stated within this section and provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph RECYCLED CONTENT.

<u>]</u>2.<u>1</u>2 MATERIALS

NOTE: In certain locations the use of recycled aluminum materials is readily available through a variety of manufacturers. The Designer of Record (DOR) must confirm that availability and edit the paragraphs below accordingly.

2.12.1 Aluminum

Must be free from defects impairing strength or durability of surface finish. Provide standard alloys conforming to standards and designations of AA ASD1. Special alloys, not covered by the following ASTM specifications, must conform to standards and designations recommended by the manufacturer for the purpose intended.

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.When the Designer of Record (DOR) has confirmed availability of recycled aluminum products, include and edit the statement below accordingly.

[Provide Aluminum [Doors][Frames][Curtain-wall Framing Members][Window Frames] with a minimum recycled content of $\frac{120}{20}$ percent. Provide data identifying percentage of [recycled content for aluminum doors and frames][recycled content for aluminum curtain-wall framing members][recycled content for aluminum windows].]

2.12.1.1 Wrought Aluminum Alloys

Must be those which include aluminum alloying elements not exceeding the following maximum limits when tested and additional in accordance with ASTM E34. These limits apply to both bare products and the core of clad products. The cladding of clad products must be within the same limits except that the maximum zinc limit may be 2.5 percent in order to assure that the cladding is anodic to the core. Special wrought alloys with a silicon content not more than 7.0 percent will be acceptable for limited structural uses where special appearance is required:

ALLOY	PERCENT
Silicon	1.5
Magnesium, Manganese, and Chromium combined	6.0
Iron	1.0
Copper	0.4
Zinc	1.0

Within the chemical composition limits set forth above, wrought aluminum alloys must conform to the following:

- a. Extruded bars, rods, shapes and tubes: ASTM B221M (ASTM B221).
- b. Sheet and Plate: ASTM B209M (ASTM B209).
- 2.12.1.2 Cast Aluminum Alloys

Provide those in which the alloying elements are silicon, magnesium, manganese, or a combination of these. Other elements must not exceed the following limits:

ALLOY	PERCENT
Iron	1.2
Copper	0.4
Nickel	0.4
Titanium	0.2
Others (total)	0.5

Within the chemical composition limits set forth above, cast aluminum alloys must conform to the following:

- a. Sand castings: ASTM B26/B26M.
- b. Die casting: ASTM B85/B85M.
- c. Permanent mold castings: ASTM B108/B108M.
- 2.12.1.3 Welding Rods and Electrodes

Provide welding rods and bare electrodes conforming to AWS A5.10/A5.10M as recommended by the manufacturer of the aluminum base metal alloy being used.

2.12.1.4 Finish

Anodized finish on aluminum surfaces must match in appearance or fall within the two extremes of color range of the approved samples. The following designation of finishes refer to standard finishes as defined in the NAAMM AMP 500. Aluminum used for framing must have a color anodized finish designation AA-MIO-C22-A34 and AA-MIOC22-A44, meeting the requirements of AAMA 611.

2.12.1.5 Strength

Aluminum extrusions for framing members used in curtain walls and main frame and sash or ventilator members in windows must have a minimum ultimate tensile strength of 152 MPa (22,000 psi) and a minimum yield strength of 110 MPa (16,000 psi).

2.12.2 Bronze

Bronze sheets, tubes, and drawn shapes must be commercial bronze, alloy No. 220. Extruded shapes must be architectural bronze, alloy No. 385. Rolled or drawn rods must be [commercial bronze, alloy No. 220] [or] [architectural bronze, alloy No. 385]. Bronze used for [] must have a [] finish.

2.12.3 Copper

Conform to ASTM B152/B152M, hot or cold-rolled of the temper suitable for the respective forming operations.

2.12.4 Carbon Steel

Conform to the following specifications:

- a. Rolled shapes, plates, and bars: ASTM A36/A36M.
- b. Galvanized sheets: ASTM A653/A653M.
- c. Sheets for porcelain enameling: ASTM A424/A424M.
- d. Other sheets: ASTM A1011/A1011M or ASTM A1008/A1008M.

2.12.5 Stainless Steel

Conform to Type 302 or 304, and finish in accordance with the NAAMM AMP 500 conform to Metal Finishes Manual as follows:

- a. Concealed flashings: Dead soft fully annealed, [2 D finish] [[____] finish].
- b. Exposed work: [No. 4 finish] [[____] finish] to match approved sample.

2.12.6 Weathering High-Strength Low-Alloy Steel

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Weathering steel must be a high-strength, low-alloy steel conforming to ASTM A242/A242M, ASTM A588/A588M, ASTM A606/A606M, and ASTM A1011/A1011M as applicable to the shapes and thicknesses required. In addition, the steel must be capable of developing a tightly adhered protective oxide coating when left unpainted and subjected to atmospheric exposure. Provide steel that conforms to the manufacturer's published mechanical properties and chemical composition. [Protect weathering steel used for [____] on the unexposed side with a shop coat of paint.] Perform cleaning, surface preparation, handling, bolting, riveting, and welding of weathering steel in strict accordance with the specification and recommendations of the steel manufacturer.

2.12.7 High-Strength, Low-Alloy Steel

Conform to ASTM A572/A572M for structural shapes, plates, and bars.

2.12.8 Metal Fasteners

Provide fasteners as specified in paragraph entitled "Fastener Metals for Joining Various Metal Combinations" in "Part 2 - Products" of the AAMA MCWM-1. [Fastener metals used in connection with weathering steel must be of type recommended by the weathering steel manufacturer.] Metals for fasteners must be chemically and galvanically compatible with contiguous materials.

2.12.9 Porcelain Enamel

Apply to all areas of each unit over base metal surfaces of [metal facing panels,] [adhesively bonded panels, metal-faced,] in compliance with PEI 1001. Apply colored enamel to exposed faces as follows:

- a. Color: [____].
- b. Texture: [____].
- c. Gloss: [____].
- d. Thickness of coating: [].
- 2.12.10 Joint Sealants and Accessories

Provide manufacturer's standard colors to closely match adjacent surfaces. For interior application of joint sealants comply with applicable regulations regarding reduced VOC's as specified in Section 07 92 00 JOINT SEALANTS.

2.12.10.1 Elastomeric, Single or Multiple Component

ASTM C920, [Type S, single component] [Type M, multiple component]. Use Grade NS, nonsag type in joints on vertical surfaces and use Grade P, selfleveling or flow type, in joints on horizontal surfaces.

2.12.10.2 Single Component Silicone Rubber Base

ASTM C920, Type S, Grade NS (Silicone).

2.12.10.3 Solvents and Primers

Provide material which is quick drying, colorless, nonstaining, compatible with compound used, as recommended by sealant manufacturer. Where primer is specified or recommended by sealant manufacturer, tests related to that material must include primer.

2.12.10.4 Backing Material

Provide material which is nonstaining, nonabsorbent, and compatible with sealing compound. Closed cell resilient urethane, polyvinylchloride or polyethylene foam; closed-cell sponge of vinyl or rubber; closed cell neoprene or butyl rod; or polychloroprene tubes or beads.

2.12.10.5 Bond Preventive Materials

Provide polyethylene tape with pressure-sensitive adhesive; aluminum foil or waxed paper.

2.12.10.6 Preformed Sealing Compound

Provide nonskinning type conforming to AAMA 800. Tapes, beads, ribbons or other shapes as required.

2.12.11 Glass and Glazing

[Materials are specified under Section 08 81 00 GLAZING.] [Conform to ASTM C1036, except ASTM C1048 for spandrel glass. All glazing material must be certified as meeting 16 CFR 1201.]

2.12.11.1 Glass Sizes and Clearances

Sizes indicated are nominal. Verify actual sizes required by measuring frames. Coordinate dimensions for glass and glass holding members to meet applicable minimum clearances as recommended by glass manufacturer. Do not nip to remove flares or to reduce oversized dimensions.

2.12.11.2 Clear Primary Float Glass

Provide Type I, Class I, quality q3, [6 mm(1/4 inch) thick] [].

2.12.11.3 Heat-Absorbing Glass

Clean cut, Type [I] [II], Class [2], style [A] [B], [____] in color, thickness [[] mm (inch)] [as indicated].

2.12.11.4 Insulating Glass

Fused glass, banded, or unbanded. Banded type, ASTM E774, Class [A] [____] must have perimeter banded or sealed, and encased in a nonferrous metal or stainless steel frame. Unbanded type must have perimeter sealed by manufacturer's standard organic sealant. Do not field cut.

2.12.11.5 Spandrel Glass [With Adhered Backing]

ASTM C1048, kind FT or HS, condition B, Type I, [____] thickness [[____] mm (inch)] [as indicated].

- 2.12.11.6 Glass Setting Materials
 - a. Sealants and preformed sealing compounds: Must be as specified under paragraph entitled "Joint Sealant and Accessories."
 - b. Preformed compression gaskets and seals: ASTM C864, color [black] [___]. Gaskets used for [___] must have durable compatible, and colorfast coating.
 - c. Preformed lock-strip type gaskets: ASTM C542, factory formed, color [black] [____]. Provide separate filler or locking strips, approximately 10 Shore "A" Durometer points harder than gasket body, and insure permanent and continuous pressure of sealing lips. Butt or miter grooves 45 degrees.
 - d. Setting blocks, edge blocks, and spacer shims: Fabricate from neoprene or other materials recommended by glass manufacturer compatible with compounds, sealants, or gaskets used. Unless otherwise recommended by the glass manufacturer, shore "A" Durometer hardness for setting and edge blocks must be 90 plus or minus 5; for spacer shims, 50 plus or minus 5.

2.12.12 Firestopping Material

[Portland cement concrete of same design and strength as floor slab] [As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE] [Mineral fiber manufactured from asbestos-free materials, and conforming to ASTM C612 or ASTM C665, meeting fire resistance requirements specified].

2.12.13 Tempered Hardboard

AHA A135.4, Class 1, [] mm (inch) thick.

2.12.14 Screens

ASTM D3656/D3656M, Class 2, 18 by 14 mesh, color [charcoal] [grey] [].

2.12.15 Paint and Finishes

2.12.15.1 Primer

Zinc-molydate, alkyd type.

2.12.16 Panels

Maximum U-value [____]. Where, in order to meet the requirements specified, the proposed panel assembly is thicker than indicated, make corresponding adjustments in accessories and other work such as door, window and louver frames, flashing, coping, and trim products at no extra cost to the Government. Unless otherwise indicated, design for installation from outside the building. Provide vapor barrier on interior face of insulation. Seal edges of panels with cores of absorptive material to prevent entrance of water and allow venting of the core space to outside air.

2.12.16.1 Metal Facing Panels, Single Thickness

Metal facing panels must be single thickness. Panel facing must be [flat sheet] [textured] [impressed-relief] [____] type, made of [porcelain enamel] [aluminum] [bronze] [stainless steel] and, with [backside stiffeners] [or] [edge flanges] spaced as required to meet flatness specified. Where indicated, backup panels with [___].

2.12.16.2 Adhesively Bonded Panels

Adhesively bonded panels must be sandwich type, metal faced both sides, and bonded to form stable and composite unit. Nonexposed face must be [galvanized steel] [____]. Exposed face must be [porcelain enamel] [aluminum] [bronze] [stainless steel] [weathering steel] [____] of thickness indicated, with continuous laminated backing or internal stiffening ribs or breaks spaced as required to meet flatness specified. The nonexposed face must be [galvanized steel] [____] of the thickness indicated. Maximum slope of exposed face surface at any point, measured from nominal plane, must not exceed the following:

a. 1.0 percent for high reflectivity finish.

- b. 1.25 percent for medium reflectivity finish.
- c. 1.5 percent for low reflectivity finish.

2.12.16.3 Nonmetallic Panels

- a. Provide panels that are glass-faced on the side that will be exposed to view. Glass must be spandrel glass with ceramic coating on its nonweathering surface and [smooth] [____] finish on the exposed surface [; backing must be adhesively bonded to nonweathering surface]. Backing must be [___] and include [galvanized steel] [___] on surface nearest the building. Color of glass when viewed from the surface that will be exposed after installation must be [___]. Where indicated, back up glass panels with [_].
- b. Adhesively bonded insulated panels must be nonmetallic faced, sandwich type, [____] [tempered hardboard] on exposed face and on nonexposed face. Apply coating of [epoxy] [polyester] [____] followed by application of [inert aggregate] [___] to exposed face in the [factory] [field]. [Inert aggregate] [___] must be [natural stone chips] [crushed marble] [___] [with minimum and maximum sizes of [_] and [_]]. Color of [_] must be [_].
- c. Nonmetallic panels, [____] surfaced: [____] [tempered hardboard]
 [____] board base with applied [factory] [or] [field] finish of
 [[___] resins and decorative natural stone chips] [___]. Apply
 [epoxy] [polyester] coating of [___] followed by application of
 [inert aggregate] [___] to exposed face in the [factory] [field].
 [Inert aggregate] [___] must be [natural stone chips] [crushed
 marble] [___] [with minimum and maximum sizes of [___] and
 [___]]. Color of [___] must be [___].

2.12.17 Metal Windows

[Fixed] [Operating] [Fixed and operating]. Comply with requirements of [____], [Steel] [Aluminum] Windows [___] [AAMA/WDMA/CSA 101/I.S.2/A440] [SWI AGSW] as modified herein. Provide inside glazing with removable metal glazing beads [except for windows having structural gaskets]. Comply with glass clearance dimensions and sealant dimensions recommended by glass manufacturer.

2.12.17.1 Frames

Frames for fixed glazed panels and window units must be [aluminum] [bronze] [stainless steel] [steel].

2.12.17.2 Operating Windows

Operating windows must be [double-hung] [projected] [horizontally pivoted] [vertically pivoted] [top-hinged inswinging] [horizontal sliding] [casement] [____] type. [Operating windows must be complete with hardware, weatherstripping, and accessories.] Hardware must comply with [AAMA/WDMA/CSA 101/I.S.2/A440] [SWI AGSW] modified as follows:

a. Metal and finish for hardware must be [____].

b. [___].

2.12.17.3 Window Construction

Weld or mechanically join and seal corners of frames and ventilators for water-tight construction. Remove excess metal from welded joints and dress smooth on exposed and contact surfaces so that no objectionable discoloration or roughness will be visible after finishing. Apply sealing compound in interior surfaces of corners and frame intersections.

2.12.18 Insect Screens

Provide insect screens for ventilators of [____] windows [____] in accordance with [___], [Steel] [Aluminum] Windows [___] [AAMA/WDMA/CSA 101/I.S.2/A440] [SWI AGSW]. Screens for double-hung windows must be [full length, top-hung type] [double vertical sliding type] [half-length fixed type]. Screens for [projected] [casement] [___] windows must be [___] type. Mount screens on [inside] [outside] of windows. Screens must be rewirable, easily removable from inside the building, and interchangeable

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for same size ventilators of similar type windows. Provide hardware, guides, stops, clips, bolts, and screws as necessary for a secure and tight attachment to window. [Where sliding or hinged wickets are required in screens to permit operation of window hardware, the frame around the wicket opening must be of similar material and strengths as the screen frames.]

- a. Frames: Construct screen frames of similar material and finish as specified for the windows to which attached. Screen frame construction must consist of closed tubular shapes standard with the manufacturer, either extruded or roll formed. Frames must be mitered, electrically flash welded, then dressed smooth; or have internal reinforcing or blocks at corners and mechanically connected corners. Screen frames must have removable splines of aluminum, stainless steel, or vinyl.
- b. Screening: Weave of screening must be parallel with frames and sufficiently tight to present a smooth appearance. Conceal edges of screening in spline channel of frames.
- c. Hardware: Screen hardware must be manufacturer's standard type and finish, unless otherwise indicated.

2.12.19 Metal Accessories

[Gravel stops and fascias,] [Flashings,] [Metal sills,] [Metal stools,] [Louvers,] [Venetian blind pockets,] [Closures,] [and soffits] [____]. Fabricate accessories of sizes and shapes indicated from similar materials and finish as specified for wall system.

- 2.23 METALS FOR FABRICATION
- 2.23.1 Aluminum-Alloy Extrusions

Extrusions must conform to ASTM B221M (ASTM B221).

Extrusions to receive an integral-color anodic coating must be the alloy and temper recommended by the aluminum producer for the specified finish with integral-color anodic coating and have mechanical properties equal to or exceeding those of 6063-T5.

2.23.2 Aluminum-Alloy Sheets and Plates

Unless otherwise specified, sheets and plates must conform to ASTM B209M (ASTM B209), Alloy 3003-H16.

Sheets and plates to receive a clear anodic coating must conform to ASTM B209M (ASTM B209), Alloy 5005-H16.

 Sheets and plates to receive an integral-color anodic coating must be the alloy and temper recommended by the aluminum producer for the specified coating and have mechanical properties equal to or exceeding those of 5005-H16.

2.23.3 Structural Steel

Hot-rolled shapes, plates, and bars must conform to ASTM A36/A36M.

Hot-formed tubing must conform to ASTM A501/A501M.

Sheet and strip for cold-formed, light-gage, structural members must conform to ASTM A1011/A1011M.

2.23.4 Metals for Fasteners

Provide aluminum-alloy bolts and screws made from rod conforming to ASTM B211M, (ASTM B211,) Alloy 2024-T351.

Provide aluminum-alloy nuts made from rod conforming to ASTM B211M, (ASTM B211,) Alloy 6061-T6.

Provide aluminum-alloy washers made from sheet conforming to ASTM B209M (ASTM B209), Alloy 2024-T4.

Provide aluminum-alloy rivets made from rod or wire conforming to ASTM B316/B316M, Alloy 6053-T61.

Provide steel fasteners made from corrosion-resistant chromium-nickel Type 302, 303, 304, 305, or 316 with the form and condition best suited for the work.

2.34 NONSKINNING SEALING COMPOUND

Sealing compound must be nonskinning, gun-grade type conforming to AAMA 800.

2.45 FABRICATION

2.45.1 Workmanship

Metal Accessories must be accurately formed; joints, except those designed to accommodate movement, accurately fitted and rigidly assembled.

Insofar as practical, fitting and assembly of the work must be done in the manufacturer's plant. Mark work that cannot be permanently factory-assembled before shipment to ensure proper assembly at the site.

2.45.2 Shop-Painting Aluminum

Shop prime aluminum surfaces that will come in contact with dissimilar metals, masonry, concrete, or wood.

Prepare aluminum surfaces for painting in accordance with ASTM D1730, Type B, Method 2 or 3.

Give aluminum surfaces one shop coat of paint applied to dry, clean, surfaces to provide a continuous minimum dry-film thickness of 0.038 millimeter. (1.5 mils.)

2.45.3 Shop-Painting Steel

Shop prime surfaces of concealed steel.

Remove scale, rust, and other deleterious materials. Remove heavy rust and loose mill scale in accordance with SSPC SP 3 or SSPC 7/NACE No.4. Remove oil, grease, and similar contaminants in accordance with SSPC SP 1.

Give steel surfaces two coats of paint; the second coat must have a color different from the first coat. Apply paint to dry, clean, surfaces to provide a continuous minimum dry-film thickness of 0.038 millimeter (1.5 mils) for the first coat and 0.025 millimeter (1 mil) for the second coat.

2.45.4 Depth of Glazing Rabbets

Depth of glazing rabbets for openings to receive glass materials or panels must be as follows:

MATERIAL	NOMINAL THICKNESS	MAXIMUM SIZE	MINIMUM RABBET DEPTH
Single-glass lights	Double strength	Up to 0.46 square meter	10 millimeter
	Double strength	Over 0.46 square meter	15 millimeter
	3 millimeter	Up to 0.46 square meter	10 millimeter
	3 millimeter	0.46 to 2.32 square meter	15 millimeter
	3 millimeter	2.32 to 6.5 square meter	16 millimeter
	4.5 millimeter	Up to 2.32 square meter	15 millimeter
	4.5 millimeter	Over 2.32 square meter	16 millimeter
	5.5 millimeter	All sizes	16 millimeter
	6 millimeter	Up to 9.3 square meter	16 millimeter
	6 millimeter	Over 9.3 square meter	20 millimeter
	8 millimeter	All sizes	20 millimeter
	10 millimeter	All sizes	22 millimeter

	15 millimeter	All sizes	22 millimeter
	20 millimeter	All sizes	22 millimeter
Double-glazing units	All thicknesses	Up to 2.23 square meter	16 millimeter
	All thicknesses	2.23 to 6.5 square meter	20 millimeter
Panels	Up to 25 mm	All sizes	16 millimeter
	25 to 40 mm	All sizes	20 millimeter

MATERIAL	NOMINAL THICKNESS	MAXIMUM SIZE	MINIMIM RARRET
			DEPTH
Single-glass lights	Double strength	Up to 5 square feet	3/8 inch
	Double strength	Over 5 square feet	1/2 inch
	1/8 inch	Up to 5 square feet	3/8 inch
	1/8 inch	5 to 25 square feet	1/2 inch
	1/8 inch	25 to 70 square feet	5/8 inch
	3/16 inch	Up to 25 square feet	1/2 inch
	3/16 inch	Over 25 square feet	5/8 inch
	7/32 inch	All sizes	5/8 inch
	1/4 inch	Up to 100 square feet	5/8 inch
	1/4 inch	Over 100 square feet	3/4 inch
	5/16 inch	All sizes	3/4 inch
	3/8 inch	All sizes	7/8 inch
	1/2 inch	All sizes	7/8 inch
	3/4 inch	All sizes	7/8 inch
Double-glazing units	All thicknesses	Up to 25 square feet	5/8 inch
	All thicknesses	25 to 70 square feet	3/4 inch
Panels	Up to 1 inch	All sizes	5/8 inch

1	to	1-1/2	inches	All	sizes
---	----	-------	--------	-----	-------

3/4 inch

2.45.5 Finish

Exposed-to-View Aluminum Finish of surfaces must be:

NOTE: Delete the following finishes that are not required. Where more than one is required, the location of each must be indicated on the drawing.

Frosted finish with Class II clear anodic coating: Medium-matte chemical etch and Architectural Class II (0.01 to 0.018 millimeter thickness) anodic coating producing a natural aluminum color. Finish must be AA C22-A31 in accordance with AA DAF45.

Frosted finish with Class I clear anodic coating: Medium-matte chemical etch and Architectural Class I (0.018 millimeter and greater thickness) anodic coating producing a natural aluminum color. Finish must be AA C22-A41 in accordance with AA DAF45.

Polished frosted finish with Class II clear anodic coating: Smooth specular-buffed mechanical, followed by a medium-matte chemical etch and Architectural Class II (0.01 to 0.018 millimeter thickness) anodic coating producing a natural aluminum color. Finish must be AA M21-C22-A31 in accordance with AA DAF45.

(Frosted finish with Class II clear anodic coating: Medium-matte chemical etch and Architectural Class II (0.4- to 0.7-mil thickness) anodic coating producing a natural aluminum color. Finish must be AA C22-A31 in accordance with AA DAF45.

Frosted finish with Class I clear anodic coating: Medium-matte chemical etch and Architectural Class I (0.7-mil and greater thickness) anodic coating producing a natural aluminum color. Finish must be AA C22-A41 in accordance with AA DAF45.

Polished frosted finish with Class II clear anodic coating: Smooth specular-buffed mechanical, followed by a medium-matte chemical etch and Architectural Class II (0.4- to 0.7-mil thickness) anodic coating producing a natural aluminum color. Finish must be AA M21-C22-A31 in accordance with AA DAF45.)

Polished frosted finish with integral-color anodic coating: Smooth specular buffed mechanical, followed by nonetching inhibitive alkaline cleaning, medium-matte chemical etch, and Architectural Class I (0.018 millimeter (0.7-mil) and greater thickness) anodic coating producing an integral-color finish. Color must be:
[Light bronze] [Medium bronze] [Dark bronze] [Black]

Match aluminum-finish color and appearance to that of the sample approved for use in the project within the aluminum producer's standard color range.

Test the anodic coating on aluminum for thickness in accordance with $\ensuremath{\mathsf{ASTM}}$ B244.

Test anodically coated aluminum for the weight of the coating in accordance with ASTM B137.

Test the resistance of anodically coated aluminum to staining by dyes in accordance with ASTM B136.

2.56 CURTAIN-WALL FRAMING MEMBERS

NOTE: Size and arrangement of all framing members must be indicated on the drawings. Curtain-wall system manufacturer's stock sizes and shapes should be used. Frame depth must be coordinated with the window sash, panels, single-glass lights, doubleglazing units, and louvers and other metal accessories that are to be incorporated into the curtain-wall system.

2.56.1 General

Framing members must be the section dimensions and arrangement indicated and designed to accommodate windows, panels, and other materials to be incorporated into the curtain-wall system.

[Curtain-wall framing must be the vertical mullion type with the vertical mullions extending the indicated distance beyond the exterior face of the curtain wall.

][Curtain-wall framing must be the grid type with both the vertical and horizontal mullions extending the indicated distance beyond the exterior face of the curtain wall.

]2.56.2 Construction

Framing members must be aluminum-alloy extrusions with a wall thickness not less than 3.1 millimeter (0.125 inch). Glazing rabbet legs must be an integral part of the frame with the leg depth not less than the minimum depth specified for the thickness and size of the glass material or panel to

be installed in the curtain-wall frame. Design and construct frames to receive window sash and louvers of the type specified when required.

Prepare vertical mullions for anchorage to the building construction at the bottom, at each intermediate floor elevation, and at the top.

[Corners of frames must be mortise-and-tenon construction except that the corners of the vertical and horizontal mullions in grid frames must be coped-and-welded construction. Welds must be on the unexposed surfaces. Corner joints must be accurately fitted and flush, with watertight hairline joints not exceeding 0.4 millimeter (1/64 inch) in width. Apply nonskinning sealing compound to the unexposed surfaces of all mortise-and-tenon joints.

][Corners of frames must be coped and welded construction. Welds must be on the unexposed surfaces. Corner joints must be accurately fitted and flush, with watertight hairline joints not exceeding 0.4 millimeter (1/64 inch) in width.

]2.67 ALUMINUM DOORS AND FRAMES

Aluminum doors and frames are specified in Section 08 11 16 ALUMINUM DOORS AND FRAMES.

2.78 METAL ACCESSORIES

2.78.1 Sills

Sills must be the shapes and dimensions indicated and fabricated of aluminum-alloy extrusions having a wall thickness not less than 3 millimeter. (0.125 inch.)

Sills must run continuously under the curtain wall and permit the lower curtain wall frame member to interlock without fastenings.

2.78.2 Coping

Coping must be the shapes and dimensions indicated and welded mitered inside and outside corner sections, concealed cover plates, and other components as required for the installation. Coping-system components must be aluminum-alloy extrusions with wall thicknesses of 1.2 millimeter (0.05 inch), minimum.

2.78.3 Exterior Architectural Louvers

Exterior architectural louvers are specified in Section 05 72 00 DECORATIVE METAL SPECIALTIES.

2.89 PANELS

2.89.1 Panel Type

Panels must be metal-faced laminated both sides, consisting of exterior metal facing, facing backing, insulating core, facing backing, and interior metal facing. Facing-panel dimensions must be as indicated.

2.89.2 Exterior Metal Facing

Facing must be Porcelain-Enamel on steel. Base metal must be steel sheets for porcelain enameling, 0.25 to 0.38 millimeter (0.010 to 0.015 inch) thick, of the quality and type best suited for the work, stretcher level standard of flatness, conforming to ASTM A424/A424M, and properly precleaned and treated for adherence of the porcelain enamel.

