
USACE / NAVFAC / AFCEC / NASA UFGS-08 51 13 (May 2011)

Preparing Activity: NAVFAC Superseding
UFGS-08 51 13 (August 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2015

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SECTION 08 51 13

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05/11

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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 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 items(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 Criteria Change Request (CCR).

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.
- g. Electrical requirements for motor driven
operators.

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.
- 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.

8. Locations of windows designated as forced entry resistant.

PART 1 GENERAL

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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 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 (2002) Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

AAMA 2604 (2010) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

AAMA 2605 (2011) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

AAMA 611 (1998; R 2004) Voluntary Specification for Anodized Architectural Aluminum

AAMA 701/702 (2004) Voluntary Specification for Pile

Weatherstripping and Replaceable
Fenestration Weatherseals

AAMA 902	(1992; R 1999; R 2007) Voluntary Specification for Sash Balances
AAMA WSG.1	(1995) Window Selection Guide
AAMA/WDMA/CSA 101/I.S.2/A440	(2011) Standard/Specification for Windows, Doors, and Skylights

ASTM INTERNATIONAL (ASTM)

ASTM A276/A276M	(2015) Standard Specification for Stainless Steel Bars and Shapes
ASTM D1972	(1997; R 2005) Standard Practice for Generic Marking of Plastic Products
ASTM E1300	(2012a; E 2012) Determining Load Resistance of Glass in Buildings
ASTM E2129	(2010) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM F1642	(2012) 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

GREEN SEAL (GS)

GS-36	(2011) Commercial Adhesives
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INTERNATIONAL WINDOW CLEANING ASSOCIATION (IWCA)

IWCA I-14.1	(2001) Window Cleaning Safety Standard
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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) Life Safety Code
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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168

(1989; R 2005) Adhesive and Sealant Applications

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC

(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

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 projects.

An "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook 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 Notebook, 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[, [____]]

Hardware; G[, [____]]

Fasteners; G[, [____]]; (LEED NC)

Window performance; G[, [____]]

Thermal-Barrier Windows; G[, [____]]

Mullions; G[, [____]]

Window Cleaners' Bolts; G[, [____]]

Submit documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

Screens; G[, [____]]

Weatherstripping; G[, [____]]

Accessories; G[, [____]]

[Adhesives; (LEED NC)

Submit manufacturer's product data, indicating VOC content.]

Thermal performance

Submit documentation for Energy Star qualifications.

[Local/Regional Materials; (LEED NC)

Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.]

[Environmental Data]

SD-04 Samples

Finish Sample

Window Sample

SD-05 Design Data

Structural calculations for deflection; G[, [_____]]

[Design Analysis; G[, [_____]]

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, shall be prepared and signed by a registered Professional Engineer. The window components and anchorage devices to the structure, as determined by the design analysis, shall 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, shall be included in a test report, providing information in accordance with ASTM F1642, as prepared by the independent testing agency performing the test. The test results shall 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

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

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

Plastic Identification

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

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

NOTE: Choose one of the following options. Include the first choice for projects requiring a large number of windows. Include the second choice for projects requiring a limited number of windows.

[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 SUSTAINABLE DESIGN REQUIREMENTS

1.7.1 Local/Regional Materials

NOTE: Using local materials can help minimize transportation impacts, including fossil fuel consumption, air pollution, and labor. Using materials harvested and manufactured within a 500 mile radius from the project site contributes to the following LEED credit: MR5. Coordinate with Section 01 33 29 LEED(tm) DOCUMENTATION. Use second option if Contractor is choosing local materials in accordance with Section 01 33 29 LEED(tm) DOCUMENTATION. Use second option for USACE projects. Army projects must include option only if pursuing this LEED credit.

[Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [800][_____] kilometer [500][_____] mile radius from the project site, if available from a minimum of three sources.][See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total local material requirements. Window materials may be locally available.]

1.7.2 Environmental Data

NOTE: ASTM E2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products.

[Submit Table 1 of ASTM E2129 for the following products: [____].]

1.7.3 Plastic Identification

NOTE: The marking system indicated below is intended to provide assistance in identification of products for making subsequent decisions as to handling, recycling, or disposal.

Verify that plastic products to be incorporated into the project are labeled in accordance with ASTM D1972. Where products are not labeled, provide product data indicating polymeric information in the 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. "Minimum Antiterrorism Performance", "Thermal Performance" and "Sound Attenuation" are optional to designer, and must be omitted or revised as needed to meet project requirements.

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

1.11.2.1 Computational Design Analysis Method

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

NOTE: The blank in the following paragraph should be the value of the equivalent 3-second duration design loading obtained from Figure 1 of ASTM F2248 for the explosive weight and standoff distance combination that is being designed for in this project.

Aluminum window framing members shall 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 shall 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 shall be in accordance with 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 shall 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 associated with the applicable low level of protection for the project.

1.11.2.3 [Standard Airblast Test Method

**NOTE: The following paragraph shall 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 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 shall be tested for evaluation of hazards generated from airblast loading in accordance with ASTM F1642 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 shall require testing to evaluate their hazard rating. Testing may be by shocktube or arena test. The test shall be performed on the entire proposed window system, which shall include, but not be limited to, the glazing, its framing system, operating devices, and all anchorage devices. Anchorage of the window frame or subframe shall replicate the method of installation to be used for the project. The minimum airblast

loading parameters for the test shall 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 F1642, shall 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 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, designer shall input Solar Heat Gain Coefficient (SHGC) and U values based on ASHRAE 90.1, using either prescriptive envelope option or energy performance modeling as applicable to project design. 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.