Porcelain-enamel processing, corrosion protection, weather resistance, color retention of red, yellow, and orange porcelain enamels, continuity of coating, and surface appearance must meet or exceed the requirements specified in PEI 1001.

NOTE: PEI designates color of porcelain enamel by the munsell color system (hue, value/chroma). 47 standard colors are shown in PEI CG-3, "Color Guide for Architectural Porcelain Enamel." The following paragraph illustrates the method of specifying the

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color of porcelain enamel and must be revised as required to suit the project.

Color of porcelain-enamel exposed-to-view surfaces must be PEI CG-3Ivory (Munsell number by 8.7/3.4) and match the color of the approved samples.

Gloss of exposed-to-view surfaces must be [high] [medium] [low] reflectivity.

2.89.3 Facing Backing

Nominal 3 millimeter (1/8-inch) thick, flat non-asbestos-cement sheets, flexible smooth-one-side surface finish, conforming to ASTM C220, Type F.

2.89.4 Core Insulation

[Core must be expanded perlite conforming to ASTM C610.

][Core must be rigid urethane conforming to ASTM C591, Type 2.

][Core must be preformed block polystyrene conforming to ASTM C578, Type II.

[Core must be cellular glass conforming to ASTM C552.]

[Core must be mineral fiberboard conforming to [ASTM C612][ASTM C553][ASTM C592][ASTM C547]].

2.89.5 Interior Metal Facing

[Facing must be 0.7 millimeter (24-gage) galvanized-steel sheets conforming to ASTM A653/A653M, coating Z275. (G90.)

][Facing must be as specified for exterior metal facing.

]2.89.6 Panel Fabrication

Securely bond panel materials together to form a stable and durable composite unit. Panels with core insulation of absorptive material must have edges sealed and provide venting to the outside air. Provide panels that conform to the following:

Flatness: Provide exterior surfaces of such flatness that, when measured at room temperature, the maximum slope of the surface at any point, measured from the nominal plane of the surface, that do not exceed the following:

1.0 percent for surfaces having a finish of high reflectivity

1.25 percent for surfaces having a finish of medium reflectivity

1.5 percent for surfaces having a finish of low reflectivity

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Structural requirements: Panels of the maximum size required by the work, when supported in the manner intended, must withstand the windload specified without permanent deformation or damage.

Accelerated aging: Panels must show no evidence of delamination, warpage, or other deterioration or damage after completion of six accelerated aging cycles in accordance with ASTM C481, Cycle A.

Thermal transmittance: U-factor of a panel, when a panel not less than 1 square meter (10 square feet) in area and of identical construction is tested in accordance with ASTM C1363, must be as follows:

Not more than [0.57] [0.85] [1.14] [1.42] [1.70] [2.27] [2.56] watt/square meter-degrees C ([0.10] [0.15] [0.20] [0.25] [0.30] [0.40] [0.45] Btu/hr-square foot-degree F).

2.910 THERMAL INSULATION MATERIALS

Thermal insulation materials are specified in [Section 07 21 16 MINERAL FIBER BLANKET INSULATION][Section 07 21 13 BOARD AND BLOCK INSULATION][Section 07 21 23 LOOSE FILL THERMAL INSULATION][Section 07 24 00EXTERIOR INSULATION AND FINISH SYSTEMS][].

2.1011 SEALANTS AND CAULKINGS

Sealants and caulkings are specified in Section 07 92 00 JOINT SEALANTS.

2.1112 CURTAIN-WALL INSTALLATION MATERIALS

Concrete inserts should be used for fastening the specified work to cast-in-place concrete construction when the anchorage device will be subjected to direct pullout loadings. Indicate concrete inserts on the drawings.

2.1112.1 Threaded Concrete Inserts

Galvanized ferrous castings with enlarged bases with not less than two nailing lugs, length as indicated, internally threaded 20 millimeter (3/4-inch) diameter machine bolt must conform to ASTM A47/A47M, Grade [32510] [35018] [Grade 22010] or ASTM A27/A27M, Grade U-60-30, and hot-dip galvanized in accordance with ASTM A153/A153M.

2.1112.2 Wedge Concrete Inserts

Galvanized, box-type, ferrous castings with an integral loop at the back of the box and designed for 20 millimeter (3/4-inch) diameter bolts with wedgeshaped heads must conform to ASTM A47/A47M, Grade [32510] [35018] or ASTM A27/A27M, Grade U-60-30, and hot-dip galvanized in accordance with ASTM A153/A153M.

Carbon steel bolts with wedge-shaped heads, nuts, washers, and shims must be hot-dip galvanized in accordance with ASTM A153/A153M.

2.1112.3 Slotted Concrete Inserts

Galvanized pressed-steel plate, welded construction, box type with a slot designed for 20 millimeter (3/4-inch) diameter square-head bolts to provide lateral adjustment must be 3 millimeter (1/8-inch) minimum thickness, conforming to ASTM A283/A283M, Grade C, hot-dip galvanized in accordance with ASTM A123/A123M. Length of the insert body less anchorage lugs must be 155 millimeter (6 inches) minimum and provided with a knockout cover.

2.1112.4 Masonry Anchorage Devices

NOTE: Masonry anchorage devices should be used only for fastening materials to solid masonry and concrete-in-place construction when the anchorage device will not be subjected to direct pullout nor to vibration. Masonry anchorage devices should be used only for nonvibratory shear loads such as for fastening sash-pole hangers, door frames, and door thresholds.

2.1112.5 Toggle Bolts

Toggle bolts must be the tumble-wing type.

2.1112.6 Steel Bolts, Nuts, and Washers

Bolts must be regular hexagon head, low-carbon steel.

Nuts must be hexagon, regular style, carbon steel.

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Plain washers must be round, general-assembly purpose, carbon steel.

Lockwashers must be helical spring, carbon steel.

2.1112.7 Machine Screws

Provide screws for concealed work that are corrosion-resistant steel, slotted or cross-recessed type, roundhead.

Provide screws for exposed-to-view work that are corrosion-resistant steel, cross-recessed, flathead.

2.1112.8 Electrodes for Welding Steel

Electrodes for welding steel by the manual shielded metal arc welding process must meet the requirements of AWS D1.1/D1.1M and be covered mild-steel electrodes conforming to AWS A5.1/A5.1M, E60 series.

- PART 3 EXECUTION
- 3.1 GENERAL

Install curtain walls and accessories in accordance with the approved drawings and as specified.

3.2 FABRICATION

Provide curtain wall components of the materials and thickness indicated or specified. The details indicated are representative of the required design and profiles. Acceptable designs may differ from that shown if the proposed system components conform to the limiting dimensions indicated and the requirements specified herein. Unless specifically indicated or specified otherwise, the methods of fabrication and assembly must be at the discretion of the curtain wall manufacturer. Perform fitting and assembling of components in the shop to the maximum extent practicable. Provide anchorage devices with adjustment capability in three directions. Exposed fastenings used on finished surfaces must be truss head, flat head, or oval head screws or bolts.

3.2.1 Joints

Provide welded or mechanical fasteners as indicated or specified. Match joints in exposed work to produce continuity of line and design. Bed-joints or rabbets receiving caulking or sealing material must be minimum 20 mm (3/4 inch) deep and 10 mm (3/8 inch) wide at mid ambient temperature range.

3.2.2 Welding

Conform to AWS D1.1/D1.1M. Use methods and electrodes recommended by manufacturers of base metal alloys. Provide welding rods of an alloy that matches the color of the metal being welded. Protect glass and other finish from exposure to welding spatter. Ground and finish weld beads on exposed metal surfaces to minimize mismatch and to blend with finish on adjacent parent metal. If flux is used in welding aluminum, completely remove it immediately upon completion of welding operations. Do not use exposed welds on aluminum surfaces.

3.2.3 Soldering and Brazing

Provide as recommended by suppliers. Solder only for filling or sealing joints.

3.2.4 Ventilation and Drainage

Provide internal ventilation drainage system of weeps or based on principles of pressure equalization to ventilate the wall internally and to discharge condensation and water leakage to exterior as inconspicuously as possible. Flashings and other materials used internally must be nonstaining, noncorrosive, and nonbleeding.

- 3.2.5 Protection and Treatment of Metals
- 3.2.5.1 General

Remove from metal surfaces lubricants used in fabrication and clean off other extraneous material before leaving the shop.

3.2.5.2 Galvanic Action

Provide protection against galvanic action wherever dissimilar metals are in contact, except in the case of aluminum in permanent contact with galvanized steel, zinc, stainless steel, or relatively small areas of white bronze. Paint contact surfaces with one coat bituminous paint or apply appropriate caulking material or nonabsorptive, noncorrosive, and nonstaining tape or gasket between contact surfaces.

3.2.5.3 Protection for Aluminum

Protect aluminum which is placed in contact with, built into, or which will receive drainage from masonry, lime mortar, concrete, or plaster with one coat of alkali-resistant bituminous paint. Where aluminum is contacted by absorptive materials subject to repeated wetting or treated with preservative noncompatible with aluminum, apply two coats of aluminum paint, to such materials and seal joints with approved caulking compound.

3.3 INSTALLATION

Installation and erection of glazed wall system and all components must be performed under direct supervision of and in accordance with approved recommendations and instructions of wall system manufacturer or fabricator.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.3.1 Bench Marks and Reference Points

Establish and permanently mark bench marks for elevations and building line offsets for alignment at convenient points on each floor level. Should any error or discrepancy be discovered in location of the marks, stop erection work in that area until discrepancies have been corrected.

3.3.2 Verifying Conditions and Adjacent Surfaces

After establishment of lines and grades and prior to system installation examine supporting structural elements. Verify governing dimensions, including floor elevations, floor to floor heights, minimum clearances between curtain wall and structural frames, and other permissible dimensional tolerances in the building frame.

3.3.3 Panels

Install panels [in framing member openings] [into framed pre-assembled units] [____] using [sealants] [gaskets] [gaskets and sealants] [___] as indicated or specified.

3.3.4 Windows

Install windows in accordance with details indicated and approved detail drawings.

3.3.4.1 Sealing

Seal exterior metal to metal joints between members of windows, frames, mullions, and mullion covers. Remove excess sealant.

3.3.4.2 Ventilators and Hardware

After installing and glazing windows, adjust ventilators and hardware to operate smoothly and to be weathertight when ventilators are closed and locked. Lubricate hardware and moving parts.

3.3.4.3 Weatherstripping

Install to make weathertight contact with frames when ventilators are closed and locked. Do not cause binding of sash or prevent closing and locking of ventilator.

Provide for ventilating sections of all windows to insure a weather-tight seal meeting the infiltration tests specified. Use easily replaceable factory-applied weatherstripping of manufacturer's stock type. Use molded vinyl, molded or molded-expanded neoprene for weatherstripping for compression contact surfaces. For sliding surfaces, use treated woven pile or wool, polypropylene or nylon pile with nylon fabric and metal or plastic backing strip weatherstripping. Do not use neoprene or polyvinyl chloride weatherstripping where they will be exposed to direct sun light.

3.3.5 Joint Sealants

3.3.5.1 Surface Preparation

Surfaces to be primed and sealed must be clean, dry to the touch, free from frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter. Enclose joints on three sides. Clean out grooves to proper depth. Joint dimensions must conform to approved detail drawings with a tolerance of plus 3 mm (1/8 inch). Do not apply compound unless ambient temperature is between 4 and 32 degrees C (40 and 90 degrees F). Clean out loose particles and mortar just before sealing. Remove protective coatings or coverings from surfaces in contact with sealants before applying sealants or tapes. Solvents used to remove coatings must be of type that leave no residue on metals.

3.3.5.2 Applications

Match approved sample. Force compound into grooves with sufficient pressure to fill grooves solidly. Sealing compound must be uniformly smooth and free of wrinkles and, unless indicated otherwise, tooled and left sufficiently convex to result in a flush joint when dry. Do not trim edges of sealing material after joints are tooled. Mix only amount of multi-component sealant which can be installed within four hours, not to exceed 19 liters (5 gallons) at any given time.

3.3.5.3 Primer

Apply to masonry, concrete, wood, and other surfaces as recommended by sealant manufacturer. Do not apply primer to surfaces which will be exposed after caulking is completed.

3.3.5.4 Backing

Tightly pack in bottom of joints which are over 13 mm (1/2 inch) in depth with specified backing material to depth indicated or specified. Roll backing material of hose or rod stock into joints to prevent lengthwise stretching.

3.3.5.5 Bond Prevention

Install bond preventive material at back or bottom of joint cavities in which no backstop material is required, covering full width and length of joint cavities.

3.3.5.6 Protection and Cleaning

Remove compound smears from surfaces of materials adjacent to sealed joints as the work progresses. Use masking tape on each side of joint where texture of adjacent material will be difficult to clean. Remove masking tape immediately after filling joint. Scrape off fresh compound from adjacent surfaces immediately and rub clean with approved solvent. Upon completion of caulking and sealing, remove remaining smears, stains, and other soiling, and leave the work in clean neat condition.

3.3.6 Glass

Install in accordance with manufacturer's recommendations as modified herein. [Install insulating glass units made with heat absorbing glass with heat absorbing pane on exterior side.]

3.3.6.1 Inspection of Sash and Frames

Before installing glass, inspect sash and frames to receive glass for defects such as dimensional variations, glass clearances, open joints, or other conditions that will prevent satisfactory glass installation. Do not proceed with installation until defects have been corrected.

3.3.6.2 Preparation of Glass and Rabbets

Clean sealing surfaces at perimeter of glass and sealing surfaces of rabbets and stop beads before applying glazing compound, sealing compound, glazing tape, or gaskets. Use only approved solvents and cleaning agents recommended by compound or gasket manufacturer.

3.3.6.3 Positioning Glass

Set glass from inside the building unless otherwise indicated or specified. Maintain specified edge clearances and glass bite at perimeter. Maintain position of glass in rabbet and provide required sealant thickness on both sides of glass. For glass dimensions larger than 1270 united millimeters (50 united inches), provide setting blocks at sill and spacer shims on all four sides; locate setting blocks one quarter way in from each jamb edge of glass. Where setting blocks and spacer shims are set into glazing compound or sealant, butter with compound or sealant, place in position, and allow to firmly set prior to installation of glass.

3.3.6.4 Setting Methods

Apply glazing compound, glazing sealant, glazing tape, and gaskets uniformly with accurately formed corners and bevels. Remove excess compound from glass and sash. Use only recommended thinners, cleaners, and solvents. Strip surplus compound from both sides of glass and tool at slight angle to shed water and provide clean sight lines. Secure stop beads in place with suitable fastenings. Do not apply compound or sealant at temperatures lower than 4 degrees C (40 degrees F), or on damp, dirty, or dusty surfaces. After glazing, fix ventilators in sash so they cannot be operated until compound or sealant has set.

- a. Use sealant glazing to completely fill channel on edges and on both sides of glass for [].
- b. Use sealant and tape glazing, with glazing sealant for cap bead above glazing tape against fixed exterior stops and glazing tape full height against removable interior stops for [].
- c. Use sealant and tape glazing, with glazing sealant full height against removable exterior stops with heel bead or glazing sealant and glazing tape full height against fixed interior stops for [].
- d. Use sealant and tape glazing, with glazing sealant cap beads above glazing tape against both exterior and interior stops for [___]. Removable stops may be on either exterior or interior side of glass.
- e. Use tape, sealant, and compound glazing, with glazing tape full height against fixed exterior stops, glazing compound as a cap bead above heel bead sealant and against removable interior stops for [].
- f. Use tape, sealant, and gasket glazing, with glazing tape full height against fixed exterior stops, glazing sealant as a heel bead at edge of

glass, and preformed vision strip gasket against removable interior snap-on stops for [].

- g. Use compression gasket glazing, with compression gaskets both sides of glass and adjustable or snap-on interior stops for [].
- h. Use lock-strip gasket glazing, with lock-strip glazing gaskets for [___]. Install gaskets in accordance with manufacturer's instructions using special tools and lubricants. When lock-strip type gaskets are used for glazing insulating glass units, follow glass manufacturer's recommendations regarding horizontal wall supports between vertical units, setting blocks, weep holes, and the use of supplementary wet sealants.

3.3.6.5 Void Space

Heat absorbing, insulating, spandrel, and tempered glass, and glass of other types that exceed 2540 united millimeters (100 united inches) in size: Provide void space at head and jamb to allow glass to expand or move without exuding the sealant.

3.3.6.6 Insulating Glass

Provide adequate means to weep incidental water and condensation away from the sealed edges of insulated glass units and out of the wall system. The weeping of lock-strip gaskets must be in accordance with the recommendation of the glass manufacturer.

3.3.6.7 Insulating Glass With Edge Bands

Insulating glass with flared metal edge bands set in lock-strip type gaskets: Follow glass manufacturer's recommendations and add supplementary wet seal as required; when used with glazing tape, use tapered tape.

3.3.7 Firestopping

Provide firestopping [, where indicated,] in openings between wall system and floor at each story to prevent passage of flame and hot gases from floor to floor under extended fire exposure. Installed fire stopping must remain in place under extended fire exposure despite distortions that may occur in wall system components. Securely attach anchoring or containment devices to building structure and not to wall system. Place [concrete] [mineral fiber] [____] on [steel plates attached to bottom of floor slab] [impaling chips embedded in edge of floor slab] [____].

3.3.8 Field Applied Insulation

Provide insulation with minimum R-value of [____], on clean, dry, properly prepared surfaces of [masonry] [concrete] [___] back-up wall in accordance with [___] INSULATION using approved accessories and methods as recommended by insulation manufacturer unless indicated or specified otherwise. Cover and protect each day's application until protection is provided by completed work.

3.4 FINISHES

3.4.1 Galvanizing

Conform to ASTM A123/A123M, ASTM A153/A153M, and ASTM A653/A653M, as applicable.

3.4.1.1 Repair of Zinc-Coated Surfaces

Repair zinc coated surfaces damaged by welding or other means with galvanizing repair paint or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved.

3.4.2 Shop Cleaning and Painting

3.4.2.1 Cleaning

Clean steel and iron work by power wire brushing or other approved manual or mechanical means, for removal of rust, loose paint, scale, and deleterious substances. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other foreign matter, with solvents until thoroughly clean. Cleaning steel embedded in concrete is not required.

3.4.2.2 Painting Steel or Iron Surfaces

[Apply one coat of primer.] [Apply primer to a minimum dry film thickness of 0.025 mm (1.0 mil).] Apply additional shop coat of specified paint, to which a small amount of tinting material has been added, on surfaces that will be concealed in the finished construction or that will not be accessible for finish painting. Accomplish painting in dry weather or under cover, and on steel or iron surfaces that are free from moisture and frost. Do not paint surfaces of items to be embedded in concrete. Recoat damaged surfaces upon completion of work. Prime coat steel immediately after cleaning. Do not apply bituminous protective coatings to items to be finish painted.

3.4.2.3 Painting Weathering Steel

Clean and paint surfaces which will not be exposed to the weather with one shop or field coat of specified primer, or other approved rust-inhibitive primer. Clean and strip-paint weathering steel contact surface to be covered by structural or compression gaskets or sealants with one coat to insure positive seal.

3.5 FIELD TESTS

Conduct field check test for water leakage on designated wall areas after erection. Conduct test on [two] [____] wall areas, two bays wide by two stories high where directed. Conduct test and take necessary remedial action as described in AAMA 501.1.

3.6 CLEANING AND PROTECTION

3.6.1 General

At the completion of the installation, clean the work to remove mastic smears and other foreign materials.

3.6.2 Glass

Upon completion of wall system installation, thoroughly wash glass surfaces on both sides and remove labels, paint spots, putty, compounds, and other defacements. Replace cracked, broken, and defective glass with new glass at no additional cost to the Government.

3.6.3 Aluminum Surfaces

Protection methods, cleaning, and maintenance must be in accordance with AAMA 609 & 610.

3.6.4 Other Metal Surfaces

After installation, protect windows, panels, and other exposed surfaces from disfiguration, contamination, contact with harmful materials, and from other construction hazards that will interfere with their operation, or damage their appearance or finish. Protection methods must be in accordance with recommendations of product manufacturers or of the respective trade association. Remove paper or tape factory applied protection immediately after installation. Clean surfaces of mortar, plaster, paint, smears of sealants, and other foreign matter to present neat appearance and prevent fouling of operation. In addition, wash with a stiff fiber brush, soap and water, and thoroughly rinse. Where surfaces become stained or discolored, clean or restore finish in accordance with recommendations of product manufacturer or the respective trade association.

3.6.5 Porcelain-Enamel Surfaces

Wash surfaces with clean water and soap and rinsed with clean water. Do not use acid solutions, steel wool, or other harsh abrasives.

3.7 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement

commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
Glass	1/4 inch	6 mm

3.8 MATERIALS EMBEDDED IN OTHER CONSTRUCTION

Install materials to be embedded in cast-in-place concrete and masonry prior to the installation of the curtain wall. Provide setting drawings, templates, and instructions for installation.

3.9 FASTENING TO CONSTRUCTION-IN-PLACE

Provide anchorage devices and fasteners for fastening work to constructionin-place. Provide fasteners as specified.

3.10 SETTING MASONRY ANCHORAGE DEVICES

Set devices in masonry or concrete-in-place construction in accordance with the manufacturer's printed instructions. Leave drilled holes rough and free of drill dust.

3.11 FIELD-WELDING STEEL AND TOUCHUP PAINTING

Procedures of manual shielded metal arc welding, the appearance and quality of the welds made, and the methods used in correcting welding work must conform to AWS D1.1/D1.1M.

After completion of welding, clean and paint field welds and scarred surfaces on steel work and on adjacent ferrous-metal surfaces. Paint must be the same as that used for shop painting.

3.12 INSTALLATION TOLERANCES

Install curtain walls within the following tolerances:

Dev	/iat:	ion	in	location	from	that	indicated	Plus	or	minus	6	millimeter	
on	the	dra	awir	ngs									

Deviation from the plumb or horizontal	
In 3660 millimeter of length	Not more than 3 millimeter
In any total length	Not more than 15 millimeter
Offset from true alignment at joints between abutting members in line	Not more than 1 millimeter

Deviation in location from that indicated on the drawings	Plus or minus 1/4 inch
Deviation from the plumb or horizontal	
In 12 feet of length	Not more than 1/8 inch
In any total length	Not more than 1/2 inch
Offset from true alignment at joints between abutting members in line	Not more than 1/16 inch

3.13 PLACING CURTAIN-WALL FRAMING MEMBERS

Install members plumb, level, and within the limits of the installation tolerances specified.

Connect members to building framing. Provide supporting brackets adjustments for the accurate location of curtain-wall components. Adjustable connections must be rigidly fixed after members have been positioned.

3.14 PANEL INSTALLATION

Panels must be set with a glazing-tape back bed, two-component elastomeric sealing-compound heel bead, glazing-tape bedding of the stop, and twocomponent elastomeric sealing-compound topping bead on both sides of the panel. Face and edge clearances must not be less than 3 millimeter (1/8 inch). Remove excess sealing compound on both sides of the curtain wall opening with a glazing knife at a slight angle over the rabbet leg or applied stop. Install applied stops on the exterior side of the curtain wall and secured with screws.

- 3.15 INSPECTION AND ACCEPTANCE PROVISIONS
- 3.15.1 Finished Curtain-Wall System Requirements

Curtain-wall work must be rejected for any of the following deficiencies:

Finish of exposed-to-view aluminum having color and appearance that are outside the color and appearance range of the approved samples.

Installed curtain-wall components having stained, discolored, abraded, or otherwise damaged exposed-to-view surfaces that cannot be cleaned or repaired.

Aluminum surfaces in contact with dissimilar materials that are not protected as specified.

3.15.2 Repair of Defective Work

Remove and replace defective work with curtain-wall materials that meet the specifications at no expense to the Government.

-- End of Section --

USACE / NAVFAC / AFCEC / NASA

UFGS-08 51 13 (May 2011) Change 2 - 05/16 ------Superseding UFGS-08 51 13 (August 2009)

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2017

SECTION 08 51 13

ALUMINUM WINDOWS 05/11

NOTE: This guide specification covers the requirements for R, LC, CW and AW performance class aluminum windows.

Note: Adhere to <u>UFC 1-300-02</u> Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a <u>Criteria Change Request (CCR)</u>.

1. Windows requiring UL fire rating must be steel, and may occur in conjunction with aluminum windows which cannot be approved for this use. When steel windows are used in conjunction with aluminum, specify finish matching aluminum windows. Steel windows should be specified in Section 08 51 23 STEEL WINDOWS.

2. Aluminum windows are not acceptable for use as security windows which should be steel, specified in Section 08 51 23 STEEL WINDOWS. Security steel windows are designed and constructed to give protection against unauthorized entrance and removal of materials from warehouses and other storage type areas; they are not designed for detention use. Guard windows for detention use are not included in this guide; where such windows are desired, consult Steel Window Institute Recommended Specifications and manufacturers' data, and specify in Section 08 51 23 STEEL WINDOWS.

3. Specify the following items of related work under other sections of the specifications:

a. Glass and glazing and the furnishing of glazing clips and gaskets.

b. Caulking and sealants.

c. Structural building supports at window mullions.

d. Wood subframes for windows in frame walls.

e. Drilling and tapping for attachment of window shades, drapery rods, and venetian blinds. The drilling and tapping of window frames to receive brackets for shades, venetian blinds, and curtain rods has been omitted from this specification. It is contemplated that this work will be done after erection of windows by the trade for the item to be installed. On projects where factory drilling for these items is required, revise this specification accordingly.

f. Brackets and supports for window shades, drapery rods, and venetian blinds.

NOTE: On the drawings, show:

1. Sizes and types of windows; metal and wood subframes, casings, or stools; and hardware.

2. Sizes, location, and swing of ventilators; direction of slide for sliding ventilators; location and details of fixed sash.

3. Typical window sections and details. Show glass thickness. Show special glazing.

4. Method of anchoring windows to adjoining construction; size and types of clips, anchors, screws, or other fasteners.

5. Details of nonstructural mullions and mullion covers; details of anchoring and reinforcing nonstructural mullions at windows to receive window cleaner anchors.

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6. Number and locations of window cleaner anchors.

7. Locations of windows requiring special operators. Show method of operation and concealment of operators, cables and rods. Show wiring diagram for motor driven operators.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DA	AF45		(2003; Reaffirmed 2009) Designation System for Aluminum Finishes
	AMERICAN	ARCHITECTURAL	MANUFACTURERS ASSOCIATION (AAMA)
AAMA	1302.5		(1976) Voluntary Specifications for Forced- Entry Resistant Aluminum Prime Windows
AAMA	1503		(2009) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
AAMA	2603		(2015) Voluntary Specification, Performance Requirements and Test Procedures for

Pigmented Organic Coatings on Aluminum Extrusions and Panels

- AAMA 2604 (2013) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
- AAMA 2605 (2013) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
- AAMA 611 (2014) Voluntary Specification for Anodized Architectural Aluminum
- AAMA 701/702 (2011) Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals
- AAMA 902 (2014) Voluntary Specification for Sash Balances

AAMA WSG.1 (1995) Window Selection Guide

AAMA/WDMA/CSA 101/I.S.2/A440 (2011; Update 1 2014) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

ASTM INTERNATIONAL (ASTM)

- ASTM A276/A276M (2017) Standard Specification for Stainless Steel Bars and Shapes
- ASTM E1300 (2016) Standard Practice for Determining Load Resistance of Glass in Buildings
- ASTM F1642/F1642M (2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
- ASTM F2248 (2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass

INTERNATIONAL WINDOW CLEANING ASSOCIATION (IWCA)

IWCA I-14.1 (2001) Window Cleaning Safety Standard

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

- NFRC 100 (2014) Procedure for Determining Fenestration Product U-Factors
- NFRC 200 (2014) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101

(2015; ERTA 2016) Life Safety Code

1.2 CERTIFICATION

Each prime window unit must bear the AAMA Label warranting that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440. Certified test reports attesting that the prime window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, including test size, will be acceptable in lieu of product labeling.

1.3 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G"

designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES: SD-02 Shop Drawings Windows; G[, []] Fabrication Drawings SD-03 Product Data Windows; G[, []] [Recycled Content of Aluminum Windows; S]][Energy Star label for residential aluminum window products; S]Hardware; G[, []] Fasteners; G[, []] Window Performance; G[, []] Thermal-Barrier Windows; G[, []] Mullions; G[, []] Window Cleaners' Bolts; G[, []] Screens; G[, []] Weatherstripping; G[, []] Accessories; G[, []] [Adhesives Submit manufacturer's product data, indicating VOC content.] Thermal Performance; G[, []] SD-04 Samples Finish Sample Window Sample SD-05 Design Data

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Structural Calculations for Deflection; G[, [____]]
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[Design Analysis; G[, [ ]]
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Submit design analysis with calculations showing that the design of each different size and type of aluminum window unit and its anchorage to the structure meets the minimum antiterrorism standards required by paragraph "Minimum Antiterrorism Performance", unless conformance is demonstrated by Standard Airblast Test results. Calculations verifying the structural performance of each window proposed for use, under the given loads, must be prepared and signed by a registered Professional Engineer. The window components and anchorage devices to the structure, as determined by the design analysis, must be reflected in the shop drawings.]

SD-06 Test Reports

Minimum Condensation Resistance Factor

[Resistance to Forced Entry]

[Standard Airblast Test; G

For Minimum Antiterrorism windows, in lieu of a Design Analysis, results of airblast testing, whether by arena test or shocktube, must be included in a test report, providing information in accordance with ASTM F1642/F1642M, as prepared by the independent testing agency performing the test. The test results must demonstrate the ability of each window proposed for use to withstand the airblast loading parameters and achieve the hazard level rating specified in paragraph "Standard Airblast Test Method".]

SD-10 Operation and Maintenance Data

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Windows, Data Package 1; G[, [___]]
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Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Plastic Identification

When not labeled, identify types in Operation and Maintenance Manual.

SD-11 Closeout Submittals

[Recycled Content of Aluminum Windows; S

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NOTE: Include energy efficient requirement below for residential windows only.

[Energy Efficient Equipment for Residential Windows; S

]1.4 QUALITY ASSURANCE

1.4.1 Shop Drawing Requirements

Provide drawings that indicate elevations of windows, full-size sections, thickness and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, [mullion details,] [method and materials for weatherstripping,] [method of attaching screens,] [material and method of attaching subframes,] [stools,] [casings,] [sills,] [trim,] [window cleaner anchors,] installation details, and other related items.

- 1.4.2 Sample Requirements
- 1.4.2.1 Finish Sample Requirements

Submit color chart of standard factory color coatings when factory-finish color coating is to be provided.

1.4.2.2 Window Sample Requirements

[Submit one full-size window of each type proposed for use, complete with AAMA Label, glazing, hardware, anchors, and other accessories. Where screens or weatherstripping is required, fit sample windows with such items that are to be used. After approval, install each sample in work, clearly identified, and record its location.]

[Submit one full-size corner of each window type proposed for use. Where screens or weatherstripping is required, fit sample with such items that are to be used.]

1.4.3 Design Data Requirements

Submit calculations to substantiate compliance with deflection requirements[and Minimum Antiterrorism Performance criteria]. A registered Professional Engineer must provide calculations.

Submit design analysis with calculations showing that the design of each different size and type of aluminum window unit and its anchorage to the structure meets the requirements of paragraph "Minimum Antiterrorism Performance Criteria". Calculations verifying the structural performance of each window proposed for use, under the given loads, must be prepared and signed by a registered professional engineer. Reflect the window components

and anchorage devices to the structure, as determined by the design analysis, in the shop drawings.

1.4.4 Test Report Requirements

Submit test reports for each type of window attesting that identical windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 including test size, [and] minimum condensation resistance factor (CRF)[, and resistance to forced entry][, and, for Minimum Antiterrorism windows, in lieu of a Design Analysis, results of a Standard Airblast Test].

1.5 DELIVERY AND STORAGE

Deliver windows to project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the jobsite. Store windows and components out of contact with the ground, under a weathertight covering, so as to prevent bending, warping, or otherwise damaging the windows. Repair damaged windows to an "as new" condition as approved. If windows can not be repaired, provide a new unit.

1.6 PROTECTION

Protect finished surfaces during shipping and handling using the manufacturer's standard method. Do not apply coatings or lacquers to surfaces to which caulking and glazing compounds must adhere.

1.7 PLASTIC IDENTIFICATION

Label plastic products provided to indicate their polymeric composition according to the following list. Where products are not labeled, provide product data indicating polymeric information in Operation and Maintenance Manual.

- a. Type 1: Polyethylene Terephthalate (PET, PETE).
- b. Type 2: High Density Polyethylene (HDPE).
- c. Type 3: Vinyl (Polyvinyl Chloride or PVC).
- d. Type 4: Low Density Polyethylene (LDPE).
- e. Type 5: Polypropylene (PP).
- f. Type 6: Polystyrene (PS).
- g. Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

1.8 FIELD MEASUREMENTS

Take field measurements prior to preparation of the drawings and fabrication.

1.9 PERFORMANCE REQUIREMENTS

1.9.1 Wind Loading Design Pressure

Design window components, including mullions, hardware, and anchors, to withstand a wind-loading design pressure of at least [____] pascal (pounds per square foot (psf)).

1.9.2 [Tests

Test windows proposed for use in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for the particular type and quality window specified.

Perform tests by a nationally recognized independent testing laboratory equipped and capable of performing the required tests. Submit the results of the tests as certified laboratory reports required herein.

Minimum design load for a uniform-load structural test must be 2400 pascal (50 psf).

[Test projected windows in accordance with the applicable portions of the AAMA WSG.1 for air infiltration, water resistance, uniform-load deflection, and uniform-load structural test.]

[Test double-hung windows in accordance with the applicable portions of the AAMA WSG.1 for air infiltration, water resistance, uniform-load deflection, and uniform-load structural test.]]

1.10 DRAWINGS

Submit the Fabrication Drawings for aluminum window units showing complete window assembly including hardware, weatherstripping, and subframe assembly details.

1.11 WINDOW PERFORMANCE

NOTE: Structural performance, air infiltration and water penetration are standard performance requirements for all aluminum window types.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-00-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the componenets of building envelope design including fenestrations and glazing.

Aluminum windows must meet the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

1.11.1 Structural Performance

Structural test pressures on window units must be for positive load (inward) and negative load (outward). After testing, there will be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There must be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA/WDMA/CSA 101/I.S.2/A440 for the window types and classification specified in this section.

[1.11.2 Minimum Antiterrorism Performance

Windows must meet the minimum antiterrorism performance as specified in the paragraphs below. Conformance to the performance requirements must be validated by one of the following methods.

1.11.2.1 Computational Design Analysis Method

Window frames, mullions, and sashes must be designed to the criteria listed herein. Computational design analysis must include calculations verifying the structural performance of each window proposed for use, under the given static equivalent loads.

Aluminum window framing members must restrict deflections of the edges of glazing they support to L/60 under two times (2X) the glazing resistance per the requirements of ASTM F2248 and ASTM E1300. Glazing resistance must be greater than equivalent 3-second duration loading of [___] pascal ([___] pounds per square foot (psf)) for type [___] window (per Window Schedule indicated on the drawings) [and [__] pascal ([__] psf) for the remaining windows types]. L denotes the length of the glazing supported edge. (L is to be based on edge length of glazing in frame and not on the distance between anchors that fasten frame to the structure.)

The glazing frame bite for the window frames must be in accordance with $\ensuremath{\mathsf{ASTM}}$ F2248.

NOTE: The blank in the following paragraph should be the value of 2 times the loading just determined in the paragraph above.

Window frames must be anchored to the supporting structure with anchors designed to resist two times (2X) the glazing resistance in accordance with ASTM F2248 and ASTM E1300.

1.11.2.2 Alternate Dynamic Design Analysis Method

As an alternative to the static equivalent load design approach described above, window framing members, anchors, and glazing may be designed using a dynamic analysis to prove the window system will provide performance equivalent to or better than a very low hazard rating in accordance with ASTM F1642/F1642M associated with the applicable low level of protection for the project.

1.11.2.3 [Standard Airblast Test Method

NOTE: The following paragraph must be used as written (without modification) and allows the contractor to supply windows that have been tested, rather than designed, to meet the window requirements of Standard 10 of UFC 4-010-01. The airblast loading parameters represent the envelope of pressures and impulses associated with the two different charge weights when located at the conventional construction standoff distances for Billeting and Primary Gathering buildings per Table B-1 of UFC 4-010-01. It is not necessary to test to the higher pressures and impulses associated with the conventional construction standoff distances for Inhabited buildings. Tests must be performed in accordance with ASTM F1642/F1642M and the results must show that the window performs to the Very Low Hazard rating or better.

As an alternative to either of the Computational Design Analysis Methods, each Minimum Antiterrorism window type must be tested for evaluation of hazards generated from airblast loading in accordance with ASTM F1642/F1642M by an independent testing agency regularly engaged in blast testing. For proposed window systems that are of the same type as the tested system but of different size, the test results may be accepted provided the proposed window size is within the range from 25 percent smaller to 10 percent larger in area, than the tested window. Proposed windows of a size outside this range require testing to evaluate their hazard rating. Testing may be by shocktube or arena test. The test must be performed on the entire proposed window system, to include, but not be limited to, the glazing, its framing system, operating devices, and all anchorage devices. Anchorage of the window frame or subframe must replicate the method of installation to be used for the project. The minimum airblast loading parameters for the test must be as follows: Peak positive pressure of 5.8 psi (40 kPa) and positive phase impulse of 41.1 psi-msec (285 kPa-msec). The hazard rating for the proposed window systems, as determined by the rating criteria of ASTM

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F1642/F1642M, must not exceed the "Very Low Hazard" rating (i.e. the "No Break", "No Hazard", "Minimal Hazard" and "Very Low Hazard" ratings are acceptable. "Low Hazard" and "High Hazard" ratings are unacceptable). Results of window systems previously tested by test protocols other than ASTM F1642/F1642M may be accepted provided the required loading, hazard level rating, and size limitations stated herein are met.]

1.11.3 Air Infiltration

Air infiltration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

]1.11.4 Water Penetration

Water penetration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

1.11.5 Thermal Performance

NOTE: Window properties are critical to energy performance and comfort. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain.

Energy Star labeling is applicable to residential units only.

For nonresidential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy efficiency and meeting minimum building envelope requirements of UFC 3-101-01 including fenestrations and glazing.

Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting bracketed energy performance requirements before specifying and edit as needed.

[Non-residential aluminum windows (including frames and glass) must be certified by the National Fenestration Rating Council with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [____] determined according to NFRC 200 procedures and a U-factor maximum of [___] W/m^2K (Btu/hr-ft²-F) in accordance with NFRC 100.]

[Residential aluminum windows (including frames and glass) must be Energy Star qualified_labeled products as appropriate to for the [Northern][North-Central][South-Central][Southern] climate zone, or have the following performance characteristics: To meet Energy Star criteria for the [Southern climate zone, thermal properties of windows must not exceed a U-factor of 0.40 3.4 W/m²K (0.60 Btu/hr-ft²-F) determined according to NFRC 100, and a solar heat gain coefficient (SHGC) not exceedingef 0.250.27 determined according to NFRC 200.] [South-Central climate zone, thermal properties of windows must not exceed a U-factor of 0.30 2.0 W/m²K (0.35 Btu/hr-ft²-F) determined according to NFRC 100, and a solar heat gain coefficient (SHGC) of not exceeding 0.25 0.30 determined according to NFRC 200.] [North-Central climate zone, thermal properties of windows must not exceed a U-factor of 0.30 1.8 W/m²K (0.32 Btu/hr=ft²=F) determined according to NFRC 100, and a solar heat gain coefficient (SHGC) of not exceeding 0.40 determined according to NFRC 200.] [Northern climate zone, thermal properties of windows must not exceed a U-factor of 0.27 1.7 W/m² (0.30 Btu/hr=ft²=F) determined according to NFRC 100]. Provide proof of Energy Star label for residential aluminum window products.]

1.11.6 [Life Safety Criteria

Provide windows that conform to NFPA 101 Life Safety Code when rescue and/or second means of escape are indicated.

]1.11.7 Sound Attenuation

The window unit must have a minimum STC of [[41] [____] with the window glazed with two pieces of 6 mm (1/4 inch) thick laminated glass] [[34] [___] with the window glazed with 13 mm (1/2 inch) air space between two pieces of 6 mm (1/4 inch) thick glass] when tested in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 acoustical performance (optional).

1.12 QUALIFICATION

Window manufacturer must specialize in designing and manufacturing the type of aluminum windows specified in this section, and have a minimum of [____] years of documented successful experience. Manufacturer must have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.13 [MOCK-UPS

Before fabrication, full-size mock-up of [each type of aluminum window] [one window unit] [____] complete with glass and AAMA certification label for structural purposes and NFRC Temporary and Permanent Label for certification

of thermal performance rating will be required for review of window construction and quality of hardware operation.

]1.14 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

12.1 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

NOTE: In certain locations the use of recycled aluminum materials is readily available through a variety of manufacturers. The Designer of Record (DOR) must confirm that availability and edit the paragraphs below accordingly.

<u>f2.1.1 Recycled content of Aluminum Windows</u>

Provide aluminum window frames meeting the recycled content requirements as stated within this section and provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph RECYCLED CONTENT.

][2.1.2 Energy Efficient Equipment for Residential Windows

Provide Energy Star residential windows in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph ENERGY EFFICIENT EQUIPMENT.

]]2.12 WINDOWS

NOTE: AAMA/WDMA/CSA 101/I.S.2/A440 includes a designation system with a four part code, which includes Product Type, Performance Class, Performance Grade (design pressure) and maximum size tested to achieve desired rating (example Double Hung or H, CW30 760 by 1520 (30 by 60)). Product Type is an abbreviation for window type (AP for awning, hopper, projected window, C for casement, H for hung, etc.). Performance classes represent the level of performance (R, LC, CW and AW). Performance Grade represents the design pressure to which the window is constructed.

AAMA/WDMA/CSA 101/I.S.2/A440 establishes minimum Performance Grade for each Performance Class: 15 for

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R (corresponding to a design pressure of 720 Pa (15
         psf)); 25 for LC (corresponding to a design pressure
         of 1200 Pa (25 psf)); 30 for CW (corresponding to a
         design pressure of 1440 Pa (30 psf)); and 40 for AW
         (corresponding to a design pressure of 1920 Pa (40
         psf)).
         AAMA/WDMA/CSA 101/I.S.2/A440 also includes criteria
         for specifying windows required to meet higher design
         pressures if minimum pressure is inadequate. These
         windows are designated as Optional Performance Grade
         and should be specified in increments of 240 Pa (5
         psf) above the minimum Performance Grade.
 NOTE: Consult AAMA 1503 "Voluntary Test Method for
         Transmittance and Condensation Resistance of Windows,
         Doors and Glazed Wall Sections" and select the
         minimum Condensation Resistance Factor (CRF) required
         for the particular project conditions.
 NOTE: Consult AAMA/WDMA/CSA 101/I.S.2/A440 to
         calculate design pressure(s) applicable to the
         project. Adjust "design factors" because naval
         facilities are typically less than 100 miles from
         hurricane oceanline.
NOTE: Use materials with recycled content where
         appropriate for use. Verify suitability,
         availability within the region, cost effectiveness
         and adequate competition before specifying product
         recycled content requirements. Use of materials with
         recycled content, contributes to meeting the
         requiements of UFC 1-200-02, High Performance and
         Sustainable Building Requirements and meeting minimum
         building envelope requirements of UFC 3-101-01
         including fenestrations and glazing. Coordinate with
         Section 01 33 29 SUSTAINABILITY REPORTING. Designer
         must verify that products meeting minimum recycled
         content are available, preferably from at least three
         sources, to ensure adequate competition. If not,
         write in suitable recycled content values that
         reflect availability and competition.
```

Provide prime windows that comply with AAMA/WDMA/CSA 101/I.S.2/A440 and the requirements specified herein. In addition to compliance with AAMA/WDMA/CSA 101/I.S.2/A440, window framing members for each individual light of glass must not deflect to the extent that deflection perpendicular to the glass light exceeds L/175 of the glass edge length when subjected to uniform loads at specified design pressures. Provide Structural calculations for deflection to substantiate compliance with deflection requirements. Provide

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windows of types, performance classes, performance grades, -combinations, and sizes indicated or specified.[__Provide aluminum window frames with a minimum recycled content of $\{20\}$ [____] percent. Provide data identifying percentage of recycled content of aluminum windows.] Design windows to accommodate hardware, glass, weatherstripping, screens, and accessories to be furnished. Each window must be a complete factory assembled unit with or without glass installed. Dimensions shown are minimum. Provide windows with insulating glass and thermal break necessary to achieve a minimum Condensation Resistance Factor (CRF) of [___] when tested in accordance with AAMA 1503.

2.12.1 Awning Windows (AP)

Type AP-[R15][LC25][CW30][AW40][[R][LC][CW] [AW]- [____] (Optional Performance Grade)]. Conceal operating mechanism within the frame members or enclose within a metal casing not less than 1.59 mm (0.0625 inch) thick sheet aluminum.

2.12.2 Casement Windows (C)

Type C-[R15][LC25][CW30][AW40][[R][LC][CW][AW]- [____] (Optional Performance Grade)]. Ventilators must be[rotary crank][handle] operated. Provide ventilators over 1650 millimeters (65 inches) high with two separate locking devices or a two-point locking device operated by rods from a single lever handle. Conceal rods where possible.[Provide casement windows in combination with[fixed][projected] windows specified below.]

2.12.3 Hung Windows (H)

[Double][___] Hung, Type H-[R15][LC25][CW30][AW40][[R] [LC][CW][AW]-[___] (Optional Performance Grade)]. Test and rate sash balance to conform with AAMA 902.

Design windows, mullions, hardware, and anchors to withstand the wind loading specified.

2.12.3.1 Window Materials

Window frames and sash members, mullions, mullion covers, screen frames, and glazing beads must be fabricated in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.

Provide woven wool pile weatherstripping 5.3 millimeter (0.210 inch) thick, conforming to AAMA 701/702, or polypropylene multifilament fiber weatherstripping installed in an integral weatherstripping groove in the sash or frame, and flexible polyvinylchloride weatherstripping installed in the sill member.

2.12.4 Horizontal Sliding Windows (HS)

Type HS-[R15][LC25][CW30][AW40][[R][LC][CW][AW]- [____] (Optional Performance Grade)].

2.12.5 Projected Windows (AP)

Type AP-[R15][LC25][CW30][AW40][[R][LC][CW][AW]- [____] (Optional Performance Grade)]. Provide projected windows with concealed four bar friction hinges only.

2.12.6 Top-Hinged Windows (TH)

Type TH-[CW30][AW40][[CW][AW]- [____] (Optional Performance Grade)]. Tophinged windows must be[inswinging][outswinging].

2.12.7 Vertically Pivoted Windows (VP)

force protection is required.

Type VP-[R15][LC25][CW30][AW40][[R][LC][CW][AW]-[____] (Optional Performance Grade)].[Provide window with remotely operated venetian blind mounted between an access sash and the main sash.]

2.12.8 Fixed Windows (F)

Type F-[R15][LC25][CW30][AW40][[R][LC][CW][AW]- [____] (Optional Performance Grade)].

2.12.9 Forced Entry Resistant Windows

NOTE: Conventional aluminum windows offer nominal resistance to forced entry by unskilled or opportunistic intruders. While there is no way to make a window absolutely "burglar proof," windows complying with AAMA 1302 can provide reasonable assurance that entry, or attempted entry, will leave ample evidence of "forced entry." It establishes only a pass/fail condition when specific concentrated loads are applied to sash or ventilator in attempt to open or remove sash or ventilator from window frame and specifies no measured time delay. It provides

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moderate degree of security against unskilled or opportunistic intruder at little or no additional cost. When forced entry resistant windows are specified, coordinate glazing requirements and specify impact resistant glass and glazing materials in Section 08 81 00 GLAZING.

For projects requiring security windows, specify steel security windows in Section 08 51 23 STEEL WINDOWS. Protection in high crime areas against skilled professional intruders requires a more sophisticated approach to physical security. Consult Design Manual 13.1 "Physical Security" for recommendations.

In addition to meeting the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, windows designated for resistance to forced entry must conform to the requirements of AAMA 1302.5.

2.12.10 Glass and Glazing

Materials are specified in Section 08 81 00 GLAZING.

2.12.11 Caulking and Sealing

Are specified in Section 07 92 00 JOINT SEALANTS.

2.12.12 Weatherstripping

AAMA/WDMA/CSA 101/I.S.2/A440.

2.12.13 Sash Poles

Seamless aluminum tube, 1.59 mm (0.0625 inch) minimum wall thickness, 25 mm (one inch) diameter, [____] m (feet) long, with cast aluminum hook and protective cover or tip on the lower end. Finish must match windows.

2.23 FABRICATION

Fabrication of window units must comply with AAMA/WDMA/CSA 101/I.S.2/A440.

2.23.1 Provisions for Glazing

NOTE: Specify glass thickness and vinyl gaskets in Section 08 81 00 GLAZING. Inside glazing is preferred, especially for windows above first floor and other locations where access is difficult. Windows designed for inside glazing may not be available in double-hung type; check manufacturers' literature. Where project requires insulating glass, show sash members, glazing beads, and hardware of sufficient size and weight to receive and support glass of thickness specified. Allow 3 mm (1/8 inch) minimum between each side of insulating glass and metal frame and between edges of glass and frame for
requirements are specified in Department of Defense Antiterrorism Standards for Buildings.

single and duplex detached family housing. These

Design windows and rabbets suitable for glass thickness shown [or specified]. [For minimum antiterrorism windows, attach glazing to its supporting frame using structural silicone sealant or adhesive glazing tape in accordance with ASTM F2248.] Design sash for[inside][outside][single][double] glazing and for securing glass with[metal beads,][glazing clips,][glazing channels,] or glazing compound.

2.23.2 Weatherstripping

Provide for ventilating sections of all windows to ensure a weather-tight seal meeting the infiltration requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440. Provide easily replaceable factory-applied weatherstripping. Use molded vinyl, molded or molded-expanded neoprene or molded or expanded Ethylene Propylene Diene Terpolymer (EPDM) compressiontype weatherstripping for compression contact surfaces. Use treated woven pile or wool, or polypropylene or nylon pile bonded to nylon fabric and metal or plastic backing strip weatherstripping for sliding surfaces. Do no use neoprene or polyvinylchloride weatherstripping where exposed to direct sunlight.

2.23.3 Fasteners

Use window manufacturer's standard for windows, trim, and accessories. Self-tapping sheet-metal screws are not acceptable for material more than 2 mm (1/16 inch) thick.

2.23.4 Adhesives

Provide joint sealants as specified in Section 07 92 00 JOINT SEALANTS. For interior application of joint sealants, comply with applicable regulations regarding reduced VOC's, and as specified in Section 07 92 00 JOINT SEALANTS.

2.23.5 Drips and Weep Holes

Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, drips must be continuous across tops of fixed windows. Provide drips and weep holes as required to return water to the outside.

2.23.6 Combination Windows

Windows used in combination must be factory assembled of the same class and grade. Where factory assembly of individual windows into larger units is limited by transportation considerations, prefabricate, match mark, transport, and field assemble.

2.23.7 Mullions and Transom Bars

[Provide mullions between multiple window units to resist two times (2X) glazing resistance in accordance with ASTM F2248 and ASTM E1300.]Provide mullions with a thermal break. Secure mullions and transom bars to adjoining construction and window units in such a manner as to permit expansion and contraction and to form a weathertight joint.[Where window cleaner anchors are required, reinforce mullions and anchor to adjoining construction so as to provide safe and adequate support.] Provide mullion covers on the interior and exterior to completely close exposed joints and recesses between window units and to present a neat appearance.[Provide special covers over structural support at mullions as indicated.]

2.23.8 Accessories

Provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation and proper operation. [Furnish extruded aluminum subframe receptors[and subsill] with each window unit.]

2.23.8.1 Hardware

AAMA/WDMA/CSA 101/I.S.2/A440. The item, type, and functional characteristics must be the manufacturer's standard for the particular window type. Provide hardware of suitable design and of sufficient strength to perform the function for which it is used. Equip all operating ventilators with a lock or latching device which can be secured from the inside.

2.23.8.2 Fasteners

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Anchors and fasteners must be compatible with the window and the adjoining construction. Provide a minimum of three anchors for each jamb located approximately 150 mm (6 inches) from each end and at midpoint.

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2.23.8.3 Window-Cleaner Anchors

NOTE: Window-cleaner anchors should be shown and specified for windows having sills more than 1800 mm (6 feet) above grade, adjoining balconies, or adjoining roofs, unless window cleaning methods at activity make use of anchors unnecessary. Coordinate window cleaning procedures and requirements with using activity. When requested by using activity, removable or tilting-type sash may be provided instead of anchors. Removable or tilting-type sash may be specified as Contractor option when these units are desired by using activity and are economically competitive with double-hung sash equipped with anchors. When appropriate, add the following at end of paragraph entitled "Window-Cleaner Anchors":

"Removable or tilting-type sash may be provided in lieu of double-hung windows equipped with window cleaner anchors. Design sash so that both sides of glass can be readily cleaned from interior without dismantling any part of window or screens. Provide removable and tilting-type sash with tamper-proof hardware to prevent sash removal by unauthorized personnel."

Provide double head anchors for windows[indicated][specified]. Anchors must be stainless steel of size and design required for the window type and application, conforming to ASTM A276/A276M. Provide two anchors for each single window[and each adjacent fixed glass window unit]. Fasten anchors 1120 mm (44 inches) above the window sill utilizing appropriate methods for the window type and application in accordance with industry safety standards.

2.23.8.4 Window Anchors

Anchoring devices for installing windows must be made of aluminum, cadmiumplated steel, stainless steel, or zinc-plated steel conforming to AAMA/WDMA/CSA 101/I.S.2/A440.

2.23.9 Finishes

Exposed aluminum surfaces must be factory finished with an[anodic coating][or][organic coating].[Color must be [____][as indicated].] All windows[for each building] must have the same finish.

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2.23.9.1 Anodic Coating

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish must be:

- [a. Architectural Class II (0.01 to 0.0175 mm (0.4 mil to 0.7 mil)), designation AA-M10-C22-[A31, clear (natural)] [A32, integral color] [A34, electrolytically deposited color] anodized.]
- [b. Architectural Class I (0.0175 mm (0.7 mil) or thicker), designation AA-M10-C22-[A41, clear (natural)] [A42, integral color] [A44, electrolytically deposited color] anodized.]

2.23.9.2 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a[baked enamel finish in accordance with AAMA 2603 with total dry film thickness not less than 0.02 mm (0.8 mil)][high-performance finish in accordance with [AAMA 2604][AAMA 2605] with total dry film thickness of not less than 0.03 mm (1.2 mils)].

2.23.10 Screens

AAMA/WDMA/CSA 101/I.S.2/A440. Provide one insect screen for each operable exterior sash or ventilator. Design screens to be rewirable, easily removable from inside the building, and to permit easy access to operating hardware.

2.34 SPECIAL OPERATORS

For windows having operating hardware or locking or latching devices located more than 1800 mm (6 feet) above the floor, provide suitably designed

operators or locking or latching devices necessary for convenient and proper window operation.

2.34.1 Pole Operators

Poles must be of proper length to permit window operation from 1500 mm (5 feet) above the floor. Provide one pole operator for each room, and one pole hanger for each pole. Locate hangers where directed.

2.34.2 Extension Crank Operators

Provide removable handles for crank-operated rotary-type operators located more than 1800 mm (6 feet) above the floor. Provide one removable handle for each room.

2.34.3 Mechanical Operators

Provide [manual] [electric motor driven] operators for group operation of continuous rows of windows [located [____] mm (feet) above the floor]. Operators must be capable of opening and closing windows without appreciable deflection, vibration or rattle. Provide means of adjustment for transmission lines. Provide operators to control window units in groups [as recommended by the window manufacturer] [or] [as indicated].

2.45 THERMAL-BARRIER WINDOWS

Provide thermal-barrier windows, complete with accessories and fittings, where indicated.

Specify material and construction except as follows:

- a. Aluminum alloy must be 6063-T6.
- b. Frame construction, including operable sash, must be factory-assembled and factory-sealed inner and outer aluminum completely separated from metal-to-metal contact. Join assembly by a continuous, concealed, low conductance divider housed in an interlocking extrusion of the inner frame. Metal fasteners, straps, or anchors must not bridge the connection between the inner and outer frame.
- c. Operating hardware for each sash must consist of spring-loaded nylon cushion blocks and pin locks designed to lock in predetermined locations.
- d. Sash must be completely separated from metal-to-metal contact by means of woven-pile weatherstripping, plastic, or elastomeric separation members.
- e. Operating and storm sash must be factory-glazed with the type of glass indicated and of the quality specified in Section 08 81 00 GLAZING.

2.56 MULLIONS

Provide mullions between multiple-window units where indicated.

Provide profiles for mullions and mullion covers, reinforced as required for the specified wind loading, and securely anchored to the adjoining construction. Mullion extrusion will include serrations or pockets to receive weatherstripping, sealant, or tape at the point of contact with each window flange.

Mullion assembly must include aluminum window clamps or brackets screwed or bolted to the mullion and the mullion cover.

Mullion cover must be screw-fastened to the mullion unless otherwise indicated.

Mullion reinforcing members must be fabricated of the materials specified in AAMA/WDMA/CSA 101/I.S.2/A440 and meet the specified design loading.

2.67 WINDOW CLEANERS' BOLTS

Provide window cleaners' bolts for all windows 2100 millimeter (7 feet) or higher above finished grade, except for windows that can be removed and cleaned from the ground or from a lower roof level without the use of an extension ladder. Provide two bolts for each single window unit and each fixed glass unit. Locate bolts 1120 millimeter (44 inches) above the window sill.

Window cleaners' bolts must be double-head type, AISI Series 300 corrosionresistant steel, size and design complying with IWCA I-14.1. Contact side of the bolts must be ground to fit flat against window jambs. Bolts must be factory- or field-attached before windows are set. Reinforce backs of frames to receive bolts with 6 by 150 millimeter (1/4 by 6-inch) corrosionresistant steel or aluminum plates bolted or welded to the frames at the factory. Special wall anchors must be provided on frames at the point of bolt attachment.

PART 3 EXECUTION

3.1 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC

Metal Casing	0.0625 inch	1.59 mm
Aluminum Tube (Diameter)	0.0625 inch	1.59 mm
	1 inch	25 mm

3.2 INSTALLATION

3.2.1 Method of Installation

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as the work progresses or install without forcing into prepared window openings. Set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Protect ventilators and operating parts against accumulation of dirt and building materials by keeping ventilators tightly closed and locked to frame. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install and caulk windows in a manner that will prevent entrance of water and wind. Fasten insect screens securely in place.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.2.2 Dissimilar Materials

Where aluminum surfaces are in contact with, or fastened to masonry, concrete, wood, or dissimilar metals, except stainless steel or zinc, protect the aluminum surface from dissimilar materials as recommended in the Appendix to AAMA/WDMA/CSA 101/I.S.2/A440. Do not coat surfaces in contact with sealants after installation with any type of protective material.

3.2.3 Anchors and Fastenings

Make provision for securing units to each other, to masonry, and to other adjoining construction. Windows installed in masonry walls must have head and jamb members designed to recess into masonry wall not less than 11 mm (7/16 inch).

3.2.4 Adjustments After Installation

After installation of windows and completion of glazing and field painting, adjust all ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts as necessary. [Adjust double hung windows to operate with maximum applied force of 25 pounds in either direction, not including breakaway friction force.] Verify that products are properly installed, connected, and adjusted.

3.3 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weather-stripping, and to prevent interference with the operation of hardware. Replace all stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

-- End of Section --

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2017

SECTION 08 51 23

STEEL WINDOWS 08/11

requirements for standard steel windows.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a <u>Criteria Change Request (CCR)</u>.

1. Sizes and types of windows; metal sub-frames, casings, or stools, if any; and hardware

2. Sizes, location and swing of ventilators; location and details of fixed sash

3. Method of anchoring windows to adjoining construction; size and types of clips, anchors, screws, or other fasteners

4. Details of non-structural mullions and mullion covers; details for anchoring and reinforcing nonstructural mullions at windows to receive window cleaners' anchors 5. Locations of special glass such as tempered, insulating, heat-absorbing, light-reducing, bulletresisting, wire, figured, plate, and spandrel glass.
6. Locations of insect screens and storm windows, if any
7. Locations of fire-rated windows, if required
8. Number and location of window cleaners' anchors
9. Number and location of extension crank operators
10. If motorized operators are required, show on electrical drawings and specify in Division 16.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B18.6.3

(2013) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A1011/A1011M

(2017) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-

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Alloy with Improved Formability, and Ultra-High Strength

- ASTM A123/A123M (2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM A653/A653M (2015; E 2016) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- ASTM D3656/D3656M (2013) Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
- ASTM E283 (2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
- ASTM E330/E330M (2014) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- ASTM E331 (2000; R 2016) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

- NFRC 100 (2014) Procedure for Determining Fenestration Product U-Factors
- NFRC 200 (2014) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2015;	ERTA 2016)	Life	Safety	Coc	le
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NFPA 80 (2016; TIA 16-1) Standard for Fire Doors and Other Opening Protectives

STEEL WINDOW INSTITUTE (SWI)

SWI SWS (2005) Steel Window Specifications

1.2 SUBMITTALS

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" classification only in SD-11 Closeout

Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows

Indicate elevations of windows, full-size sections, thicknesses and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, [mullion details,] [method and materials for weatherstripping,] [method of attachment of screens,] [metal subframes,] [stools,] [casings,] [sills,] [trim,] [window cleaners' bolts,] other related items, and installation details.

SD-03 Product Data

Steel Framing Materials

Recycled Content for Steel Framing Materials; S

Mullions

Hardware

Hardware Materials

Fasteners

Accessories

Operators

Screens

SD-04 Samples

Color Coating; G[, []]

Submit chart of manufacturer's color coatings if factory finish is to be provided in lieu of field painting.

Windows

Submit one complete, full size glazed window of each type proposed for use, complete with hardware, anchors, and other accessories. [Where screens or weatherstripping are required, fit sample windows with such items that are to be used.] After approval, install each sample in the work, clearly identified, with location recorded.

SD-06 Test Reports

Air Infiltration

Water Infiltration

Mullion and Transom Bar Wind Load

SD-10 Operation and Maintenance Data

Windows, Data Package 1; G[, []]

Submit in accordance with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Recycled Content for Steel Framing Materials; S

1.3 TEST REPORT REQUIREMENTS

1.3.1 Air and Water Infiltration

ASTM E283 and ASTM E331. Do not exceed maximum air infiltration of 0.05 cubic meter per minute per meter (one-half cubic foot per minute per foot)

of crack length when subjected to a static pressure of 75 Pa (1.56 pounds per square foot) (equivalent to a wind velocity of 40 kilometers per hour (kph) (25 miles per hour (mph))). Water infiltration must be "zero."

1.3.2 Mullion and Transom Bar Wind Load Tests

NOTE: Delete when not applicable.

ASTM E330/E330M. Members must withstand a uniform wind load of 958 Pa (20 pounds per square foot) of window area without deflecting more than 1/175 of the span.

1.4 DELIVERY AND STORAGE

Deliver to project site in undamaged condition. Store windows and components on edge, out of contact with the ground, under weathertight covering, and arranged to avoid bending, warping, or other damage.

PART 2 PRODUCTS

NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements. Use of materials with recycled content, contributes to the requirements of UFC 1-200-02, High Performance and Sustainable Building Requirements. Coordinate with Section 01 33 29 SUSTAINABILITY REPORTING. Designer must verify suitability, availability and adequate competition before specifying product recycled content requirements.

Steel window framing typically contains up to 100 percent recycled material coming from recycled steel billets. Therefore, extensive research into recycled material for fasteners and hardware may not be required to meet recycled material criteria.

NOTE: Window properties are critical to energy performance and visual satisfaction. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain. Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the componenets of building envelope design including fenestrations and glazing.

Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting bracketed energy performance requirements before specifying and edit as needed.

2.1 PRODUCT SUSTAINABILITY CRITERIA

2.1.1 Recycled Content for Steel Framing Materials

Provide steel framing materials meeting the recycled content requirements as stated within this section and provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph RECYCLED CONTENT.

2.12 MATERIALS

2.12.1 General System Requirements

{Steel framing materials must contain a minimum of {5}[10][____] percent post-consumer recycled content, or a minimum of [20][40][____] percent post-industrial_total recycled content. Provide data identifying percentage of recycled content for steel framing materials.]{See Section 01 33 29 SUSTAINABILITY REPORTING for cumulative total recycled content requirements. Metal materials may contain post-consumer or post-industrial recycled content.]

[Non-residential glazed systems (including frames and glass) must be certified by the National Fenestration Rating Council with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [____] determined according to NFRC 200 procedures and a U-factor maximum of [___] W per square m by K (Btu per square foot by hr by degree F) in accordance with NFRC 100.]

2.12.2 Steel Bars

SWI SWS.

2.12.3 Sheet Steel

ASTM A1011/A1011M.

2.12.4 Zinc-Coated Sheet Steel

ASTM A653/A653M.

2.12.5 Zinc Coating

ASTM A123/A123M.

2.12.6 Screws and Bolts

ASME B18.6.3 as applicable.

2.23 FABRICATION OF WINDOWS

Form permanent joints by welding or mechanically fastening as specified for each type window. Use joints of strength to maintain structural value of members connected. Weld joints solid, remove excess metal, and dress smooth on exposed and contact surfaces. Closely fit joints formed with mechanical fastenings and make permanently watertight. Assemble frames and sash, including ventilators and thermal breaks, at the plant and ship as a unit with hardware unattached. Provide the following construction:

- a. Where fixed window sections adjoin ventilator sections, provide fixed sash, fabricated from similar frame members, and of manufacturer's standard type suitable for the purpose.
- b. Roll weathering surfaces integrally to provide two-point parallelsurface contact with overlap at both inside and outside points of closure.
- c. Provide drips and weep holes as required to return water to outside.
- d. Design glazed windows and rabbets suitable for glass thickness shown on drawings [or specified].
- e. Use flathead, cross recessed type, exposed head screws and bolts with standard threads on windows, trim and accessories. Screw heads must finish flush with adjoining surfaces. Self tapping sheet-metal screws are not acceptable.
- f. For hot-dipped galvanized windows, use stainless steel or hot-spun galvanized steel fasteners. For windows with painted finish use cadmium plated or electro-galvanized fasteners. Finish exposed heads to match finish of windows.

2.34 FIRE RATED WINDOWS

Provide sash and frame with necessary hardware to conform to the requirements of Underwriters Laboratories Inc. (UL), for class of window indicated. Submit proof of conformance. UL label will be accepted as proof. Labeled window details take precedence over details indicated or specified for nonlabeled windows, except when sections required for nonlabeled windows are heavier than those required by UL. In lieu of UL label, written certification by approved nationally recognized testing agency may be submitted. Certification must state that complete window unit of type provided has been tested and conforms to published standards, including methods of tests, of UL.

2.45 PROVISIONS FOR GLAZING

NOTE: Exterior frames, mullions, and window hardware must be designed to resist equivalent static design loads in accordance with ASTM F1642/F1642M. Frame and mullion deflection must not exceed L/160 of the unsupported member lengths. The Contractor must demonstrate by calculations or dynamic tests in accordance with ASTM F1642/F1642M that the window complies with the loading requirement. Equivalent static design loads for connections of window to the surrounding walls or hardware and associated connections, and glazing stop connections must be in accordance with ASTM F2248 and ASTM E1300.

NOTE: Inside glazing is preferred, especially for windows above first floor and other locations where access is difficult. Windows designed for inside glazing may not be available in double-hung type. Check manufacturers' literature. Where project requires insulated glass, specify sash members, glazing beads, and hardware of sufficient size and weight to receive and support glass of thickness shown. Allow 3 mm (1/8 inch) minimum between each side of insulating glass and metal frame for glazing compound and expansion. Also allow 3 mm (1/8 inch) between edges of glass and frame. Drawings should indicate method for securing insulating glass.

Design sash for [inside] [outside] glazing and for securing glass with [metal beads] [glazing clips] and glazing compound. [Where insulating glass is indicated, use rabbets of adequate weight and depth to receive and properly support glass and glazing accessories.]

2.56 MULLIONS AND TRANSOM BARS

Provide mullions between multiple window units designed to withstand specified wind load requirements. [Provide mullions with a thermal break.] Secure mullions and transom bars to adjoining construction and window units in such a manner as to permit expansion and contraction and to form weathertight joint. [Anchor mullions between windows requiring window cleaner's bolts to provide safe and adequate support for window cleaner. Where window cleaners' bolts are fastened to mullions, reinforce backs of mullions.] Provide mullion covers of manufacturer's stock design on the interior and exterior to completely cover exposed joints and recesses

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between window units and for neat appearance. [Provide special covers over structural supports at mullions as indicated.]

2.67 METAL-TO-METAL JOINTS

Set in mastic, using type recommended by window manufacturer to provide weathertight joints. Remove excess mastic before it hardens.

2.78 ACCESSORIES

Provide windows with hardware, clips, fins, anchors, glazing beads, and fastenings, necessary for complete installation and operation of ventilators.

2.78.1 Anchors

Use hot-dip galvanized steel anchors. Secure anchors and fastenings to heads, jambs, and sills of openings, and fasten securely to windows or frames. Use anchors recommended by window manufacturer for specific type of construction and conceal. Anchor each frame at jambs with minimum of three adjustable steel anchors. [Provide perforated anchor stems for mortar keying with anchor flanges of sufficient width to provide sliding friction fit inside frames. Extend perforated stems not less than 100 mm (4 inches) into masonry.] [For anchorage at concrete walls and prepared openings, equip frames with manufacturer's standard bent-clips located approximately 150 mm (6 inches) from each end and at midpoint.]

2.78.2 Window-Cleaners' Anchors

NOTE: Where sills are more than 2 meters (6 feet) above grade, adjoining balconies, or adjoining roofs, specify window-cleaners' anchors unless window cleaning methods at installation make use of anchors unnecessary. Coordinate requirements with the user.

Provide on window frames [at indicated locations] [for [___]]. Use double-head stainless steel anchors, two for each single window [and each adjacent fixed glass window unit.] Locate 1120 mm (44 inches) above window sill. Apply to frames at factory or ship loose for field attachment to frames before windows are set. Reinforce backs of frames to receive bolts with 6 mm (0.25 inch) thick by 150 mm (6 inch) long steel plates welded or fastened securely to frames at factory. Provide special wall anchors on backs of frames at points where bolts are located.

2.78.3 Weatherstripping

Provide on all operable windows so that, when tested before leaving factory, in accordance with ASTM E283, do not exceed a maximum air infiltration of 0.05 cubic meter per minute per meter (one half cubic foot per minute per foot) of crack length when subjected to static pressure of 75 Pa (1.56 pounds per square foot) equivalent to wind velocity of 40 kmh (25 mph).

2.78.4 Hardware

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Equip all operable sash with latching device which can be secured from inside. The item, type, and function of hardware required is specified under individual window type. Attach hardware securely to windows with corrosion resisting bolts or machine screws; do not use sheet metal screws. At fixed screens, adapt hardware to permit operation of ventilators. Fit and test hardware for each window at factory to ensure satisfactory operation and security.

2.78.4.1 Hardware Materials and Finish

Provide non-magnetic type stainless steel exposed hardware with satin finish; white bronze with satin finish; yellow bronze with dull (oxidized) finish. Use steel or malleable iron hinges, with nonferrous pins, or with steel pins and non-ferrous bushings or washers.

2.78.5 Fasteners

NOTE: Designer must verify that products meeting the indicated minimum recycled content are available, preferably from at least three sources, to ensure adequate competition. If not, write in suitable recycled content values that reflect availability and competition.

Steel window framing typically contains up to 100 percent recycled material coming from recycled steel billets. Therefore, extensive research into recycled material for fasteners and hardware may not be required to meet recycled material criteria.

Fabricated from 100 percent re-melted steel. [Stainless steel or aluminum materials[; zinc-coated or cadmium plated steel elsewhere as shown on Drawing Sheet No. [____.]] Prime exposed heads of coated or plated fasteners and finish to match adjacent material.

2.78.6 Metal Sub-frames and Stools

Manufacturer's standard type designed to suit the particular window. Match exposed surfaces to windows.

2.89 WINDOW FINISH

finish only for hot-rolled solid-section windows in areas where corrosion is prevalent. Optional factory applied color coat is acceptable for all locations. Include field coats under Section 09 90 00 PAINTS AND COATINGS.

2.89.1 Shop Primed Finish

After fabrication, clean all surfaces of windows, fins, mullions, cover plates, and screen frames and provide [a phosphate-treated and shop-primed finish] [a hot-dip galvanized, phosphate-treated and shop primed finish]. Conform to SWI SWS for the methods of cleaning, chemical treatment, galvanizing, and painting.

2.89.2 Factory Finish

In lieu of shop primed finish, factory finish may be provided using the following method, in which case finish field painting will not be required:

- a. Chemically clean and bonderize windows. Apply dip coat of epoxy primer baked on for not less than 15 minutes at not less than 149 degrees C (300 degrees F), followed by finish coat of alkyd-amine enamel of not less than 0.025 mm (one mil) thickness, baked on for 15 minutes at not less than 149 degrees C (300 degrees F).
- b. Finish color coating to be selected from manufacturer's standard color chart.
- c. Touch up abraded surfaces with enamel as specified for factory finish.

2.910 WINDOW TYPES

Conform to SWI SWS. Provide combinations, types and sizes indicated. Each window must consist of a unit including [subframe,] [frame,] sash, hardware, [mullions,] trim, [casing,] [insect screen,] [storm units,] and anchors. Design windows indicated to have screen [or storm units] to accommodate items to be furnished.

2.910.1 Awning Windows

Provide compression-type weatherstripping. Heavy Intermediate materials in group of top-hinged or projected out-swinging ventilators:

2.910.1.1 Operators

NOTE: Specify push-bar operators in lieu of rotary hand crank operation wherever feasible. Experience indicates that rotary hand cranks require excessive maintenance and, in most cases, will not withstand continued hard usage. In the event push-bar

operation is not feasible, specify removable crankhandles. Remote and group operation of windows may require rotary crankhandle operation. See paragraph SPECIAL OPERATORS.

[Control must be simultaneous by means of cam-type lever handle fastener for hand push-pull operation. For windows with screens, provide with underscreen push bar operators. For operators more than 2 meters (6 feet) above floor, provide with hardware designed for pole operation.]

[Provide simultaneous control by means of a rotary mechanical power unit manually operated by bronze [removable] crankhandle, providing positive adjustment and holding of vents in any position from fully open to fully closed. Operator must securely close ventilators on both sides of window without additional locking devices. Heavy-duty worm-gear rotary operator with machine-cut case-hardened steel gears in steel housing with smooth lacquer finish.]

2.910.1.2 Ventilators

Support on two hinges and two arms, or on two steel slide arms pivoted to vent and to principal frame member. Provide bronze-brushed pivots and hinges with bronze pins. Design ventilators to close and weather on each other, or on independent meeting rails assembled as part of window frame. Provide for positive adjustment of individual vents to ensure positive contact between sash and frame when closed.

2.910.2 Casement Windows

[Standard Intermediate] [Heavy Intermediate] [Heavy Custom]. Provide continuous drip molds immediately above ventilators. Where fixed sections adjoin ventilators, provide drips continuous across top of fixed sections. Provide each side hinged ventilator with one pair of non-friction extension hinges, one sash operator, and one locking handle. Provide sash over 1680 mm (66 inches) high with three hinges. Provide hinges with strength necessary to permanently support glazed ventilator without twist or sag. Provide compression-type weatherstripping.

2.910.2.1 Sash Operators

Use [sliding underscreen] [crank-operated rotary] sash operators. Design operators to hold ventilators firmly in position at any angle up to 90 degrees. [Use friction or thumb-screw sliding operators.] Use heavy-duty worm-gear rotary operators, with machine-cut, case hardened steel gears. Provide pivoted lever type locking handles, engaging beveled strike plate or keeper. For ventilators exceeding 1680 mm (66 inches) in height, provide two-point locking device, operated by rods from single lever handle. Conceal rods where design of sash section will permit.

2.910.2.2 Hopper or Sill Type Ventilators

For hopper or sill type ventilators occurring under casement or fixed sash, provide cam-acting locking handle. For hinged type, provide one pair of hinges and two concealed friction stay arms; for projected type, use two friction shoes with nonfriction stay arms to hold ventilator in any

position, up to 45 degrees. For hopper vents over 1220 mm (48 inches) wide, use two locking handles.

2.910.2.3 Transom Ventilators

When transom ventilators occur above casement or fixed sash, hang on two stay arms sliding in friction shoes. Provide ventilators with hardware designed for pole operation.

2.910.3 Continuous Windows

Continuous type with [manual] [motorized] mechanical operation.

2.910.4 Fixed Windows

[Standard Intermediate] [Heavy Intermediate] [Heavy Custom] windows.

2.910.5 Horizontally Pivoted Windows

[Standard Intermediate] [Heavy Intermediate] [Heavy Custom]. Make pivots integral with jamb weathering bars to ensure permanent alignment. Hold ventilator in place at pivots with solid bronze, replaceable shouldered pivots, washer and nuts.

2.910.5.1 Operators

Equip ventilators with chain roller guide, chain and chain stay located at convenient distance from floor. Attach chain to spring-latch at ventilator head, looping down and back up through roller-guide in spring-catch. Secure end to keeper on frame. Unscreened ventilators readily accessible from floor may have steel stay adjusters.

2.910.6 Projected Windows

[Standard Intermediate] [Heavy Intermediate] [Heavy Custom].

2.910.6.1 Operators

Equip ventilators under 1220 mm (48 inches) wide with one cam-type lever handle fastener; equip ventilators 1220 mm (48 inches) wide and over, and not pole operated, with two fasteners. Where fixed screens occur at projected-out ventilators, provide underscreen push bar operators. Provide ventilators with locking rails more than 2 meters (6 feet) above the floor with hardware designed for pole operation.

2.910.7 Security Windows

NOTE: Use steel for security windows; aluminum windows are not acceptable. Steel security windows may occur in conjunction with aluminum windows, in which case, a finish matching that of the aluminum windows should be specified. Security steel windows are designed and constructed to give protection against unauthorized entrance and removal of materials from warehouses and other storage type areas; they are not designed for detention use. The stock ventilators are bottom hung to project-in with the grill frame on outside of ventilator. Guard windows for detention use are not included in this guide; where such windows are desired, consult SWI SWS, and modify this guide section accordingly.

SWI SWS. Provide ventilators with manufacturer's standard hardware of iron, steel or zinc. Equip ventilators having locking rails more than 2 meters (6 feet) above floor with hardware designed for pole operation.

2.1011 SCREENS

Provide one insect screen for each operable exterior sash or ventilator. Locate screen units either inside or outside, depending upon window type and method of operation. Provide [full-length top-hung] [double vertical sliding] [half-length sliding] [half-length fixed] type screens. Design screens to fit closely around entire perimeter of ventilator or opening, to be rewirable, easily removable from inside building, and interchangeable for same size ventilators of similar type windows, with minimum of exposed fasteners and latches. Provide all guides, stops, clips, bolts, and screws, as necessary, for a secure and insect-tight attachment to window. Where wickets are necessary, use sliding or hinged type, with friction catches, framed and trimmed for durability and tight fit. Provide wicket opening frames of similar material and cross-section as screen frames. Provide continuous framing bar between the two sides of screen frames.

2.1011.1 Construction

Provide screen frames of steel with finish matching that of windows. Equip frames with removable splines of steel or vinyl. Form groove in frame for holding screen cloth in place with noncylindrical splines. Make spline and groove assembly so that cloth cannot be removed from groove by pressure on cloth. Make splines of such size and shape that rotation of spline in groove will be prevented and spline will tightly hold cloth in place.

2.1011.2 Insect Screening

ASTM D3656/D3656M, Class 2, 18 by 14 mesh, color [charcoal] [gray] [____]. Install with weave parallel to frames. Stretch tight for smooth appearance. Conceal edges in spline channels.

2.1112 SPECIAL OPERATORS

2.1112.1 Pole Operators

Provide for windows having operating hardware or locking rails more than 2 meters (6 feet) above floor. Provide window manufacturer's standard pole

design of length to provide operation from 1.67 meters (5 feet) above floor, and with push-pull hooks of proper shape and length. Provide one pole operator for each room, and one pole hanger for each pole in location as directed.

2.1112.2 Extension Crank Operators

Provide removable handles for crank operated rotary operators located more than 2 meters (6 feet) above floor. Provide one removable handle for each room.

2.1112.3 Mechanical Operators

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Provide [manual] [motorized] operators for group operation of continuous rows of windows, and for windows located at unusual heights, where other types of remote operation are not feasible. Provide operators that open and close windows without appreciable deflection, vibration or rattle. Provide transmission lines equipped with means of adjustment. Control window units in groups with operators as recommended by window manufacturer for the particular window arrangement shown, unless specifically indicated otherwise. Use mechanical operators of one of the following types:

- a. On-Sill Operators: Centrally located, manually controlled mechanisms for adjusting ventilators, assembled of bronze telescoping shafts with machine cut threads. Conceal, except for linkage members, by appropriate covers. Provide one operator, secured to sill, for each window. Finish operators exposed to view to match hardware finish. Finish covers to match window casings.
- b. Geared Lever-Arm Operator: Provide power unit with machine-cut gears and machined thrust bearings housed in dustproof oil-tight case, with provision for lubrication. Provide torsion shaft of standard black iron pipe not less than 25 mm (one inch)inside diameter. Rigidly clamp steel or malleable iron operating arms to shaft and connect to ventilator by push bar and hinge bracket. Support operating mechanism on brackets securely attached to building structure or mullions. No single line is allowed to extend more than 9 meters (30 feet) from either or both sides of power unit.
- c. Geared Rack-and-Pinion Operator: Provide power unit with machine-cut gears and machined thrust bearings housed in dustproof oil-tight case, with provision for lubrication. Provide torsion shaft of standard black iron pipe not less than 25 mm (one inch)inside diameter. Cut steel rack to a pitch that will mesh accurately with the cut teeth on a steel or cast iron pinion. Fasten pinion securely to torsion shaft. Provide steel rack with a hinged bracket for attaching to ventilator. Hold rack in mesh with pinion by steel yoke with bearing rollers of solid brass or cadmium plated steel. Support operating mechanism on steel brackets securely attached to building structure or mullions. No

single line is allowed to extend more than 15 meters (50 feet) from either or both sides of power unit.

2.1112.3.1 Operating Arms and Racks

Provide each ventilator not more than 900 mm (36 inches) wide with single operating arm or rack attached at center of rail. Provide each ventilator more than 900 mm (36 inches) wide with two operating arms or racks attached to side rails or near ends of horizontal rail of ventilator.

2.1112.3.2 Chain Control

Provide power unit with hand chain, operating over chain wheel with chain guard. Drill and secure wheel to worm shaft by key. Terminate chain approximately 600 mm (2 feet) above floor. Where building construction makes it impracticable to hang chain vertically from power unit, furnish single or double chain idlers to convey chain to point shown or directed.

2.1112.3.3 Steel Shaft Control

Provide power unit with vertical standard black iron pipe of not less than 19 mm (0.75 inch) inside diameter or solid steel shaft with malleable iron or steel coupling. Support vertical shaft with brackets spaced not over 2 meters (6 feet) apart. Where hand operating wheel is indicated 1.5 meters (4 feet 6 inches) above floor, place wheel in vertical position. Where hand operating wheel is indicated 2 meters (6 feet 6 inches) above floor, place wheel in horizontal position. Secure wheel in place permanently. Furnish universal joints or beveled gears to locate control at point shown or as directed on nearest wall or column. Where practicable, mount vertical shafts on walls instead of pilasters.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with window manufacturer's printed instructions and details. Coordinate installation with commissioning as specified in Section [___]. [Install fire rated windows in accordance with NFPA 80 and NFPA 101.] Build in windows as work progresses or install without forcing into prepared window openings. Set at proper elevation, location, and reveal; plumb, square, level, and in alignment. Brace and stay to prevent distortion and misalignment. Protect ventilators and operating parts against dirt and building materials by keeping closed and locked to frame. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant recommended by

window manufacturer. Install and seal windows in a manner that will prevent entrance of water and wind. [Fasten insect screens securely in place.]

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.2 ANCHORS AND FASTENINGS

Make provision for securing units to each other and to adjoining construction. Design head and jamb members to enter into masonry not less than 11 mm (7/16 inch) where windows are installed in direct contact with masonry. Where windows are set in prepared masonry openings, build in anchors and fastenings to jambs of openings and fasten securely to windows or frames and to adjoining construction. Space anchors not more than 450 mm (18 inches) apart on jambs and sills, and install a minimum of three anchors on each side of each opening. Anchors and fastenings must have sufficient strength to hold member firmly in position. Where type, size, or spacing of anchors is not shown or specified, use expansion or toggle bolts or screws as best suited to construction material. Provide expansion shield and bolt assemblies of type designed to give holding power beyond tensile and shearing strength of bolt. Minimum fastener penetration must be not less than that recommended by manufacturer for type fastener and wall material involved.

3.3 OPERATORS

Install operators before glazing. Plumb and level shaft risers and runs. Adjust ventilators for free opening and tight closing. Secure housings and adjustable supports to wall. Anchor operator parts to steel window mullions with 13 mm (1/2 inch) bolts. Couple individual lengths of shafting with steel rivets or bolts. Leave mechanical equipment and ventilators in proper operating condition.

3.4 WEATHERSTRIPPING

Use bronze, spring-brass, or stainless steel and secure with non-ferrous screws. Secure weatherstripping or rubbing-blocks to parting-strip and each end of meeting-rails. For solid bar stock windows, use manufacturer's standard weatherstripping inserted into groove.

3.5 ADJUSTMENTS AFTER INSTALLATION

After installation of windows and completion of glazing and field painting, adjust all ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts. Adjust weatherstripping to assure weathertight contact with frames when ventilators are closed and locked. Weatherstripping must not cause binding of sash, or prevent closing and locking of ventilator. Verify products are properly installed, connected, and adjusted.

3.6 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance and to prevent fouling of weathering surfaces and weatherstripping, or interference with operation of hardware. Clean and touch up abraded surfaces. Replace with new windows any stained, discolored, or abraded windows that cannot be restored to original condition.

-- End of Section --

Change 2 - 05/16 ------Superseding UFGS-08 52 00 (July 2006)

Preparing Activity: NAVFAC

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2017

SECTION 08 52 00

WOOD WINDOWS 08/11

NOTE: This guide specification covers the requirements for wood windows of the following types: single-hung, double-hung, awning, casement, horizontal sliding, and non-operative (stationary window unit).

Adhere to <u>UFC 1-300-02</u> Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a <u>Criteria Change Request (CCR)</u>.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

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place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designati	on System
	for Aluminum Finishes	

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

- AAMA 2603 (2015) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
- AAMA 2604 (2013) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
- AAMA/WDMA/CSA 101/I.S.2/A440 (2011; Update 1 2014) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

ASTM INTERNATIONAL (ASTM)

ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D3656/D3656M	(2013) Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM D6007	(2014) Standard Test Method for Determining Formaldehyde Concentration in Air from Wood Products Using a Small Scale Chamber
ASTM D6330	(1998; R 2014) Standard Practice for Determination of Volatile Organic Compounds (Excluding Formaldehyde) Emissions from Wood- Based Panels Using Small Environmental Chambers Under Defined Test Conditions

ASTM E1333 (2014) Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber NATIONAL FENESTRATION RATING COUNCIL (NFRC) NFRC 100 (2014) Procedure for Determining Fenestration Product U-Factors NFRC 200 (2014) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence SCREEN MANUFACTURERS ASSOCIATION (SMA) SMA 1004 (1987; R 1998) Aluminum Tubular Frame Screens for Windows U.S. DEPARTMENT OF ENERGY (DOE) Energy Star (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP) WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA) WDMA I.S.4 (2013) Preservative Treatment for Millwork SUBMITTALS 1.2 NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

> For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" classification only in SD-11 Closeout

Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wood Windows; G[, [___]]

Indicate elevations of units, full-size sections, fastenings, methods of installation and anchorage, method of glazing, locations of operating hardware, mullion details, method and material for weatherstripping, [bar and muntin layouts,] method of attaching [insect screens] [storm windows], details of installation, and connections with other work.

SD-03 Product Data

Wood Windows; G[, []]

[Energy Star label for Residential Windows; S

][Engineered Wood Products

Submit documentation verifying that no urea-formaldehyde resins were used.

]Fasteners

[Adhesives

]SD-08 Manufacturer's Instructions

Wood Windows

Submit manufacturer's written instructions for installation.

SD-10 Operation and Maintenance Data

Wood Windows, Data Package 1; G[, []]

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Submit data package in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Plastic Identification

When not labeled, identify types in Operation and Maintenance Manual.

SD-11 Closeout Submittals

Reduced VOC's for Window Materials; S

[Energy Efficient Equipment for Residential Windows; S

]1.3 DELIVERY AND STORAGE

Deliver windows to site in sealed undamaged cartons or in palletized multiple units. Protect from damage, dampness and extreme temperature or humidity changes. Store under cover in well-ventilated enclosed space. Do not store in a building under construction until concrete, masonry, and plaster are dry. Replace defective or damaged windows.

1.4 MATERIAL IDENTIFICATION REQUIREMENTS

1.4.1 Plastic Identification

Label plastic products provided to indicate their polymeric composition according to the following list. Where products are not labeled, provide product data indicating polymeric information in Operation and Maintenance Manual. Type 1: Polyethylene Terephthalate (PET, PETE). Type 2: High Density Polyethylene (HDPE). Type 3: Vinyl (Polyvinyl Chloride or PVC). Type 4: Low Density Polyethylene (LDPE). Type 5: Polypropylene (PP). Type 6: Polystyrene (PS).

Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

PART 2 PRODUCTS

2.1 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

2.1.1 Reduced VOC's for Window Materials

Products must not contain added urea formaldehyde and must meet other reduced VOC requirements as stated within this section. Provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph REDUCE VOLATILE ORGANIC COMPOUNDS.

[2.1.2 Energy Efficient Equipment for Residential Windows

Provide Energy Star residential windows in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph ENERGY EFFICIENT EQUIPMENT.

-2.12 MATERIALS

NOTE: Wood is a renewable resource. Non-sustainable harvesting of wood can produce soil erosion, pollutant runoff, increased levels of atmospheric carbon dioxide, global warming, and habitat loss. Supplies of clear grades and large-dimension timbers are limited. Specify lower grades and engineered wood products for large-dimension timbers when appropriate.

2.12.1 Virgin Lumber

NOTE: Old growth timber comes from trees over 200 years old. In industry, it is high quality lumber in "upper" or "architectural" grades. Lumber suppliers should know which timber is old growth and which is not, but sources are not always tracked.

Lumber fabricated from old growth timber is not permitted. Avoid companies who buy, sell, or use old growth timber in their operations, when possible.

2.12.2 Engineered Wood Products

NOTE: Engineered wood products include plywood, OSB, composite wood panels, fiberboard, particleboard, glue-laminated beams, structural composite lumber, including laminated veneer lumber and parallel strand lumber, as well as I-joists and metal plate connected wood trusses. The use of engineered wood products can result in higher resource efficiencies than conventional lumber/timber construction. Waste is

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<pre>minimized due to uniformity of product. Spans and/or spacing may be increased for engineered joists over spans for same depth dimensional lumber. However, adhesive binders used in engineered wood products are any of several synthetic resins that pose varying degrees of human health risks. Engineered wood products might be more difficult to recycle than standard, solid sawn lumber due to the binders used in manufacturing.</pre>
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***************************************
NOTE: Choose one of the formaldehyde options. If
products are known to contain no added formaldehyde,
testing for formaldehyde concentration is not
<del>required. Formaldehyde can be harmful (as an</del>
allergen or carcinogen) at any level of concentration
above zero. At concentrations of about 40 ppb
(cumulative for the indoor air space), formaldehyde
can cause eye, nose, and lung irritations.
***************************************
***************************************
NOTE: Using formaldehyde-free interior wood window
products contributes to the requirements of Section
01 33 29 SUSTAINABILITY REPORTING. Army projects
shall specify formaldehyde free requirements only for
wood windows that are not part of the building
weatherproofing system.
***************************************

[Products cannot contain added urea-formaldehyde. [Determine formaldehyde concentrations in air from engineered wood products under test conditions of temperature and relative humidity in accordance with ASTM D6007 or ASTM E1333. Products must not be used if formaldehyde concentration is found to be greater than [0][____]. ]Determine Volatile Organic Compounds (VOCs), excluding formaldehyde, emitted from manufactured wood-based panels in accordance with ASTM D6330. Products must not be used if VOC emissions exceed [___].]

#### 2.2<del>3</del> WOOD WINDOWS

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NOTE: Show locations where storm units are to be installed. Do not provide storm units for windows in equipment rooms, laundry rooms and similar spaces. Storm windows are not required over double-glazed insulating type windows.

Specify window screens in medical facilities, food preparation areas, dining areas, sleeping areas, and

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similar locations. Show screen locations on drawings. NOTE: Window properties are critical to energy performance and visual satisfaction. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain. Energy Star labeling is applicable to residential units only. For non-residential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy efficiency and meeting minimum building envelope insulation requirements of UFC 3-101-01 including fenestrations and glazing. Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting

bracketed energy performance requirements before

specifying and edit as needed.

Wood windows must consist of complete units including sash, glass, frame, weatherstripping, [insect screen,] and hardware. Window units must meet the Grade 40 requirements of AAMA/WDMA/CSA 101/I.S.2/A440, except maximum air infiltration must not exceed 0.00016 cu m per second (0.34 CFM per linear foot) of sash crack when tested under uniform static air pressure difference of 75 pascals (1.57 psf). [Residential glazed systems (including frames and glass) must be Energy Star qualified labeled products as appropriate to for the [Northern] [North+-Central] [South-Central] [Southern] climate zone. Provide proof of Energy Star label for residential windows.][ Nonresidential glazed systems (including frames and glass) must be certified by the National Fenestration Rating Council with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [____] determined according to NFRC 200 procedures and a U-factor maximum of [ ] W per square m by K (Btu per square foot by ht by degree F) in accordance with NFRC 100. ]In addition to general hardware requirements of AAMA/WDMA/CSA 101/I.S.2/A440, provide hardware for various window types as indicated below. Glass and glazing materials must conform to Section 08 81 00 GLAZING. For good sash insulation performance, preference must be given to engineered wood core clad in wood veneer or PVC-wood composite (uninsulated), using postindustrial wood fiber and 100 percent post-consumer HDPE plastic. [Storm windows must conform to Section 08 51 69.10 ALUMINUM STORM WINDOWS]. [Wood members which will receive transparent finish must be in one piece, not finger-jointed.]

2.23.1 Single-Hung and Double-Hung Windows

Section 08 52 00 Page 8

# 

Provide with one sash fastener and two sash lifts, except provide one sash lift when window is fitted with a balance that counterbalances weight of sash.

2.23.2 Awning Windows (Top Hinged)

Awning window ventilators in same bay must operate [separately] [in unison]. Provide two or more hinges, pivots, or sash-supporting arms for each operative sash to allow easy operation, substantial support and cleaning of both sides of sash from inside. Provide latches for securing each sash if operating devices do not include locking features. Provide operating devices for controlling position of sash, including full open, tight close, and intermediate firm hold. Provide operating devices with rotary operators of worm-gear type with wear-resistant and impact-resistant gears or lever operators of lever handle, off-set arm type. Provide venting sash with corrosion resistant steel hinges connected to top and bottom rails of sash. When lever operators are used, operating arms must be adjustable so that even sash edge contact can be maintained. Provide compression-type weatherstripping.

### 2.23.3 Casement Windows

Provide two or more hinges, pivots, or sash-supporting arms for each operative sash to allow easy operation, substantial support and cleaning of both sides of sash from inside. Provide latches for securing each sash if operating devices do not include locking features. Provide operating devices for controlling the position of the operative sash, including full open, tight close, and intermediate firm hold. Operating devices must include rotary gears and adjustable operating arms so that even sash contact can be maintained. Provide compression-type weatherstripping.

2.23.4 Horizontal-Sliding Windows

Provide latches, pulls, and corrosion resistant steel slides necessary to control and secure window. Provide for cleaning of both sides of sash from inside.

2.23.5 Stationary Windows

Provide fixed sash and basic frame in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.

- 2.34 ACCESSORIES
- 2.34.1 Adhesives
Comply with applicable regulations regarding toxic and hazardous materials, andProvide sealants as specified in Section 07 92 00 JOINT SEALANTS. For interior application of joint sealants comply with applicable regulations regarding reduced VOC's as specified in Section 07 92 00 JOINT SEALANTS and Section 01 33 29 SUSTAINABILITY REPORTING.

#### 2.34.2 Fasteners

Provide fastener types as standard with the window manufacturer for windows, trim, and accessories.

#### 2.4<del>5</del> FINISHES

# 

[2.4<del>5</del>.1 Paint

Furnish windows with factory-primed surfaces which will be exempt from first paint coat application required in Section 09 90 00 PAINTS AND COATINGS.

#### ][2.45.2 Vinyl (PVC) Cladding

## 

Preservative treat all basic wood frame and sash members in accordance with WDMA I.S.4 and Section 06 10 00 ROUGH CARPENTRY, except do not use pentachlorophenol. Clad all exterior surfaces with rigid polyvinyl sheathing, complying with ASTM D1784, class 14344-C, not less than 0.9 mm (35 mil) average thickness.

][2.4<del>5</del>.3 Aluminum Cladding

Preservative treat all basic wood frame and sash members in accordance with WDMA I.S.4, except do not use pentachlorophenol. Clad all exterior surfaces with roll formed aluminum with joints sealed during assembly. Aluminum clad frames and sash must meet performance requirements of AAMA/WDMA/CSA 101/I.S.2/A440.

2.4<del>5</del>.3.1 Aluminum Finish

Factory finish with [anodic coating] [or] [organic coating].

2.45.3.2 Anodic Coating

 Conform to AA DAF45. Finish must be [clear (natural), designation AA-M10-C22-A31, Architectural Class II 0.010 to 0.0175 mm (0.4 mil to 0.7 mil)] [clear (natural), designation AA-M10-C22-A41, Architectural Class I 0.0175 mm (0.7 mil) or thicker] [integral color-anodized, designation AA-M10-C22-A32, Architectural Class II 0.010 to 0.0175 mm (0.4 mil to 0.7 mil)] [integral color-anodized, designation AA-M10-C22-A42, Architectural Class I 0.0175 mm (0.7 mil) or thicker] [electrolytically deposited color-anodized designation AA-M10-C22-A34, Architectural Class II 0.010 to 0.0175 mm (0.4 mil to 0.7 mil)] [electrolytically deposited color-anodized, designation AA-M10-C22-A44, Architectural Class I 0.0175 mm (0.7 mil) or thicker]. [Finish Color: [____] [as indicated].]

2.45.3.3 Organic Coating

Clean and prime exposed aluminum surfaces. Provide [baked enamel finish in accordance with AAMA 2603 with total dry film thickness not less than 0.020 mm (0.8 mil)] [high performance finish in accordance with AAMA 2604 with total dry film thickness of not less than 0.030 mm (1.2 mils)]. Finish color [ ] [as indicated].

][2.56 INSECT SCREENS

ASTM D3656/D3656M, Class 2, 18 by 14 mesh, color [charcoal] [grey] [____]. Aluminum frames to meet SMA 1004.

][2.67 STORM SASH

As specified in Section 08 51 69.10 ALUMINUM STORM WINDOWS.

[2.67.1 Finishes

Factory finish exposed aluminum surfaces with anodic coating or organic coating.

- ]]PART 3 EXECUTION
- 3.1 INSTALLATION

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.1.1 Wood and Wood Clad Windows

Install in accordance with the approved installation instructions. Securely anchor windows in place. Install and seal windows in a manner that will prevent entrance of water and wind.

[3.1.2 Insect Screen

Install screen panels in accordance with manufacturer's instructions. Install aluminum framed screens in accordance with SMA 1004.

][3.1.3 Storm Windows

Install storm windows in accordance with manufacturer's standards and instructions.

# ]3.2 ADJUSTMENTS

Make final adjustment for proper operation of ventilating unit after glazing. Make adjustments to operating sash or ventilators to assure smooth operation. Units must be weathertight when locked closed. Verify products are properly installed, connected, and adjusted.

# 3.3 CLEANING

Clean windows on both exterior and interior in accordance with manufacturer's recommendations.

-- End of Section --

#### 

Preparing Activity: NAVFAC

## UFGS-08 53 00 (August 2011) Change 2 - 08/15 ------Superseding UFGS-08 53 00 (February 2011)

#### UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2017

SECTION 08 53 00

PLASTIC WINDOWS 08/11

## 

NOTE: This guide specification covers the requirements for prime and replacement PVC windows.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a <u>Criteria Change Request (CCR)</u>.

1. Glass and glazing and the furnishing of glazing clips and gaskets.

2. Caulking and sealants.

3. Structural building supports at window mullions.

4. Wood or metal subframes for windows in frame walls.

5. Drilling and tapping for attachment of window shades, drapery rods, and venetian blinds. The drilling and tapping of window frames to receive brackets for shades, venetian blinds, and curtain

rods has been omitted from this specification. It is contemplated that this work will be done after erection of windows by the trade for the item to be installed. On projects where factory drilling for these items is required, revise this specification accordingly. 6. Brackets and supports for window shades, drapery rods, and venetian blinds. NOTE: On the drawings, show: 1. Sizes and types of windows; subframes, casings, stools, and hardware. 2. Sizes, location, and swing of ventilators; direction of slide for sliding ventilators; location and details of fixed sash. 3. Typical window sections and details. Show glass thickness and air spaces of insulating glass. Show special glazing, if any. Method of anchoring windows to adjoining 4. construction; size and types of clips, anchors, screws, and other fasteners. 5. Details of nonstructural mullions and mullion covers; details of anchoring and reinforcing nonstructural mullions at windows to receive window cleaner anchors. Details of transom bars. 6. Number of window cleaner anchors required and locations. Types and details of accessories to be furnished, 7. such as, trim, screens, grills, and integral venetian blinds. PART 1 GENERAL 1.1 REFERENCES NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this

> Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

paragraph by organization, designation, date, and

title.

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 1503	(2009) Voluntary Test Method for Thermal
	Transmittance and Condensation Resistance of
	Windows, Doors and Glazed Wall Sections

AAMA/WDMA/CSA 101/I.S.2/A440 (2011; Update 1 2014) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

ASTM INTERNATIONAL (ASTM)

ASTM D3656/D3656M	(2013)	Insed	ct Screening	and L	ouver	Cloth
	Woven	from V	Vinyl-Coated	Glass	Yarns	

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100 (2014) Procedure for Determining Fenestration Product U-Factors

NFRC 200 (2014) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992;	R	2006)	Energy	Star	Energy	Efficiency
	Labelin	g	System	n (FEMP)			

1.2 SUBMITTALS

#### 

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is

Section 08 53 00 Page 3

sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows; G[, [ ]]

Indicate elevations of windows, full-size sections, thicknesses of PVC, reinforcing members, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, [mullion details,] [method and materials for weatherstripping,] [method of attaching screens,] [material and method of attaching subframes,] [fins,] [stools,] [casings,] [sills,] [trim,] [window cleaner anchors,] accessories, installation details, window flashings and other related items.

Schedule of windows; G[, [ ]]

Submit with drawings indicating location of each window unit.

#### SD-03 Product Data

Windows; G[, [ ]]

[Energy Star label for Residential Windows; S

]Fasteners

Hardware

Screens

Weatherstripping

Accessories

[Adhesives

]SD-04 Samples

Windows; G[, [____]]

Submit one full-size window of each type, complete with certification label indicating conformance to AAMA/WDMA/CSA 101/I.S.2/A440, glazing, hardware, [fins,] anchors, and other accessories. [Where screens or weatherstripping are required, fit sample windows with such items that are to be provided.] After approval, install each sample in the work, clearly identified, and record its location.

#### SD-06 Test Reports

Windows; G[, [ ]]

Submit for each window type attesting that identical or larger windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 and the specified minimum Condensation Resistance Factor (CRF).

#### SD-10 Operation and Maintenance Data

Windows, Data Package 1; G[, [ ]]

Submit data package in accordance with Section 01  $78\ 23$  OPERATION AND MAINTENANCE DATA.

#### Plastic Identification

When not labeled, identify types in Operation and Maintenance Manual.

[SD-11 Closeout Submittals

Energy Efficient Equipment for Residential Windows; S

# -1.3 QUALITY ASSURANCE

#### 1.3.1 Labels

Each window unit must bear a certification label from an independent, nationally recognized testing organization validating that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440 for the type, grade, and performance class specified.

# 1.3.2 Certification

Certified test reports attesting that the window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440 as specified will be acceptable in lieu of product labeling or marking.

# 1.4 DELIVERY, STORAGE, AND HANDLING

# 

Deliver windows to the project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the job site. Store windows and components out of contact with the ground, under a weathertight covering, to prevent bending, warping, or otherwise damaging the windows. [Store windows and components so they will not have to be handled at minus 28 degrees C (20 degrees F) or colder.] Repair damaged windows to an "as new" condition as approved. Provide new units if windows cannot be repaired.

# 1.5 PROTECTION

Protect finished surfaces during shipping and handling using the manufacturer's standard method, except do not apply coatings or lacquers on surfaces to receive caulking and glazing compounds.

1.6 MATERIAL IDENTIFICATION

#### 1.6.1 Plastic Identification

Plastic products to be incorporated into the project provide product data indicating polymeric information in Operation and Maintenance Manual. Type 1: Polyethylene Terephthalate (PET, PETE). Type 2: High Density Polyethylene (HDPE). Type 3: Vinyl (Polyvinyl Chloride or PVC). Type 4: Low Density Polyethylene (LDPE). Type 5: Polypropylene (PP). Type 6: Polystyrene (PS). Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

## PART 2 PRODUCTS

2.1 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

#### [2.1.1 Energy Efficient Equipment for Residential Windows

```
Provide Energy Star residential windows in accordance with Section 01 33 29

SUSTAINABILITY REPORTING paragraph ENERGY EFFICIENT EQUIPMENT.

NOTE: This guide specification presents

nonproprietary materials. When the guide

specification is edited or supplemented to suit

project requirements, care must be exercised to

present a project specification section which

contains no proprietary materials.
```

#### 2.12 GENERAL REQUIREMENTS FOR WINDOWS

NOTE: Edit to indicate materials and items required. Consult AAMA 1503, "Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections" and select the minimum Condensation Resistance Factory (CRF) required for the particular project conditions. NOTE: Window properties are critical to energy performance. Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain. Energy Star labeling is applicable to residential units only. For nonresidential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy

efficiency and meeting minimum building envelope requirements of UFC 3-101-01 including fenestrations and glazing.

Coordinate with Section 08 81 00 GLAZING. Designer must verify availability and adequate competition for products meeting bracketed energy performance requirements before specifying and edit as needed.

Provide windows conforming to AAMA/WDMA/CSA 101/I.S.2/A440 and to requirements specified herein. Provide windows of materials, types, grades, performance classes, combinations and sizes indicated or specified. Provide each window as a unit consisting of [subframe,] frame, sash, glass, hardware, [mullions,] [fins,] [trim,] [casing,] [screen,] [weatherstripping,] anchors and accessories complete. Design windows to accommodate glass, hardware, [screens,] [weatherstripping,] and accessories to be furnished. Provide factory or field installed glass. Provide windows with a minimum CRF of [____] when tested in accordance with AAMA 1503.

[Provide Energy Star qualified_labeled_residential plastic windows (including frames and glass) appropriate to for the [Northern] [North-_ Central] [South-Central] [Southern] climate zone. Provide proof of Energy Star label for residential windows.] [Provide non-residential plastic windows (including frames and glass) certified by the National Fenestration Rating Council with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [____] determined according to NFRC 200 procedures and a U-factor maximum of [___] in accordance with NFRC 100.]

2.2<del>3</del> MATERIALS

2.2<del>3</del>.1 Windows

NOTE: Use of materials with recycled content, calculated on the basis of post-industrial and postconsumer percentage content, contributes to the requirements of UFC 1-200-02, High Performance and Sustainable Building Requirements. Coordinate with Section 01 33 29 SUSTAINABILITY REPORTING. Designer must verify suitability, availability and adequate competition before specifying product recycled content requirements.

Provide PVC, reinforcing members, fasteners, hardware, weatherstripping, and anchors conforming to AAMA/WDMA/CSA 101/I.S.2/A440 and as specified herein. [See Section 01 33 29 SUSTAINABILITY REPORTING for cumulative total recycled content requirements. Metal and plastic materials may contain post-consumer or post-industrial recycled content.]

2.23.2 Sash Insulation

Use hollow PVC or fiberglass profile insulated with foam or fiberglass, or use foamed PVC for good sash insulation performance.

2.23.3 Glass and Glazing

As specified in Section 08 81 00 GLAZING.

## 2.23.4 Caulking and Sealing

As specified in Section 07 92 00 JOINT SEALANTS.

#### 2.2<del>3</del>.5 Adhesives

Provide sealants as specified in Section 07 92 00 JOINT SEALANTS. For interior application of joint sealants comply with applicable regulations regarding reduced VOC's as specified in Section 07 92 00 JOINT SEALANTS and Section 01 33 29 SUSTAINABILITY REPORTING.

2.23.6 Insect Screening

ASTM D3656/D3656M, Class 2, 18 by 14 mesh, color [charcoal] [grey] [ ].

2.2<del>3</del>.7 Accessories

As standard with the manufacturer and as specified herein.

#### 2.34 WINDOW TYPES

#### 

NOTE: Edit for window types to be included in the project. Consult the AAMA "Window Selection Guide" or the Certified Products Directory for definitions of each type and design consideration. The most commonly used window types have been listed in this specification; windows are available in other types and can be made in various combinations and custom fabrications. Select window types on basis of functional requirements and economic considerations. Functional requirements include operation of window, weather environment, conditions of usage and aesthetic factors. Economic considerations include initial cost as well as maintenance costs over life of the facility.

Provide windows of the following types, as indicated.

2.34.1 Awning Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type A- [R 15] [C 20] [[____] (Optional Performance Class)]. Provide compression-type weatherstripping.

2.34.2 Casement Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type C- [R 15] [C 20] [HC 40] [[____] (Optional Performance Class)]. Provide [rotary crank] [handle] operated

Section 08 53 00 Page 9

ventilators. Provide ventilators over 1675 mm (66 inches) high with two separate locking devices or a two-point locking device operated by rods from a single lever handle. Conceal rods where possible. Provide compressiontype weatherstripping. [Provide casement windows in combination with [fixed] [projected] windows specified below.]

#### 2.34.3 Hung Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type [R 15] [(Optional Performance Class)].

# 2.34.4 Horizontal Sliding Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type HS- [R 15] [(Optional Performance Class)].

## 2.34.5 Projected Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type P- [R 15] [(Optional Performance Class)]. Provide projected windows with concealed four bar friction hinges only.

## 2.34.6 Fixed Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type F- [R 15] [(Optional Performance Class)].

2.34.7 Dual Action (Tilt/Turn) Windows

Provide dual action windows with a ventilator which swings into the room from the top for ventilation and swings in from the side for cleaning of the outside surface. When swung from the side, the ventilator must swing in sufficiently to allow safe access to the outside surface.

# 2.34.7.1 Construction

Provide ventilators with one or more stabilizing arms attached to the frame when ventilator is opened from top. When ventilator is in the tilt-open position, stabilizing arms must provide positive positioning of the ventilator.

### 2.34.7.2 Hardware

Equip each ventilator with one handle to provide both tilt and swing operation. The tilt or swing operation must be individually selected and rendered operable starting only from the closed sash position. Provide a secondary locking device for each ventilator to prevent accidental swing operation.

#### 2.34.7.3 Performance Requirements

Provide dual action windows to meet the primary performance requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440 for Grade and Performance Class [R 15] [(Optional Performance Class)].

## 2.45 FABRICATION

Conform to AAMA/WDMA/CSA 101/I.S.2/A440 and to the requirements specified herein.

## 2.45.1 Subframes, Mullions and Transom Bars

#### 

NOTE: Edit and include this paragraph when PVC subframes, mullions and/or transom bars are included, otherwise delete. Specify the design pressure used to specify the Performance Class or the Optional Performance Class for the adjoining windows. Avoid mullion covers in cold climate installations.

Provide subframes, transom bars and mullions between multiple window units which meet the design pressure of [72] [96] [192] [____] kilograms per square meter (kg/sq m) ([15] [20] [40] [___] pounds per square foot (psf)). Fabricate mullions and transom bars in such a manner as to permit expansion and contraction between adjoining construction and window units and to form a weathertight joint. [Provide mullion covers on the interior and exterior to completely close exposed joints and recesses between window units and to present a neat appearance.] [Provide special covers over structural support at mullions as indicated.] [Where window cleaner anchors are required, reinforce mullions to provide safe and adequate support.]

2.45.2 Combination Windows

Provide factory assembled combination windows of the same grade and performance class. Where factory assembly of individual windows into larger units is limited by transportation considerations, prefabricate, match mark, transport, and field assemble.

2.45.3 Frames and Sash

2.45.3.1 Corners and Reinforcement

# 

Provide [mechanically fixed and sealed or welded] [welded] corners on PVC frames and sashes. Reinforce frames and sash as necessary to meet the requirements for the performance classes or grades specified herein.

#### 2.4<del>5</del>.3.2 Adjustability

Ventilating sash must be adjustable vertically and horizontally to ensure smooth operation.

2.45.3.3 Drips and Weep Holes

 [Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, provide continuous drips across tops of fixed windows.] Provide drips and weep holes as required to return water to the outside.

#### 2.45.3.4 Provisions for Glazing

#### 

NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

Specify glass thickness in Section 08 81 00 GLAZING. Inside glazing is preferred, especially for windows above first floor and other locations where access is difficult. Windows designed for inside glazing may not be available in double-hung type. Check manufacturer's literature. Where project requires insulating glass, show sash members, glazing beads, and hardware of sufficient size and weight to receive and support glass of specified thickness. Allow sufficient space between each side of insulating glass and frame for glazing compound or glazing gaskets and expansion as well as sufficient space between edges of glass and frame. Drawings must clearly indicate method for securing insulating glass in place. Specify windows which will require glazing beads if they are indicated as such; specify vinyl, EPDM or silicone rubber gaskets in Section 08 81 00 GLAZING. Do not use glazing compound, vinyl glazing gaskets or exterior glazing beads in cold climates; dry glaze with EPDM or silicone rubber gaskets. 

Design windows and rabbets suitable for glass thickness shown [or specified]. Design sash for [inside] [outside] [single] [double] [triple] glazing and for securing glass with [glazing beads,] [glazing clips,] [glazing channels,] [glazing gaskets,] [or glazing compound].

#### 2.4<del>5</del>.4 Hardware

The item, type, and functional characteristics must be the manufacturer's standard for the particular window type. Provide hardware of suitable design and of sufficient strength to perform the function for which it is used. Equip operating ventilators with a lock or latching device which can be secured from the inside.

# 2.45.5 Weatherstripping

Provide for ventilating sections of windows to ensure a weathertight seal meeting the infiltration requirements specified in AAMA/WDMA/CSA

101/I.S.2/A440. Provide easily replaceable factory-applied weatherstripping.

# 2.4<del>5</del>.6 Screens

Provide one insect screen for each operable exterior sash or ventilator. Design screens to be rewirable, easily removable from inside the building, and to permit easy access to operating hardware.

2.4<del>5</del>.7 Color

# 

Provide [white][____] window PVC color. Color must be integral or coextruded to the PVC to prevent heat build-up.

#### 2.4<del>5</del>.8 Fasteners

Provide fastener types as standard with the window manufacturer for windows, trim, and accessories.

# 2.4<del>5</del>.9 Accessories

Provide windows complete with clips, fins, anchors, [grills,] [venetian blinds,] and other appurtenances necessary for complete installation and proper operation.

## 2.4<del>5</del>.9.1 Anchors

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Provide anchors and fasteners compatible with the window and the adjoining construction. For each jamb 900 mm (36 inches) or longer, provide a minimum of three anchors located approximately 150 mm (6 inches) from each end and at midpoint. For jambs less than 900 mm (36 inches) long, provide two anchors.

## 2.45.9.2 Window Cleaner Anchors

#### 

NOTE: Show and specify window cleaner anchors where sills are more than 1800 mm (6 feet) above grade, adjoining balconies, or adjoining roofs, unless window cleaning methods at the activity make use of anchors unnecessary. Coordinate with using activity in making decision as to need for anchors. When requested by activity, removable or tilting-type sash may be provided instead of anchors. Removable or tilting-type sash may be specified as Contractor's option when these units are desired by using activity and when economically competitive with conventional double-hung sash equipped with window cleaner anchors. When appropriate, add the following at the end of paragraph WINDOW CLEANER ANCHORS:

"Removable or tilting-type sash may be provided in lieu of hung windows equipped with window cleaner anchors. Design sash so that both sides of glass can be readily cleaned from interior without dismantling any part of window or screens. Provide removable and tilting-type sash with tamper-proof hardware to prevent sash removal by unauthorized personnel."

Provide double head anchors for windows [indicated] [specified]. Provide stainless steel anchors of size and design required for the window type and application. Provide two anchors for each single window [and each adjacent fixed glass window unit]. Fasten anchors 1120 mm (44 inches) above the window sill utilizing appropriate methods for the window type and application in accordance with industry safety standards. Reinforce frames to receive anchors. Provide wall anchors on backs of frames at points where anchors are located.

## 2.4<del>5</del>.9.3 Grills

Provide the manufacturer's standard grills for the windows indicated. Grills must be removable type or sealed within insulating glass units. Provide manufacturer's standard grill pattern design or as approved, unless otherwise indicated.

#### 2.45.9.4 Integral Venetian Blinds

Provide the manufacturer's standard venetian blinds mounted within the window frame for the windows indicated. Venetian blinds must be fully adjustable allowing full angle tilting and stops at any position. Provide [white ]blinds[ to match color of the PVC].

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as work progresses or install without forcing into prepared window openings. Set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, builtin fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install and seal windows in a manner that will prevent entrance of water and wind. [Fasten insect screens securely in place.] Fasten hardware to windows.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

## 3.1.1 Anchors and Fastenings

Secure units to each other, to masonry, and to other adjoining construction with clips, fins, screws, or other devices recommended by the window manufacturer. [Where window cleaner anchors are provided, anchor windows and mullions to provide safe and adequate support for the window cleaner.]

# 3.2 ADJUSTING

After installation of windows and completion of glazing and field painting, adjust ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts as necessary. Verify products are properly installed, connected, and adjusted.

### 3.3 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weatherstripping, and to prevent interference with operation of hardware. Replace stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

# 3.4 PROTECTION

Protect ventilators and operating parts against accumulation of dirt and building materials by keeping ventilators tightly closed and locked to frame.

-- End of Section --

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UFGS-08 62 00 (August 2009)

Preparing Activity: USACE

# UNIFIED FACILITIES GUIDE SPECIFICATIONS

Superseding

References are in agreement with UMRL dated October 2017

#### SECTION 08 60 45

[SKYLIGHTS] [ AND ] [TRANSLUCENT PANELS] 02/12

#### 

NOTE: This guide specification covers the requirements for skylights and translucent panels manufactured from glass-fiber or thermoplastic polycarbonate.

Adhere to <u>UFC 1-300-02</u> Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a <u>Criteria Change Request (CCR)</u>.

PART 1 GENERAL

#### 1.1 SUMMARY

Provide commercially available [roof windows] [unit skylights [flat glass] [domed] [pyramidal] [vaulted]] [metal or wood framed skylights] which satisfy all requirements contained in this section and have been verified by load testing and independent design analyses (if required) to meet specified design requirements. Provide environmentally preferable products and work practices, applicable to skylights, considering raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, and/or disposal of the products or services used in the skylights. Provide UV-stabilized, shatterproof and energy efficient skylight systems. Provide light transmitting plastics in the manufacturing of skylights for daylighting applications. Systems must meet requirements of UFC 4-010-01.

### 1.2 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003;	Reaffirmed	2009)	Designation	System
	for Al	uminum Finis	shes		

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA	2603	(2015) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
AAMA	2604	(2013) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
AAMA	2605	(2013) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA	611	(2014) Voluntary Specification for Anodized Architectural Aluminum

AAMA/WDMA/CSA 101/I.S.2/A440 (2011; Update 1 2014) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

# ASTM INTERNATIONAL (ASTM)

ASTM C297/C297M	(2016) Flatwise Tensile Strength of Sandwich Constructions
ASTM D1002	(2010) Apparent Shear Strength of Single-Lap- Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
ASTM D1003	(2013) Haze and Luminous Transmittance of Transparent Plastics
ASTM D1037	(2012) Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D1929	(2016) Standard Test Method for Determining Ignition Temperature of Plastics
ASTM D2244	(2016) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2843	(2016) Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics
ASTM D3841	(2016) Standard Specification for Glass Fiber-Reinforced Polyester Plastic Panels
ASTM D572	(2004; R 2010) Rubber Deterioration by Heat and Oxygen
ASTM D635	(2014) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM E108	(2011) Fire Tests of Roof Coverings
ASTM E283	(2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330/E330M	(2014) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2016) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

- ASTM E661 (2003;R 2015; E 2015) Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads
- ASTM E695 (2003; R 2015; E 2015) Measuring Relative Resistance of Wall, Floor, and Roof Construction to Impact Loading
- ASTM E72 (2015) Conducting Strength Tests of Panels for Building Construction
- ASTM E84 (2017) Standard Test Method for Surface Burning Characteristics of Building Materials

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC04 (2012) Acceptance Criteria for Sandwich Panels

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC (2015) International Building Code

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

- NFRC 100 (2014) Procedure for Determining Fenestration Product U-Factors
- NFRC 200 (2014) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01 (2012; with Change 1) DoD Minimum Antiterrorism Standards for Buildings

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23 Guarding Floor and Wall Openings and Holes

UNDERWRITERS LABORATORIES (UL)

UL 972 (2006; Reprint Dec 2015) Standard for Burglary Resisting Glazing Material Type

1.3 SUBMITTALS

> The Guide Specification technical editors have designated those items that require Government

> > Section 08 60 45 Page 4

approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" classification only in SD-11 Closeout

Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G[, [____]]

SD-03 Product Data

[Skylights][ and ][Translucent Panels]; G[, [ ]]

[Recycled Content for Aluminum Framing Materials; S]

[Energy Star Label for Residential Skylights; S]

Warranty

SD-06 Test Reports

Test Reports

SD-07 Certificates

Systems

Qualifications

SD-11 Closeout Submittals

Recycled Content for Aluminum Framing Materials; S Energy Efficient Equipment for Residential Skylights; S

## 1.4 QUALITY ASSURANCE

- a. Provide documentation of Qualifications for the following: The manufacturer is a company specializing in the manufacture of the specified products with a minimum of [5] [10] years documented experience. The installer has documented experience of [5] [____] years minimum performing the work specified.
- b. Before fabrication, provide a full service mock-up of [each type of skylight] [one skylight unit] [___] complete with glass and AAMA certification label for structural purposes and NFRC temporary and Permanent Label for certification of thermal performance rating for review of skylight construction and quality of hardware operation. Glass and glaze in conformance with the applicable requirements of Section 08 81 00 GLAZING.
- 1.5 DELIVERY, STORAGE, AND HANDLING

Provide factory assembled system modules to the greatest extent possible. Ship panels to the jobsite in rugged shipping units, ready for erection. Affix conspicuous decals on all skylights warning individuals against sitting or stepping on the units. Store skylight panels on the long edge, several mm (inches) above the ground, blocked and under cover to prevent warping. Deliver unit skylights in manufacturer's original containers, dry, undamaged, with seals and labels intact. Deliver, store and protect all products in accordance with manufacturer's recommendations.

#### 1.6 WARRANTY

Provide the manufacturer's complete warranty for materials, workmanship, and installation. The warranty is for [5] [___] years from the time of project completion and with no proration. The warranty must guarantee, but not be limited to, the following:

- a. [No change in light transmission and color of the panels after exposure to heat of 149 degrees C (300 degrees F) for 25 minutes. ][In accordance with ASTM D2244, panels do not darken more than 3.0 Delta E units after 5 years of outdoor weathering in South Florida at 45 degrees facing south. Document compliance with this requirement in submitted Test Reports.]
- b. There is no delamination of the panel affecting appearance, performance, weatherability or structural integrity of the panels or the completed system.

- c. There is no fiberbloom on the panel face.
- d. Change in light transmission of no more than 6 percent in accordance with ASTM D1003, and in color (yellowing index) no more than 10 points in comparison to the original specified value over a 10 year period.
- e. Provide a single source warranty for the glazing panels and the framing system. Third party warranty for the glazing panels will not be accepted.

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PART 2 PRODUCTS
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12.1 PRODUCT SUSTAINABILITY CRITERIA

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following:

[2.1.1 Recycled Content for Aluminum Framing Materials

Provide aluminum components with a minimum recycled content of [20][____] percent. Provide documentation in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph RECYCLED CONTENT.

][2.1.2 Energy Efficient Equipment for Residential Skylights

Provide Energy Star residential skylight units in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph ENERGY EFFICIENT EQUIPMENT.

#### ]]2.12 [SKYLIGHTS] [ AND ] [TRANSLUCENT PANELS]

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NOTE: A polyvinyl fluoride film coating may be specified for the exterior surface of skylight panels when longer wearability is considered necessary. For fire rated construction, panels with fire ratings consistent with the overall construction of the building should be specified. Retain appropriate bracketed statements and corresponding paragraphs below and delete the others.

The designer must consider the differences and performance characteristics of the two materials: glass-fiber reinforced polyester and extruded

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Fabricate skylight panels of [glass-fiber reinforced polyester] [or] [extruded cellular thermoplastic polycarbonate] panels conforming to the specified requirements and other appropriate lab test specified criteria, weighing not less than 2.4 kg/square meter (8 ounces/square foot). Submit certified Test Reports from independent testing laboratory for each type and class of panel system. Reports must verify that the material meets specified performance requirements. Previously completed test reports will be acceptable if they are current and indicative of products used on this project. Where a Class A, B or C roof is part of the project, provide a listing certificate for roof covering systems category certifying that the product complies with the safety standards of ASTM E108 and ICC IBC. Size and color of skylight panels as indicated.

2.23 GLASS-FIBER PANELS

Provide glass-fiber reinforced polyester panels conforming to ASTM D3841, Class [ ] and to the requirements of AAMA/WDMA/CSA 101/I.S.2/A440.

2.23.1 Weatherability

Provide the exposed faces of fiberglass sandwich type panels with a permanent glass veil erosion barrier embedded integrally to provide maximum long term resistance to reinforcing fiber exposure. The exterior face sheet must be uniform in strength and resistant to penetration by pencil point.

#### 2.23.2 Non Combustible Grid Core

Use 6063-T6 aluminum I-beams with provisions for mechanical interlocking of muntin-mullion and perimeter to prevent high and low intersections which do not allow full bonding surface to contact with face material. I-beam width no less than 11 mm (7/16 inch). Machine I-beam grid to tolerances of not greater than plus or minus 0.05 mm (0.002 inch) for flat panels. Panels must withstand 650 degrees C (1200 degrees F) fire for a minimum of one hour without collapse or exterior flaming.

# 2.2<del>3</del>.3 Adhesive

Use heat and pressure resin-type laminate adhesive engineered for structural sandwich panel use; which passes testing requirements specified by the International Conference of Building Officials' "Acceptance Criteria for Sandwich Panel Adhesive". Provide with the following minimum strength:

- a. Tensile Strength of 5.2 MPa (750 psi) in accordance with ASTM C297/C297M after two exposures to six cycles each of the aging conditions prescribed in ASTM D1037.
- b. Shear Strength, after exposure to five separate aging conditions in accordance with ASTM D1002:
  - (1) 3.7 MPa (540 psi) at 50 percent relative humidity and 23 degrees C
     (73 degrees F).

- (2) 5.5 MPa (800 psi) under accelerated aging in accordance with ASTM D1037 at room temperature.
- (3) 1.7 MPa (250 psi) under accelerated aging in accordance with ASTM D1037 at 83 degrees C (182 degrees F).
- (4) 9.7 MPa (1400 psi) after 500 hour Oxygen Bomb in accordance with ASTM D572.
- (5) 690 kPa (100 psi) at 83 degrees C (182 degrees F).

## 2.23.4 Panel Construction

NOTE :	Use materials with recycled content where
appro	priate for use. Verify suitability,
avail	ability within the region, cost effectiveness
and a	dequate competition before specifying product
recyc	led content requirements. Where it is confirmed
panel	s are readily available with aluminum containing
recyc	led content, include the last bracketed
sonto	inces

Provide panels consisting of fiberglass faces laminated to an aluminum Ibeam grid core and deflecting no more than 48 mm (1.9 inches) at 147 kg per square meter in 3 m (30 psf in 10 feet) in accordance with ASTM E72, without a supporting frame. Include manufacturing facilities, sandwich panel components and production sandwich panels in the quality control inspections and required testing, conducted at least once each year, -for conformance with ICC-ES AC04 or equivalent. [Provide aluminum framing materials with a minimum recycled content of 20 percent. Provide data identifying percentage of recycled content for aluminum framing materials.]

# 2.34 THERMOPLASTIC POLYCARBONATE PANELS

Manufacture systems from translucent polycarbonate panels designed for architectural applications. Provide panels consisting of a polycarbonate resin with a permanent, co-extruded, ultra-violet protective layer; coextruded by the manufacturer during the original extrusion of the panel a permanent part of the exterior and interior layers. Pot-applied coatings or films of dissimilar materials are unacceptable. Provide panel width not to exceed 600 mm (2 feet) to ensure best performance for wind uplift, vibration, oil canning and visual appearance. Meet the following manufacturing requirements:

- a. Extruded in one single formable length. Transverse sections are unacceptable. Manufacture the panels with upstands which are integral to the unit, and with the upstands 90 degrees to the panel face (standing seam dry glazed concept). Welding or gluing of upstands or standing seam is unacceptable.
- b. Provide dry glazed profiles mullions, using no sealant, welding, adhesives or gaskets; thermally break mullions continuous for panel length.
- c. For structural performance, the use of adhesives, plastic or sonic welding or sealant is not allowed.

- d. For longevity, the minimum ratio of panel weight to thickness must be [2.44 kg/m² for 10 mm (0.5 psf for 0.4 inch)] [3.3 kg/m²for 16 mm (0.68 psf for 0.63 inch)] [4.4 kg/m² for 55, 75,and 100 mm double glazed (0.91 psf for 2.2, 3, and 4 inch double glazed)] thick panel.
- e. Extruded panel includes integral extruded multi-cells, and truss-like structural core for resistance to buckling. Interconnect the panel's exterior skins and space apart by supporting ribs, perpendicular to the skins, at a spacing not to exceed 4 mm (0.16 inches) (truss-like construction). In addition, divide the space between the two exterior skins in a cross section by multiple parallel intermediate surfaces, at a spacing not to exceed 4 mm (0.16 inches).
- f. Interior flame spread classification is Class [I] [II] in accordance with ASTM E84.
- g. Smoke density no greater than 70 in accordance with ASTM D2843.
- h. The exterior and interior faces must be an approved light transmitting panel with a CC1 fire rating classification in accordance with ASTM D635.
- i. Self-ignition greater than 570 degrees C (1058 degrees F) in accordance with ASTM D1929.
- j. Fire rated roof assembly translucent panels must be successfully evaluated for fire from exterior exposure per [ASTM E108] [____] to meet Class [A] [B] [C] rating. Provide panel listed by an independent recognized listing laboratory.
- 2.45 COMMON PANEL REQUIREMENTS
- 2.4<del>5</del>.1 Appearance

Provide face sheets uniform in color to prevent splotchy appearance and completely free of ridges and wrinkles which prevent proper surface contact. Clusters of air bubbles/pinholes which collect moisture and dirt are not acceptable.

2.45.2 Panel Fabrication

Panel construction msut meet the following requirements:

- a. Light transmission [ ] percent; color [ ].
- b. Assembled panel thickness [____] mm (inches).
- c. Grid size [ ][as indicated].

2.45.3 Thermal Performance

solar heat gain coefficient to reduce summer solar heat gain.

Energy Star labeling is applicable to residential units only. For nonresidential applications, refer to UFC 1-200-02, High Performance and Sustainable Building Requirements, for minimum requirements for energy efficiency and meet minimum building envelope requirements of UFC 3-101-01 including fenestrations and glazing.

# Select the performance requirements for nonresidential skylights and the residential skylights.

Provide non-residential skylights (including frames and glass) certified by the National Fenestration Rating Council with a whole-unit Solar Heat Gain Coefficient (SHGC) maximum of [____] determined according to NFRC 200 procedures and a U-factor maximum of [___] W/m2-K(Btu/hr-ft2-F) in accordance with NFRC 100.

[Provide residential skylights (including frames and glass) that are Energy Star qualified labeled products as appropriate to for the [Northern] [North-Central] [South--Central] [Southern] climate zone, or have the following performance characteristics: . To meet Energy Star criteria for the [Southern climate zone, thermal properties of windows must not exceed a Ufactor of 0.60 4.0 W/m2-K (0.70 Btu/hr-ft2-F) determined according to NFRC 100, and a solar heat gain coefficient (SHGC) of 0.30 not exceeding 0.28 determined according to NFRC 200.] [ South-Central climate zone, thermal properties of windows must not exceed a U-factor of 0.53 3.2 W/m2-K (0.57 Btu/hr-ft2-F) determined according to NFRC 100, and a solar heat gain coefficient (SHGC) of 0.30not exceeding 0.28 determined according to NFRC 200.] [ North-Central climate zone, thermal properties of windows must not exceed a U-factor of 0.53 3.1 W/m2-K 0.55 Btu/hr-ft2-F determined according to NFRC 100, and a solar heat gain coefficient (SHGC) not exceeding 0.35 of 0.40 determined according to NFRC 200.] [ Northern climate zone, thermal properties of windows must not exceed a U-factor of 0.50 3.1 W/m2-K (0.55 Btu/hr-ft2-F) determined according to NFRC 100.] Provide proof of Energy Star label for residential skylights.]

## 2.45.4 Condensation Index Rating

The condensation index rating must be [____] as determined using National Fenestration Rating Council approved software THERM.

## 2.56 [SKYLIGHT] [ AND ] [TRANSLUCENT PANEL] SYSTEMS

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Since the skylight becomes an integral element of the roofing system after installation, it must meet or exceed the roof requirements for fire protection, insulation value, energy efficiency rating, thermal performance, air infiltration, and water penetration. Design must meet the requirements of UFC 1-200-02, High Performance And Sustainable Building Requirements and meet minimum building envelope requirements of UFC 3-101-01 "Architecture" including fenestrations and glazing.

Submit manufacturer's certificate that the systems meet or exceed specified requirements. Provide systems evaluated and listed (the whole [skylight][ and ][translucent panel] as a unit, not just a glazing material in the unit) by the recognized building code authorities: ICC and SBCCI-Public Safety Testing and Evaluation Services Inc. Product ratings determined using NFRC 100 and NFRC 200 must be authorized for certification and properly labeled by the manufacturer. Provide [skylight][ and ][translucent panel] systems meeting the following requirements:

- a. Integral perimeter framing system assembly by the manufacturer.
- b. Exterior panel faces [crystal] [clear matte] [white] [____] in color. Interior panel faces [crystal] [clear matte] [white] [____] in color.
- c. Air infiltration at 75 Pa (1.57 psf) less than [0.2] [___] L/s/m²
   ([0.04] [___] cfm/ft²) and at 300 Pa (6.24 psf) less than [0.36][0.5]
   [___] L/s/m² ([0.07][0.1] [___] cfm/ft²) in accordance with ASTM
   E283.
- d. Water penetration at test pressure of 718 Pa (15 psf) equals zero in accordance with ASTM E331.
- e. Manufacturer is responsible for maximum system deflection, in accordance with the applicable building code, and without damage to system performance. Calculate deflection in accordance with engineering principles.

- f. Incorporate weepage elements within the perimeter framework of the glazing system for drainage of any condensation or water penetration.
- g. System must accommodate movement within the system; movement between the system and perimeter framing components; dynamic loading and release of loads; and deflection of supporting members. Achieve this without damage to system or components, deterioration of weather seals and fenestration properties specified.
- h. The exterior panel face must repel an impact of[ 68 N-m (50 foot-pounds) without fracture or tear when impacted by a 83 mm diameter, 2.3 kg (3.25 inch diameter, 5 pound) free falling ball dropped from a vertical distance of 3 m (10 feet)][ 271 N-m (200 foot-pounds) without fracture or tear when impacted by a 83 mm diameter, 2.3 kg (3.25 inch diameter, 5 pound) free falling ball dropped from a vertical distance of 12 m (40 feet)] when tested in accordance with UL 972.
- i. Provide system meeting the fall through requirements of 29 CFR 1910.23 as demonstrated by testing in accordance with ASTM E661 or ASTM E695, thereby not requiring supplemental screens or railings.
- j. Exposed aluminum color must be [a [ ] shade] selected from the manufacturer's standard range. Provide corrosion resistant [oven dried Kynar 500, [50 percent fluoropolymer, two coat high-performance organic finish in accordance with AAMA 2604][70 percent fluoropolymer, two coat superior-performance organic finish in accordance with AAMA 2605] finish] [baked-on enamel coating in accordance with AAMA 2603 with a total dry film thickness not less than 20 µm (0.8 mil)] [[highperformance organic finish in accordance with AAMA 2604][superiorperformance organic finish in accordance with AAMA 2605] with total dry film thickness of not less than 30  $\mu m$  (1.2 mils)][anodized finish complying with AA DAF45 and AAMA 611 must be [Architectural Class II (10 µm to 18 µm(0.4 mil to 0.7 mil)), designation AA-M10-C22-[A31, clear (natural)] [A32, integral color] [A34, electrolytically deposited color]][Architectural Class I ( $18 \mu m (0.7 mil)$  or thicker), designation AA-M10-C22-[A41, clear (natural)] [A42, integral color] [A44, electrolytically deposited color] anodized.]].
- k. Provide a system requiring no scheduled recoating to maintain its performance or for UV resistance.
- 1. Design criteria:
  - (1) Wind Load [____]; snow load [____].
  - (2) Frame Blast Loads: Design framing to resist 2.4 kPa (50 pounds per square foot) blast load at L/160 deflection.
  - (3) Anchor Blast Loads: Design anchors to resist 4.8 kPa (100 pounds per square foot) blast load.
- m. Use 6063-T6 and 6063-T5 extruded aluminum; all fasteners of stainless steel or cadmium plated steel.

2.56.1 Glass Glazed Skylights and Roof Windows

Provide roof windows to withstand dead and live loads caused by pressure and uplift of wind acting normal to the plane of roof and tested by an ICC listed, independent testing and quality control inspection agency to an allowable downward pressure of [0.57-8.71] [___] MPa ([12-182] [__]] psf) and an uplift pressure of [1.05-5.03] [__] MPa ([22-105] [__]] psf) measured in accordance with ASTM E330/E330M, as recommended by the manufacturer for the type of window tested.

# 2.5<del>6</del>.1.1 Fixed Skylight

Fixed skylight featuring a select wood frame, mortise and tenon joints, gaskets to drain any condensation to the outside, a choice of tempered clear, laminated, insulated daylight area. Provide [aluminum] [copper] protective exterior cladding for protection and low profile appearance. The skylight must have a [ventilation flap that opens to allow air circulation and contains a filter within the flap to keep dust and insects out] [ventilating panel and insect screen with an operator hook that allows easy opening and closing, with control rods, for out-of-reach installations or smooth-turning handle for within-reach installation].

2.56.1.2 Emergency Escape and Rescue Roof Window

Emergency escape and rescue roof window which opens [45] [____] degrees to satisfy egress requirements for emergency escape. When the unit is closed, a ventilation flap can be opened to allow in fresh air. For easy cleaning from inside the room, the sash rotates completely inward. Insect screen and sunscreen accessories are available.

## 2.56.1.3 Balcony Roof Window Featuring Dual-Sash Operation

The top sash opens for maximum ventilation and also pivots completely inward for easy cleaning from inside the room; the bottom sash opens outward to create a roof balcony. When the window is closed, a ventilation flap allows fresh air circulation. Insect screen and sunscreen accessories are available.

2.56.2 [Plastic Glazed Unit Skylight] [ and ] [Translucent Panels]

# 2.5<del>6</del>.2.1 Dome

Provide factory assembled dome skylight units each consisting of [a single dome or sealed double domes with a 1.5 mm (0.06 inch) extruded aluminum frame and 1.5 mm (0.06 inch)] [sealed double or triple domes with 1.5 mm (0.06 inch) extruded aluminum frame with a polyurethane thermal break to prevent condensation on the interior portion of the frame and 1.75 mm (0.07 inch)] extruded aluminum retainer cap. Submit Manufacturer's descriptive data, catalog cuts and certificate stating that products meet or exceed specified requirements. Provide the skylight with an integral condensation gutter with weep hole slots to provide sufficient drainage to the outside; and [clear] [white] [bronze] [____] dome. Use the manufacturer's standard for self-flashing domes, the curbs, treated wood nailer, and insulation. Uniform design load capacity of composite dome and frame must meet or exceed [1.9] [1.4] [___] MPa ([40] [30] [___] psf) snow load. Insulated curbs with PVC thermal barriers connecting the top and bottom of the inner and outer walls are available.

# 2.5<del>6</del>.2.2 Pyramid

Pyramid skylights are, for all practical purposes, just a configuration alternative to the dome skylights; the requirements specified above for the domes also apply to the pyramids. Pyramid skylight units are available from 1.2 to 6 m (4 to 20 foot) square and can be used for both self-flashing or curb mount installations; 22 and 40 degrees are standard. The maximum horizontal thrust load on the pyramid curb is [0.4 to 1.5 kN (90 to 330 lbs) (1 panel per side)] [1.8 to 3.2 kN (410 to 730 lbs) (2 panels per side)] [3.8 to 5.8 kN (850 to 1300 lbs) (4 panels per side)] depending on size. Pyramids are available in grid and tandem models.

## 2.5<del>6</del>.2.3 Vault

Provide [single] [double] glazed vault skylights; barrel vault height, for low rise vaults, at 10 percent of the vault width, and 50 percent of the vault width for half round vaults; provide outside curbs in accordance with the manufacturer's details. Vaults must support a 1.4 or 1.9 MPa (30 or 40 psf) roof snow or live load, and a negative 1.2 MPa (25 psf) wind load plus dead load; rafter spacing is determined by load requirements but must not exceed 900 mm (36 inches) on center for 1.9 MPa (40 psf) and 1200 mm (48 inches) on center for 1.4 MPa (30 psf). Provide sill members that are factory slotted at anchors for thermal movement, and weep water infiltration and condensation. Use EPDM gaskets. Ship all units over 2.2 m (87 inches) unassembled for access to anchors from roof level.

2.56.3 [Framed Skylights] [ and] [Translucent Panels]

Framed skylights must [be designed to [____] size] [span up to [3.4] [____] m ([12] [____] feet) in a single pitch and up to [6] [___] m ([20] [___]] feet) in a double pitch configuration]; determine rafter and purlin spacing by loading requirements. Skylights manufactured in prefabricated sections easy to install are available in a wide range of standardized pitches. Provide [tubular] [I-beam] framing members; deflection of rafters not to exceed [L/175] [L/180] [____] of the rafter span. A registered professional engineer must size all framing members and design all structural connections; submit a copy of the calculations. Framing includes a primary gutter system with secondary gutters to control water infiltration and condensation runoff from the underside of the glazing material and channel it to the exterior. Design skylight structural members for a live load of [___] MPa (psf) and wind load of [___] MPa (psf); do not induce objectionable distortion or stress in fastenings and joinery due to expansion and contraction when subjected to a 55 degree C (100 degree F) temperature change.

#### 2.67 FLEXIBLE SEALING TAPE

Provide manufacturer's standard pre-applied sealing tape to closure system at the factory under controlled conditions.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

Field verify all submitted opening sizes, dimensions and tolerances; preparation of openings includes isolating dissimilar materials from aluminum system to avoid damage by electrolysis. The installer must examine

area of installation to verify readiness of site conditions and to notify the Contractor about any defects requiring correction. Verify when structural support is ready to receive all specified work and to convene a pre-installation conference, if approved by the Contracting Officer, including the Contractor, skylight installer and all parties directly affecting and affected by the specified work. Do not install any materials that show visual evidence of biological growth due to the presence of moisture. Do not commence work until conditions are satisfactory.

# 3.2 ERECTION

Erect translucent skylight system in accordance with the approved shop drawings supplied by the manufacturer. Submit drawings showing fabrication details, materials, dimensions, installation methods, anchors, and relationship to adjacent construction. Fasten and seal in accordance with the manufacturer's shop drawings. Remove all panel, after other trades have completed work on adjacent materials. Carefully inspect and adjust panel installation as necessary to ensure proper installation and weather-tight conditions. provide all staging, lifts and hoists required for the complete installation and field measuring. Install system clean of dirt, debris or staining and thoroughly examined for removal of all protective material prior to final inspection of the designated work area. Do not use snow rakes on roof windows or skylights.

-- End of Section --

#### 

Preparing Activity: NAVFAC

# UNIFIED FACILITIES GUIDE SPECIFICATIONS

Superseding

UFGS-08 81 00 (February 2011)

References are in agreement with UMRL dated October 2017

SECTION 08 81 00

GLAZING 08/11

> Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a <u>Criteria Change Request (CCR)</u>.

# 

Section 08 81 00 Page 1

NOTE: On the drawings, show:

 Locations of each type of glass, using same terminology as in specification.
 Thickness of glass, unless glass of each type is same thickness.
 Frame and rabbet details, indicating method of glazing.

#### 1.1 REFERENCES

#### 

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

#### AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1 (2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7

(2017) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM C1036

(2016) Standard Specification for Flat Glass
ASTM	C1048	(2012; E 2012) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass				
ASTM	C1172	(2014) Standard Specification for Laminated Architectural Flat Glass				
ASTM	C1184	(2014) Standard Specification for Structural Silicone Sealants				
ASTM	C509	(2006; R 2015) Elastomeric Cellular Preformed Gasket and Sealing Material				
ASTM	C864	(2005; R 2015) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers				
ASTM	C920	(2014a) Standard Specification for Elastomeric Joint Sealants				
ASTM	D2287	(2012) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds				
ASTM	D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set				
ASTM	D4802	(2016) Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet				
ASTM	E119	(2016a) Standard Test Methods for Fire Tests of Building Construction and Materials				
ASTM	E1300	(2016) Standard Practice for Determining Load Resistance of Glass in Buildings				
ASTM	E2226	(2015a) Standard Practice for Application of Hose Stream				
ASTM	E413	(2016) Classification for Rating Sound Insulation				
ASTM	E90	(2009) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements				
	GLASS ASSOCIATION OF NOP	RTH AMERICA (GANA)				
GANA	Glazing Manual	(2009) Glazing Manual				
GANA	Sealant Manual	(2008) Sealant Manual				
GANA	Standards Manual	(2001) Tempering Division's Engineering Standards Manual				
INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)						
IGMA	TB-3001	(2001) Guidelines for Sloped Glazing				

IGMA TM-3000	(1990; R 2004) North American Glazing
	Guidelines for Sealed Insulating Glass Units
	for Commercial & Residential Use
IGMA TR-1200	(1983; R 2007) Guidelines for Commercial

200 (1983; R 2007) Guidelines for Commercial Insulating Glass Dimensional Tolerances

## NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2014)	Procedure	for	Determining	Fenestration
	Product	t U-Factors	5		

NFRC 200 (2014) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA	252	(2017) Standard Methods of Fire Tests of Door Assemblies
NFPA	257	(2012; ERTA 2017) Standard on Fire Test for Window and Glass Block Assemblies
NFPA	80	(2016; TIA 16-1) Standard for Fire Doors and Other Opening Protectives

#### U.S. DEPARTMENT OF ENERCY (DOE)

Energy Star (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201 Safety Standard for Architectural Glazing Materials

UNDERWRITERS LABORATORIES (UL)

UL 752	(2005; Repri	nt Dec	2015)	Standard	for	Bullet-
	Resisting Eq	uipmen	t			

UL MEAPD (2011) Mechanical Equipment and Associated Products Directory (online version is listed under Certifications at www.ul.com)

### 1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality,

with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

### Installation

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

[Control Tower Insulating Glass

][Control Tower Laminated Glass

] Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

NOTE: Regarding the use of SD-03 Product Data and SD-07 Certificates, only use one of these on complicated and large products. It is preferred to use SD-03 Product Data. If control tower glazing data is only available by certificates, use SD-07 Certificates.

SD-03 Product Data

Insulating Glass

Exterior Glazing - performance documentation for all glass types

Plastic Glazing

]Glazing Accessories

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

[Environmental Data

]SD-04 Samples

Insulating Glass

Plastic Sheet

Glazing Compound

Glazing Tape

Sealant

Two 203 by 254 mm (8 by 10 inch) samples of each of the following: tinted glass, patterned glass, heat-absorbing glass, [ ] and insulating glass units.

Three samples of each indicated material. Samples of plastic sheets must be minimum 125 by 175 mm (5 by 7 inches).

[SD-07 Certificates

Insulating Glass

Plastic Glazing

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

[Control Tower Insulating Glass

][Control Tower Laminated Glass

## ]Glazing Accessories

Certificates from the manufacturer attesting that the units meet the luminous and solar radiant transmission requirements for heat absorbing glass.

### ]SD-08 Manufacturer's Instructions

Setting and Sealing Materials

Glass Setting

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.[ Include cleaning instructions for plastic sheets.]

SD-11 Closeout Submittals

- [Energy efficient equipment for Residential Windows; S

## 

### [1.3 SYSTEM DESCRIPTION

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Fabricate and install watertight and airtight glazing systems to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, or defects in the work. Glazed panels must comply with the safety standards, in accordance with ANSI Z97.1, and comply with indicated wind/snow loading in accordance with ASTM E1300.

### ]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

#### 1.5 ENVIRONMENTAL REQUIREMENTS

Do not start glazing work until the outdoor temperature is above 4 degrees C(40 degrees F) and rising, unless procedures recommended by the glass manufacturer and approved by the Contracting Officer are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

## 1.6 WARRANTY

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1.6.1 Warranty for Insulating Glass Units

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Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Government. [For control tower units, provide a warranty signed by the manufacturer for a period of [10][ ] years.]

1.6.2 Warranty for Polycarbonate Sheet

For a 5-year period following acceptance of the work:

- a. Warranty Type I, Class A (UV stabilized) sheets against breakage;
- b. Warranty Type III (coated, mar-resistant) sheets against breakage and against coating delamination;
- c. Warranty Type IV (coated sheet) against breakage and against yellowing;
- d. Warranty extruded polycarbonate profile sheet against breakage.

For a 10-year period following acceptance of the work, warranty Type IV against yellowing and loss of light transmission.

[1.6.3 Monolithic Reflective Glass

Manufacturer must warrant the monolithic reflective glass to be free of peeling or deteriorating of coating for a period of 10 years after Date of Substantial Completion. Warranty must be signed by manufacturer.

][1.6.4 Monolithic Opacified Spandrel

Manufacturer must warrant the opacifier film on the spandrel to be free of peeling for a period of five years after Date of Substantial Completion. Warranty must be signed by manufacturer.

]PART 2 PRODUCTS

2.1 PRODUCT SUSTAINABILITY CRITERIA

[2.1.1 Energy Efficient Equipment for Residential Windows

Provide Energy Star residential windows in accordance with Section 01 33 29 SUSTAINABILITY REPORTING paragraph ENERGY EFFICIENT EQUIPMENT.

### -2.1<del>2</del> GLASS

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NOTE: Glazed openings subject to accidental human impact must be glazed with safety glazing material in accordance with Consumer Products Safety Commission (CPSC) Standard, 16 CFR Part 1201, Safety Standard for Architectural Glazing Materials. Consult applicable building codes for detail requirements.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

ASTM C1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

### 2.1<del>2</del>.1 Clear Glass

NOTE: Glass areas and thicknesses are based on 1.20 kilopascals (25 pounds per square foot (psf)) design wind load and vertical glazing with annealed glass. For other glass and for wind loads greater than 1.20 kPa (25 psf), thickness will depend upon aspect ratio (length divided by width), area, and design wind load. The thickness and area limitations for each type of glass must be indicated or specified. Do not specify glass less than 3.0 mm (1/8 inch).

Method of Determination for Minimum Glass Thickness:

Refer to UFC 4-010-01 "DoD Minimum Antiterrorism Standards for Buildings", ASTM E1300, ASTM F1642//F1642M and ASTM F2248.

1. Determine peak gust wind speed and corresponding design wind loads, considering location, height, shape, and orientation, in accordance with ASCE 7 "Minimum Design Loads for Buildings and Other Structures", latest edition.

2. Determine aspect ratio, area, and type of glass for each opening to be glazed.

 NOTE: Use the following data on Army projects

a. Category I Products: Doors and glazed panels that contain single piece of glazing material no greater than 0.84 m2 (9 ft2) in area. The product must be capable of withstanding 203 Nm (150 foot pound) impact load test.

b. Category II Products: Doors and glazed panels that contain any single piece of glazing material greater than 0.84 m2 (9 ft2) in area. The product must be capable of withstanding a 542 Nm (400-footpound) impact load test. Category II products may be used in both Category I and Category II situations.

c. Doors: 16 CFR 1201 applies to all types of interior doors and exterior doors, including storm doors and combination doors. FIRE/SAFETY RATED GLASS: Is not required for openings in doors through which a 76 mm (3 inch) diameter sphere is unable to pass. Glazing for fire doors must be in accordance with NFPA 80, even though this may be at variance with requirements of 16 CFR 1201.

d. Glazed Panels: 16 CFR 1201 no longer applies to exterior and interior glazed panels. FIRE/SAFETY RATED GLASS: Glazed panels must conform to ANSI Z97.1, SAFETY PERFORMANCE SPECIFICATION AND METHODS OF TEST FOR SAFETY GLAZING MATERIALS USED IN BUILDINGS. Since glazed panels may be hazardous, safety glazing should be generally provided as described below:

### FIRE/SAFETY RATED GLASS

(1) Glazed panels of any size located adjacent to a doorway, with the nearest vertical edge of panel within 1219 mm (48 inches) of doorway, and with bottom edge of panel below top of door. Safety glazing is not required for panels separated from the doorway by an intervening interior permanent wall.

(2) Glazed panels with a surface area greater than 0.84 m2 (9 ft2) where there is a walking surface on either side of panel, and the walking surface is within 914 mm (36 inches) of the panel. Safety glazing is not required if the lowest edge of the glazing material is 457 mm (18 inches) or more above both walking surfaces, or if the panels have a horizontal member, such as a mullion or permanent railing not less than 38 mm (1-1/2 inches) in width, capable of withstanding a horizontal load of 75 kg/m (50 plf), on the accessible sides of the glazing and located between 609 mm and 914 mm (24 and 36 inches) above the walking surface.

(3) Where insulating glass units are used in locations requiring safety glazing, both panes must be safety glass.

(4) For exterior applications, safety glazing must also meet the wind and snow load requirements in accordance with ASTM E1300.

(5) In general, any glazed area subject to human impact should be provided with safety glazing or other acceptable protective devices such as handrails or horizontal mullions.

ASTM C1036 covers the quality requirements for clear annealed glass, transparent tinted heat-absorbing and light-reducing glass, patterned and wired glass with a series of classification designations such as Types, Classes, Styles, Forms, Qualities, Finishes, and Intended Uses, as defined below:

1. Type designations are: Type 1 - Transparent Flat Glass; Type II - Patterned and Wired Glass.

2. Class designations are: Class 1-clear; Class 2tinted Heat-Absorbing and Light-Reducing; Class 3tinted, light-reducing.

3. Style designations are: Style A - Higher light transmittance; Style B - Lower light transmittance.

4. Form designations are: Form 1 - Wired polished both sides; Form 2 - Patterned and wired, Form 3 - Patterned.

5. Quality designations including intended uses for ASTM C1036 transparent flat glass are:

a) Quality q1 - Mirror Select Quality: Coated for premium mirrors.

c) Quality q3 - Glazing Select: For architectural fenestrations or other applications where distant objects are viewed through the glass by the observer.

d) Quality q4 - Intended for greenhouses or other applications where restrictions on aesthetic conditions are not required.

 e) Quality q5 - Intended for general glazing applications that have lesser aesthetic demands than q3 or q4 quality grade.

f) Quality q6 - Intended for greenhouses or other applications where restrictions on aesthetic conditions are not required.

6. Quality designations and intended uses for Patterned and Wired Flat Glasses:

 a) Quality q7 - Decorative: For use where design and aesthetic characteristics are major considerations.

b) Quality q8 - Glazing: For general glazing where functional or aesthetic characteristics are a consideration and where surface blemishes are not a major concern.

c) Wired Glass: For skylights and general glazing where fire retardation or glass retention in a frame are a consideration.

[For interior glazing (i.e., pass and observation windows), 6 mm (1/4 inch) thick glass should be used.]

Type I, Class 1 (clear), Quality [q4 (A)] [q5 (B)]. Provide for glazing openings not indicated or specified otherwise. Use double-strength sheet glass or 3 mm (1/8 inch) float glass for openings up to and including 1.39 square meters (15 square feet), 4.5 mm (3/16 inch) for glazing openings over 1.39 square meters (15 square feet) but not over 2.79 square meters (30 square feet), and 6 mm (1/4 inch) for glazing openings over 2.79 square meters (30 square feet) but not over 4.18 square meters (45 square feet).

2.12.2 Annealed Glass

Annealed glass must be Type I transparent flat type, Class 1 - [clear] [tinted], Quality q3 - glazing select, [____] percent light transmittance, [____] percent shading coefficient, conforming to ASTM C1036. Color must be [[gray] [bronze] [___]].

2.12.3 Heat-Absorbing Glass

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NOTE: For Use On Army Projects Only: Heatabsorbing and light-absorbing glass may be used in accordance with TI 800-01, DESIGN CRITERIA. Tinted (light-reducing) glass may be used where glare is a problem and a reduction of visible light transmission is desired. Visible light transmittance will vary from 15 to 85 percent, depending on color density and thickness. Color density is a function of thickness and increases as the thickness increases; visible light transmittance will decrease as thickness increases. ASTM C1036 separates Heat-Absorbing and Tinted (light-reducing) glasses into categories, Higher light transmittance, and Lower light transmittance, which is based on the maximum solar energy transmittance by glass thickness.

Refer to ASTM C1036 for evaluation quality requirements and glass manufacturer's data for color selection, light transmittance and shading coefficient. When specifying performance and color, the available ranges of performance and colors should be specified for glazing units to allow several manufacturers to bid. When matching existing glass, provide existing manufacturer's name, color and acceptable range for shading factor, light transmittance, indoor and outdoor reflectance.

Heat-absorbing and light-reducing glass is affected by thermal stresses which can result in breakage. Care should be taken to make sure that the glass units will not be thermally overburdened. Glass that will be thermally overburdened should be Heat-Strengthened or, if safety glazing is required, Fully Tempered to resist thermal breakage. Refer to ASTM C1048 for quality evaluation and refer to manufacturer's data for performance and color selection.

Type I, Class 2 (heat absorbing and light reducing), Quality [q3 (select)] [q4 (A)], [___] mm (inch) thick, [blue][green] in color, [___] percent light transmittance, [__] percent shading coefficient, conforming to ASTM C1036. Color must be [[gray] [bronze] [___]] for 6 mm (1/4 inch) thickness.

## 2.12.4 Wired Glass

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NOTE: Wired glass is no longer produced in the United States. On 17 March 1992 (effective for a five year period) OSD determined that the Buy America Act does not apply to the procurement of wired glass and added the product to the list of excepted materials under FAR 25.108(d)(1). Accordingly, wired glass furnished in compliance with Section 08 81 00 GLAZING does not violate the Buy America Act.

Types of wired glass available are polished, patterned, and tinted/heat-absorbing wired glass. Wired glass cannot be tempered. Wired Glass does not meet the requirements of 16 CFR 1201 and cannot be used as safety glazing materials in situations governed by that regulation.

Typically 6 mm (1/4 inch) thick wired glass is used for fire-rated windows and doors where required by building codes and other fire-protection criteria.

Only wired glass in Mesh 1 - Diamond and Mesh 2 -Square are acceptable for fire rated door and window openings. Mesh 3 - Parallel is not acceptable for fire rated openings.

Wired glass, because of the wire mesh and edge damage from cutting, is very susceptible to thermal breakage. Heat absorbing wired glass increases the tendency for breakage. Wired glass is also susceptible to edge breakage from water penetrating the capillary in which the wires reside. The glazing system should insure that the edges are kept dry by sealing the edges with silicone.

Provide UL listed glass for fire-rated windows rated for [45] [20] minutes when tested in accordance with ASTM E2226. Wired glass must be Type II flat type, Class [1 - translucent] [2 - tinted, heat-absorbing] [3 - tinted, light-reducing], Quality [q7 - decorative] [q8 - glazing], Form [1 - wired and polished both sides] [2 - patterned and wired], [____] percent light transmittance, [____] percent shading coefficient, conforming to ASTM C1036. Wire mesh must be polished stainless steel Mesh [1 - diamond] [2 square] [3 - parallel]. Wired glass for fire-rated windows must bear an identifying UL label or the label of a nationally recognized testing agency, and be rated for [20] [45] minutes when tested in accordance with NFPA 257. Wired glass for fire-rated doors must be tested as part of a door assembly in accordance with NFPA 252.

2.12.5 Patterned Glass

NOTE: Patterned glass is normally provided for windows of toilet rooms, vertical sliding sash in post offices borrowed light sash at entrances, etc. Patterned glass is available in various thicknesses, with a pattern embossed on one or both sides. This glass is frequently called "figured", "obscure", or "decorative" glass. The degree of diffusion achieved is a function of the pattern and whether the pattern is on one or both sides. Some patterned glass cannot be heat-strengthened or tempered because of the pattern depth. Pattern glass does not offer complete obscurity and must be used with caution in very private areas such as toilets. The appropriate pattern designation should be selected from ASTM C1036. If a more specific pattern designation is desired, a manufacturer's name and pattern may be specified. When specific manufacturer's names and patterns are specified, the designer should add the following note to the spec: "Manufacturer's name and patterns indicated are for identification purposes only; the listing is not intended to limit selection of similar patterns from other manufacturers." Refer to GANA GLAZING MANUAL, and glass manufacturer's performance tables for proper evaluation of patterned glass thickness and size of opening to be glazed. Patterned glass 3 mm (1/8 inch) thick should not be larger than 2.15 square meters (6 square feet). 

Type II, Class 1 (translucent), Form 3 (patterned), Quality q7 (decorative), Finish [f1 (patterned one side)] [f2 (patterned two sides)], Pattern [p1 (linear)] [p2 (geometric)] [p3 (random)] [p4 (special)], [[____] percent light transmittance, [___] percent shading coefficient.] [3] [6] mm ([1/8] [7/32] inch) thick. [Provide [__].]

## 2.12.6 Laminated Glass

[ASTM C1172, Kind LA fabricated from two nominal [3] [____] mm ([1/8] [___] inch)pieces of Type I, Class 1, Quality q3, flat annealed transparent glass conforming to ASTM C1036. Flat glass must be laminated together with a minimum of 0.75 mm (0.030 inch)thick, clear polyvinyl butyral interlayer with a total nominal thickness of 6 [___] mm (1/4 [___] inch).] [Fabricated from two pieces of Type I, Class 1, Quality q3 glass laminated together with a clear [___] [0.38] mm ([0.015] inch) thick polyvinyl butyral interlayer or alternatives such as resin laminates, conforming to requirements of 16 CFR 1201 and ASTM C1172. Color must be

Section 08 81 00 Page 15

[[clear] [gray] [bronze] [____]] . The total thickness must be nominally
[____] mm (inch). [Provide [____].]]

## 2.12.7 Bullet-Resisting Glass

Fabricated from Type I, Class 1, Quality q3 glass with polyvinyl butyral plastic interlayers between the layers of glass and listed by UL MEAPD as bullet resisting, with a power rating of [Medium--Small Arms] [High--Small Arms] [Super--Small Arms] [High--Rifle] in accordance with UL 752. Provide [ ] [where indicated].

[2.1<del>2</del>.8 Mirrors

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NOTE: For Army projects only. Navy projects will specify mirrors in Division 10, Specialties. Select the frames (J-Mold channels) or clips to secure mirror to wall. Mastic is required with each type of installation. Mirror sizes will be shown on the drawings. Coordinate with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS, section 05 51 00 METAL STAIRS or section 05 51 33 METAL LADDERS and Section 10 28 13 TOILET ACCESSORIES to ensure that frames are specified for these mirrors.

One-way vision glass should be used for psychiatric and security observation windows. Where safety glazing is required, specify either laminated glass or tempered glass.

2.12.8.1 Glass Mirrors

Glass for mirrors must be Type I transparent flat type, Class 1-clear, Glazing Quality ql 6 mm (1/4 inch) thick conforming to ASTM C1036. Glass must be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating must be highly adhesive pure silver coating of a thickness which must provide reflectivity of 83 percent or more of incident light when viewed through 6 mm (1/4 inch) thick glass, and must be free of pinholes or other defects. Copper protective coating must be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and must be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint must consist of two coats of special scratch and abrasion-resistant paint , and must be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

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]2.12.9 One-Way Vision Glass (Transparent Mirrors)

Type I, Class 1, Quality q1, 6 mm (1/4 inch) thick, coated on one face with a hard, adherent film of chromium or other approved coating of equal durability. Glass must transmit not less than 5 percent or more than 11 percent of total incident visible light and must reflect from the front surface of the coating not less than 45 percent of the total incident visible light. [Provide [ ].]

2.12.10 Tempered Glass

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ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class [1 (transparent)] [2 (tinted heat absorbing)], Quality q3, [___] mm (inch) thick, [___] percent light transmittance, [___] percent shading coefficient conforming to ASTM C1048 and GANA Standards Manual. Color must be [[clear] [bronze] [gray] [___]]. [Provide [___]] [and wherever safety glazing material is indicated or specified].

2.12.11 Heat-Strengthened Glass

ASTM C1048, Kind HS (heat strengthened), Condition A (uncoated), Type I, Class [1 (clear)] [2 (tinted heat absorbing)], Quality q3, [____] mm (inch) thick. [Provide [ ].]

2.12.12 Spandrel Glass

2.12.12.1 Ceramic-Opacified Spandrel Glass

Ceramic-opacified spandrel glass must be Kind HS heat-strengthened transparent flat type, Condition B, coated with a colored ceramic material on No. 2 surface, Quality q3 - glazing select, [___] mm ([___] inch)thick, conforming to ASTM C1048. Glass performance must be K-Value/Winter Nighttime [___], (R-Value/Winter Nighttime [___],) shading coefficient [__]. Color must be [__].

2.12.12.2 Film-Opacified Spandrel Glass

Film-opacified spandrel glass must be Kind HS heat-strengthened transparent flat type, Quality q3 - glazing select, Condition C glass with a polyester or polyethylene film 0.025 mm to 0.127 mm (2 mils to 5 mils) thick attached to No. 2 surface of a sputtered solar-reflective film, conforming to ASTM C1048. Film opacification must be compatible to and specifically developed for application to solar reflective films. Glass performance must be K-Value/Winter Nighttime [____], (R-Value/Winter Nighttime [___],) shading coefficient [___].

2.12.12.3 Spandrel Glass With Adhered Backing

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NOTE: Spandrel glass with adhered backing is required wherever glass spandrels are located above sidewalks, pedestrian or vehicular ramps, paved plazas, entrances not covered by a protective canopy, and other locations where glass could fall onto an area used by the public.

ASTM C1048, Kind HS or FT, Condition B (ceramic coated), Type I, Quality q5, [___] mm (inch) thick and must pass the fallout resistance test specified in ASTM C1048. [Provide [ ].]

2.12.13 Fire/Safety Rated Glass

Fire/safety rated glass must be laminated Type I transparent flat type, Class 1-clear. Glass must have a [20] [45] [60] [____] minute rating when tested in accordance with ASTM E119. Glass must be permanently labeled with appropriate markings.

2.12.14 Tinted (Light-Reducing) Glass

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Tinted (light-reducing) glass must be Type I transparent flat type, Class 3tinted, Quality q3 - glazing select, [____] percent light transmittance, [____] percent shading coefficient, conforming to ASTM C1036. [Color must be [[gray] [bronze] [___]] [as shown in Section 09 06 00 SCHEDULES FOR FINISHES].]

## 2.23 INSULATING GLASS UNITS

performance and comfort.

Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

U value (rate of heat transfer) and SHGC (how much heat the building gains from the sun) are determined on a whole-opening basis (glazing and frame). Energy

Star labeling is applicable to residential units only. Specify U value and SHGC in the appropriate exterior opening (window, door, curtain wall) sections and coordinate insulated glass description with energy performance requirements specified in those sections. Include bracketed U value and SHGC requirements here only if not specified elsewhere as a whole-opening rating for frame and glass.

Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain. Windows on the west and east sides experience maximum solar gain in summer and should have a low SHGC (how much heat the building gains from the sun). Low SHGC is achieved with selective glass, tinted glass, or reflective coating. Specify selective glass for clear appearance or when high visible transmittance is required for daylighting goals. In the Northern Hemisphere, south side glass may be protected from summer sun by an overhang and have a high SHGC if winter heat is useful. Specify a low SHGC for southside glass if the building is dominated by internal heat gain and solar heat is unwelcome even in winter. North side receives very little sun and requires no special treatment.

Installing energy efficient windows contributes to the requirements of UFC 1-200-02, High Performance and Sustainable Building Requirements and meeting minimum building envelope insulation requirements of UFC 3-101-01, Architecture.

NOTE: STC levels higher than 35 may require costly design modifications and special glazing. STC addresses construction subject to interior sound frequencies and does not include all typical outdoor frequencies; Outside-Inside Transmission Class (OITC) was developed to evaluate an expanded sound-frequency range generally considered to be more reflective of exterior noise conditions imposed on the building envelope such as road, rail, and airplane traffic.

Two panes of glass separated by [a dehydrated [ 13 mm (1/2 inch) airspace, filled with argon][ 10 mm (3/8 inch) airspace, filled with krypton] gas,][ [16][32][___] mm ([0.63][1.26][___] inches) of aerogel] and hermetically sealed. [Residential windows (including frames and glass) must be Energy Star qualified products as appropriate to [Northern] [North/Central] [South/Central] [Southern] climate zone.] [Non-residential glazed systems (including frames and glass) must be certified by the National Fenestration Rating Council with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [___] determined according to NFRC 200 procedures and a Ufactor maximum of [___] [W/m2-K] ([Btu/hr-ft2-F]) in accordance with NFRC 100.] Glazing must meet or exceed a luminous efficacy of 1.0. Glazed panels must be rated for not less than [26] [30] [35] [ ] Sound

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Transmission Class (STC) when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413. Dimensional tolerances must be as specified in IGMA TR-1200. Spacer must be black, roll-formed, [thin-gauge, C-section steel] [steel-reinforced butyl rubber] [thermally broken aluminum] [polyurethane and silicon foams], with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal must be compressed polyisobutylene and the secondary seal must be a specially formulated silicone.

Two panes of glass separated by a dehydrated airspace and hermetically sealed. Dimensional tolerances must be as specified in IGMA TR-1200. Spacer must be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal must be compressed polyisobutylene and the secondary seal must be a specially formulated silicone.

## 2.23.1 Buildings

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NOTE: When antiterrorism/force protection requirements apply, specify laminated annealed flat glass for interior light. Use the bracketed option regarding ASTM C1172 in the paragraph below.

NOTE: Where safety glazing is required, both lights of insulating units must be safety glass, and each light must have a permanent label.

NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

NOTE: U value (rate of heat transfer) and SHGC (how much heat the building gains from the sun) are determined on a whole-opening basis (glazing and frame). Specify U value and SHGC in the appropriate exterior opening (window, door, curtain wall) sections and coordinate insulated glass description with energy performance requirements specified in those sections. Include bracketed U value and SHGC requirements here only if not specified elsewhere as a whole-opening rating for frame and glass. Determine appropriate values by consulting ASHRAE 90.1 - SI (ASHRAE 90.1 - IP).

Window properties are critical to energy performance and visual satisfaction. Low SHGC is achieved with selective glass, tinted glass, or reflective coating. Specify selective glass for clear appearance or when high visible transmittance is

required for daylighting goals. In the Northern Hemisphere, south side glass may be protected from summer sun by an overhang and have a high SHGC if winter heat is useful. Specify a low SHGC for southside glass if the building is dominated by internal heat gain and solar heat is unwelcome even in winter. North side receives very little sun and requires no special treatment.

Consider glazing with aerogel insulation between 2 panels of glass, producing the highest visual transmittance with the highest insulation values currently available. Verify availability and cost before specifying aerogel.

Installing energy efficient windows contributes to achieving sustainability requirements as outlined in UFC 1-200-02.

For specifying pre-assembled window units used in residential buildings, utilize the following UFGS Sections: 08 51 13 Aluminum Windows, 08 52 00 Wood Windows, or 08 53 00 Plastic Windows.

Designer must verify availability and adequate competition for products energy performance requirements before specifying and edit as needed.

NOTE: STC levels higher than 35 may require costly design modifications and special glazing. STC addresses construction subject to interior sound frequencies and does not include all typical outdoor frequencies; Outside-Inside Transmission Class (OITC) was developed to evaluate an expanded soundfrequency range generally considered to be more reflective of exterior noise conditions imposed on the building envelope such as road, rail, and airplane traffic.

Two panes of glass separated by a dehydrated airspace[, filled with argon gas][, filled with krypton gas,][, filled with aerogel] and hermetically sealed.

[Insulated glass units must have a Solar Heat Gain Coefficient (SHGC) maximum of [____] and a U-factor maximum of [___] W per square m by K ( Btu per square foot by hr by degree F).]

[Glazing must meet or exceed a luminous efficacy of 1.0.] [See section[s][____] for energy performance requirements for glazed systems (glazing and frames).] [Glazed panels must be rated for not less than [26] [30] [35] [___] Sound Transmission Class (STC) when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E413.]

Dimensional tolerances must be as specified in IGMA TR-1200. Spacer must be black, roll-formed, [thin-gauge, C-section steel] [steel-reinforced buty]

rubber] [thermally broken aluminum] [polyurethane and silicon foams], with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal must be compressed polyisobutylene and the secondary seal must be a specially formulated silicone.

The inner light must be [ASTM C1172, clear annealed flat glass Type I, Class I, Quality q3] [ASTM C1036, Type I, Class 1, Quality q4, [____] mm (inch) thick] [ASTM C1048, Grade B (fully tempered), Style I (uncoated), Type I, Class 1 (transparent), Quality q4, [____] mm (inch) thick]. The outer light must be [ASTM C1036, Type I, Class [1 (transparent)] [2 (tinted heat absorbing)], [2 (solar-reflective)], Quality q4, [____] mm (inch) thick] [ASTM C1048, Grade B (fully tempered), Style I (uncoated), Type I, Class [1 (clear)] [2 (tinted heat absorbing)][solar-reflective], Quality q4, [___] mm (inch) thick].

### 2.23.2 Control Towers

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NOTE: For Air Force installations, do not modify these requirements without approval of Headquarters, U.S. Air Force. Where design wind speed is more than 225 kilometers (140 miles) per hour, delete the first and use the second bracketed sentence. Coordinate term of warranty with paragraph WARRANTY.

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NOTE: Requirements for control tower cab windows will be included in the project specification for Air Force construction. The use of these requirements by other agencies should be governed by agency criteria. Requirements for control tower cab windows are for the sizes and details on the current standard Air Force control tower drawings. Any modification from Air Force installations will be made only with the approval of Headquarters, U.S. Air Force. Edit this paragraph to include only the heat-absorbing insulating glass or the clear insulating glass.

Wind load requirements must be determined by the designer and the blanks filled in for each project.

If spare units are required for a particular project an "Extra Materials" paragraph must be developed for PART 1 which identifies the items, states quantities, and indicates to whom, when and where to be delivered.

For overseas work the following subparagraph will also be added:

1. When units other than United States manufacturer are proposed for use, the manufacturer must prove successful use of the insulating window units in aircraft control tower cabs.

#### 

Control tower glass units must be of sizes required to properly fit aluminum frames. Tolerances and clearances for units must be designed to prevent the transfer of stress in aluminum frames to the glass. Resilient setting blocks, spacer strips, clips, bolts, washers, angles, glazing sealants, and resilient channels or cemented-on-materials must be of the type recommended in the glass manufacturer's approved written instructions. Edges and corners of units must not be ground, nipped, cut, or fitted after leaving the factory.

### 

NOTE: The insulated glass system should be used for clarity and insulation, unless structural loadings dictate laminated glass be used. Navy/Marine Corps Air Traffic Control Towers must normally use laminated glass in hurricane prone or high wind areas and for large panes of glass where it would be difficult to maintain the 13 mm (1/2 inch) separation evenly in an insulated glass system. Refer to UFC 4-133-01N, "Navy Air Traffic Control Facilities" for guidance.

### 2.23.2.1 Control Tower Insulating Glass

Insulating glass units for air traffic control towers must meet the wind load design requirement of [ ] kPa ([ ] psi,) as determined in accordance with ASCE 7. Insulating glass must be Class A preassembled units of dual-seal construction consisting of two lites of glass separated by a dark bronze aluminum, steel, or stainless steel, spacer with desiccant and dehydrated space. Spacer must be roll-formed, with bent or tightly welded or keyed and sealed joints, to completely seal the spacer periphery to eliminate moisture and hydrocarbon vapor transmission into airspace through corners. Primary seal must be compressed polyisobutylene. Secondary seal must be silicone. Insulating glass units must be fabricated for use at an elevation of [___] meters ([___] feet) above mean sea level and [___] meters ([___] feet) above grade. Within bottom 1/3 of one of the vertical edges of each unit, the manufacturer must install an open 305 mm (12 inch) long capillary/breather tube for pressure equalization. The insulating glass units must be free of parallax or optical distortions. The manufacturer's identifying label must be permanently affixed to both exterior surfaces of the glass units. The insulating glass units must be a total thickness of 26 mm (1 inch) consisting of two 6 mm (1/4 inch) thick panels and air space, or a total thickness of 32 mm (1-1/4 inch) consisting of two 10 mm (3/8 inch) thick panels and air space, or a total thickness of 38 mm (1-1/2 inch) consisting of two 13 mm (1/2 inch) thick panels and an air space, as required to meet the wind loads indicated. Glass type must be as follows.

2.23.2.2 Control Tower Heat-Absorbing Insulating Glass

 Heat-absorbing insulating glass must consist of two glass panels separated by an air space and must conform to ASTM C1036, Type I, transparent flat glass, Style A, Quality q3 - glazing select. Interior glass must be Class 1-clear and exterior glass must be Class 2-tinted green. Glass performance must be minimum Visible Transmittance of [70.8] [____] percent for each panel and K-Value of 3.07 (R-Value of 1.85) for the unit.

### 2.23.2.3 Control Tower Clear Insulating Glass

Clear insulating glass must consist of two float glass panels separated by an air space and must conform to ASTM C1036, Type I transparent flat glass, Quality q3-glazing select. Interior glass and exterior glass must be Class 1-clear. Glass performance must be minimum Visible Transmittance of [87.3] [____] percent for each panel and K-Value of 3.07 (R-Value of 1.85) for each unit.

## 2.23.2.4 Control Tower Laminated Glass

Laminated glass units for air traffic control towers must meet the wind load design requirement of [___] kPa ([___] psi,) as determined in accordance with ASCE 7. ASTM C1172, Kind LA fabricated from two nominal 12.5 mm (1/2 inch)pieces of Type I, Class 1, Quality q3, flat annealed transparent glass conforming to ASTM C1036. Flat glass must be laminated together with a minimum of 0.75 mm (0.030 inch )thick, clear polyvinyl butyral interlayer or alternatives such as resin laminates, conforming to requirements of 16 CFR 1201 and ASTM C1172. The total thickness must be nominally 25 mm (1 inch). Color must be [[clear] [gray] [bronze] [___]]. [Provide [___].]

### 2.23.3 Low Emissivity Insulating Glass

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NOTE: Low emissivity coating should be on the air space surface of the inner pane of glass (the number 3 surface) in heating-dominated buildings, and on the number 2 surface (inside surface of the exterior pane) in cooling-dominated buildings.

NOTE: Design must meet the requirements of UFC 1-200-02, "High Performance and Sustainable Building Requirements" which invokes the requirements within UFC 3-101-01, "Architecture". UFC 1-200-02 and UFC 3-101-01 make references throughout to various ASHRAE documents governing energy efficiency and requirements for the components of building envelope design including fenestrations and glazing.

Interior and exterior glass panes for Low-E insulating units must be Type I annealed flat glass, Class [1-clear] [2-tinted] with anti-reflective lowemissivity coating on [No. 2 surface (inside surface of exterior pane)][No. 3 surface (inside surface of interior pane)], Quality q3 - glazing select, conforming to ASTM C1036. Glass performance must be U value maximum of [____] [W/m2-K] ( [Btu/hr-ft2-F]), Solar Heat Gain Coefficient (SHGC) maximum of [____]. Color must be [[green] [gray] [bronze] [blue] [___]] [as shown in Section 09 06 00 SCHEDULES FOR FINISHES].

# 2.<u>3</u>4 PLASTIC GLAZING

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*****	***************************************
NOTE	Plastic glazing may be used in some areas
wher	e high resistance to breakage is required, but
comb	oustibility must be considered in the design. See
manu	ifacturers' literature for many types available.
Do n	not specify plastic for glazing unprotected
oper	lings, for roof panels, or for skylights without
CODS	sulting HFC 3-600-01. "Fire Protection Engineering
for	Facilities" and NAVFACENGCOM Code 04F
****	***************************************
*****	*************************
NOTE	2: Polycarbonate is more expensive than acrylic
and	should only be selected for locations which are
high	blouid only be beleeded for receipting which are
	ny vuinelable co vandalism of other types of
abus	se. Avoid polycarbonate il possible due to
pote	Intially nazardous constituent chemicals
(inc	Luding Bisphenol A). Where only one material is
used	l in the project, the other one should be deleted.
Wher	e translucent plastic sheets are required,
loca	tions will be shown on the contract drawings.
The	following will be added at the end of the
para	lgraph:
"Tra	anslucent sheets, where shown, must be white
havi	ng light transmission of [ ] percent for
shee	ets [ ] mm (inches) thick, or clear with matt
fini	.sh."
The	light transmission required for a particular
shee	at thickness will be selected from plastic sheet
manu	ifacturer's catalogs.
Acres	lic-plactic is a combustible material and must
ACLY	he used in areas where evenesure to fire would
100	be used in areas where exposure to fire would
Crea	tte a nazard condition.
Cons	der glazing with aerogel insulation between 2
pane	els of plastic, producing the highest visual
tran	smittance with the highest insulation values
curr	rently available. Plastic glazing must have a U-
fact	or maximum of the specified II-factor for
incu	Jating glass units Varify availability and cost
LIISU	rating grass units. Verity availability and Cost
Derc	re specifying derogel.
Plastic glazin	g must have a U-factor maximum of [] W per square m by K
(Btu per squar	e foot by hr by degree F). [Plastic glazing must include a
[16][32][	] mm ([0.63][1.26][] inch) layer of aerogel between
panels.]	

2.<u>3</u>4.1 Acrylic Sheet

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ASTM D4802, [Type I, regular] [Type II, heat resistant,] [clear and smooth on both sides] [translucent, textured on both sides,] [gray tint,] [bronze tint,] ultraviolet stabilized, [scratch resistant,] [___] [6] [___] mm ([0.236] [ ] in.) thick.

2.34.2 Polycarbonate Sheet

ANSI 297.1, [Clear and smooth both sides] [Translucent, textured both sides] [Gray tint] [Bronze tint] [mar-resistant] [high abrasion resistant], ultraviolet stabilized, [___] mm (inch) thick and listed in UL MEAPD as burglar resisting.

2.34.3 Extruded Polycarbonate Profiled Sheet

Provide [double] [triple] walled, surface treated for improved UV resistance, offering thermal efficiency and impact strength.

2.34.4 Bullet-Resistant Plastic Sheet

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NOTE: Bullet-resisting glazing material is available in four power ratings to resist scattered shots from (1) medium-power small arms (MSA); (2) high-power small arms (HSA); (3) super-power small arms (SSA); and (4) high-power rifles (HR). Bullet-resisting acrylic sheet is listed by UL for MSA rating only and is 25.4 mm (one inch) thick. Bullet-resisting polycarbonate sheet is listed for MSA 25.4 mm (one inch) and for HSA and SSA ratings 31.8 mm (1 1/4 inch). Consult manufacturers for exact thicknesses and availability.

Cast acrylic sheet or mar-resistant polycarbonate sheet laminated with a special interlayer, and listed in UL 752 as bullet resisting, Class [I] [II] [III], [clear] [ ] in color. [Provide [ ].]

## 2.45 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted must be gray or neutral color.

2.45.1 Putty and Glazing Compound

Provide glazing compound as recommended by manufacturer for face-glazing metal sash. Putty must be linseed oil type. Do not use putty and glazing compounds with insulating glass or laminated glass.

## 2.45.2 Glazing Compound

Use for face glazing metal sash. Do not use with insulating glass units or laminated glass.

### 2.4<del>5</del>.3 Sealants

1

Provide elastomeric [and structural] sealants.

2.45.3.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing [wood] [and] [metal] sash. Sealant must be chemically compatible with setting blocks, edge blocks, and sealing tapes[, with sealants used in manufacture of insulating glass units] [, and with plastic sheet]. Color of sealant must be white.

2.45.3.2 Structural Sealant

ASTM C1184, Type S.

2.4<del>5</del>.4 Joint Backer

Joint backer must have a diameter size at least 25 percent larger than joint width; type and material as recommended in writing by glass and sealant manufacturer.

2.45.5 Preformed Channels

Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the particular condition. [Channels for bullet-resistant glass must be synthetic rubber, ASTM C864, not less than 6 mm (1/4 inch) thick and sufficiently resilient to accommodate expansion and contraction while maintaining a vaportight seal between glass and frame.] [Channels must be chemically compatible with plastic sheet.]

2.45.6 Sealing Tapes

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D2287. Use only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes must be chemically compatible with the product being set.

2.4<del>5</del>.7 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks must be dense extruded type conforming to ASTM C509 and ASTM D395, Method B, Shore A durometer between 70 and 90. Edge blocking must be Shore A durometer of 50 (plus or minus 5). Provide silicone setting blocks when blocks are in contact with silicone sealant. Profiles, lengths and locations must be as required and recommended in writing by glass manufacturer. Block color must be black.

2.45.8 Glazing Gaskets

Glazing gaskets must be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening must be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets must be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Provide glazing gasket profiles as recommended by the manufacturer for the intended application.

### 2.45.8.1 Fixed Glazing Gaskets

Fixed glazing gaskets must be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C509, Type 2, Option 1.

2.45.8.2 Wedge Glazing Gaskets

Wedge glazing gaskets must be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C864, Option 1, Shore A durometer between 65 and 75.

2.45.8.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing must be permanent, elastic, nonshrinking, non-migrating, watertight and weathertight.

2.4<del>5</del>.9 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

#### [2.5<del>6</del> MIRROR ACCESSORIES

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### 2.5<del>6</del>.1 Mastic

Mastic for setting mirrors must be a [polymer] [____] type mirror mastic resistant to water, shock, cracking, vibration and thermal expansion. Provide mastic compatible with mirror backing paint, and as approved by mirror manufacturer.

### 2.5<del>6</del>.2 Mirror Frames

Provide mirrors with mirror frames (J-mold channels) fabricated of one-piece roll-formed Type 304 stainless steel with No. 4 brushed satin finish and concealed fasteners which will keep mirrors snug to wall. Frames must be 32 by 6 by 6 mm (1-1/4 by 1/4 by 1/4 inch) continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material must be provided with mirror frames.

## 2.5<del>6</del>.3 Mirror Clips

Provide clips with concealed fasteners of type to suit wall construction material.

## ]PART 3 EXECUTION

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

## 3.1 PREPARATION

Preparation, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

## 3.2 GLASS SETTING

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Aluminum windows, wood doors, and wood windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

## 3.2.1 Sheet Glass

Cut and set with the visible lines or waves horizontal.

3.2.2 Patterned Glass

Set glass with one patterned surface with smooth surface on the weather side. When used for interior partitions, place the patterned surface in same direction in all openings.

### 3.2.3 Insulating Glass Units

Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation must conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

3.2.4 Installation of Wire Glass

Install glass for fire doors in accordance with installation requirements of NFPA 80.

3.2.5 Installation of Heat-Absorbing Glass

Provide glass with clean-cut, factory-fabricated edges. Field cutting will not be permitted.

3.2.6 Installation of Laminated Glass

Sashes which are to receive laminated glass must be weeped to the outside to allow water drainage into the channel.

### 3.2.7 Plastic Sheet

Conform to manufacturer's recommendations for edge clearance, type of sealant and tape, and method of installation.

### 3.3 ADDITIONAL REQUIREMENTS FOR GLAZING CONTROL TOWER WINDOWS

### 3.3.1 Materials and Methods of Installation

Comply with the manufacturer's warranty and written instructions, except as indicated. Install units with the heat-absorbing glass to the exterior. Secure glass in place with bolts and spring clips. The minimum clearance between bolts and edge of glass unit must be 4.75 mm (3/16 inch). The glass must be edged with 4.75 mm (3/16 inch) thick continuous neoprene, vinyl, or other approved material. Trim edging after installation. The channel shapes or strips must be firmly held against the glass by the spring action of the extruded metal moldings. Resilient setting blocks, spacer strips, clips, bolts, washers, angles, applicable glazing compound, and resilient channels or cemented-on materials must be as recommended in the written instructions of the glass manufacturer, as approved.

3.3.2 Tolerances and Clearances of Units

Design to prevent the transfer of stress in the setting frames to the glass. Springing, twisting, or forcing of units during setting will not be permitted.

3.4 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass must be clean at the time the work is accepted. [Clean plastic sheet in accordance with manufacturer's instructions.]

## 3.5 PROTECTION

Protect glass work immediately after installation. Identify glazed openings with suitable warning tapes, cloth or paper flags, attached with nonstaining adhesives. Protect reflective glass with a protective material to eliminate any contamination of the reflective coating. Place protective material far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Upon removal, separate protective materials for reuse or recycling. Remove and replace glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities with new units.

## 3.6 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
Glass	1/8 inch	3 mm
	3/16 inch	4.5 mm
	7/32 inch	6 mm
	1/4 inch	6 mm
	3/8 inch	10 mm
Interlayer	0.015 inch	0.38 mm
Glazing Channels	1/4 inch	6 mm

-- End of Section --