Installing energy efficient windows contributes to the following LEED credits: EA Prerequisite 2; EA1.

[Non-residential aluminum windows (including frames and glass) shall 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/m²K Btu/hr-ft²-F in accordance with NFRC 100.]

[Residential aluminum windows (including frames and glass) shall be Energy Star qualified products as appropriate to [Northern] [North-Central] [South-Central] [Southern] climate zone. To meet Energy Star criteria for the [Southern climate one, thermal properties of windows must not exceed a U-factor of 3.4 W/m²K 0.60 Btu/hr-ft²-F determined according to NFRC 100, and a solar heat gain coefficient (SHGC) of 0.27 determined according to NFRC 200.] [South-Central climate zone, thermal properties of windows must not exceed a U-factor of 2.0 W/m²K 0.35 Btu/hr-ft²-F determined according to NFRC 100, and a solar heat gain coefficient (SHGC) of 0.30 determined

according to NFRC 200.][North-Central climate zone, thermal properties of windows must not exceed a U-factor of $1.8 \text{ W/m}^2\text{K}$ $0.32 \text{ Btu/hr-ft}^2\text{-F}$ determined according to NFRC 100, and a solar heat gain coefficient (SHGC) of 0.40 determined according to NFRC 200.][Northern climate zone, thermal properties of windows must not exceed a U-factor of 1.7 W/m^2 $0.30 \text{ Btu/hr-ft}^2\text{-F}$ determined according to NFRC 100].]

1.11.6 [Life Safety Criteria

NOTE: Designer must indicate on the drawings which windows serve as rescue and/or secondary means of escape.

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

NOTE: Aluminum environmental control windows have a "built-in" sound attenuation. This paragraph will be used only when sound attenuation is a design parameter.

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

NOTE: Requesting mock-up samples of aluminum windows is not required for most projects. Size of project and scope of quality control should be carefully evaluated before requiring Contractor to provide a costly mock-up. Delete paragraph if mock-ups are not required.

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

2.1 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 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 of materials with recycled content, calculated on the basis of post-industrial and

post-consumer percentage content, contributes to the following LEED credit: MR4. Coordinate with Section 01 33 29 LEED(tm) DOCUMENTATION. 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. Use second option if Contractor is choosing recycled content products in accordance with Section 01 33 29 LEED(tm) DOCUMENTATION.

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 windows of types, performance classes, performance grades, combinations, and sizes indicated or specified.[Windows must contain a minimum of [5][10][_____] percent post-consumer recycled content, or a minimum of [20][40][_____] percent post-industrial recycled content.][See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Window materials may contain post-consumer or post-industrial recycled content.] 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.

NOTE: Performance Grades represent design pressure values for which products have been tested. Specify an Optional Performance Grade where a higher than minimum Performance Grade is desired due to severe weather conditions and wind loadings. Optional Performance Grade windows must be tested in compliance with AAMA/WDMA/CSA 101/I.S.2/A440. Testing must substantiate requirements for uniform loading (structural), water resistance, and air infiltration.

2.1.1 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.

2.1.2 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.]

2.1.1.3 Hung Windows (H)

NOTE: Tilt-in windows most likely will not meet ATFP pressure requirements and should not be specified if force protection is required.

[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.

2.1.1.3.1 Window Materials

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

Weatherstripping will be 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.

2.1.1.4 Horizontal Sliding Windows (HS)

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

2.1.1.5 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.

2.1.1.6 Top-Hinged Windows (TH)

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

2.1.1.7 Vertically Pivoted Windows (VP)

NOTE: Pivoting windows most likely will not meet ATFP pressure requirements and should not be specified if 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.]

2.1.1.8 Fixed Windows (F)

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

2.1.1.9 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 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.

2.1.1.10 Glass and Glazing

Materials are specified in Section 08 81 00 GLAZING.

2.1.1.11 Caulking and Sealing

Are specified in Section 07 92 00 JOINT SEALANTS.

2.1.1.12 Weatherstripping

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

2.1.1.13 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.

2.2 FABRICATION

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

2.2.1 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 glazing compound and expansion. Drawings should clearly indicate method for securing insulating glass in place.

NOTE: Include the bracket option for minimum glazing frame bite requirements when personnel density is greater than one person per 40 square meters 430 square feet and minimum ATFP standoff distances are met. This does not include guard type facilities, single and duplex detached family housing. These requirements are specified in Department of Defense Antiterrorism Standards for Buildings.

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.

2.2.2 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) compression-type 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 not use neoprene or polyvinylchloride weatherstripping where they will be exposed to direct sunlight.

2.2.3 Fasteners

Fabricated from 100 percent re-melted steel. Use fasteners as standard

with the window manufacturer for windows, trim, and accessories.
Self-tapping sheet-metal screws are not acceptable for material more than 2 mm 1/16 inch thick.

2.2.4 Adhesives

NOTE: Adhesives are potential sources of VOCs in indoor air. Using interior low-VOC products contributes to the following LEED credit: EQ4. Include VOC submittal if pursuing this LEED credit, and coordinate with Section 01 33 29 LEED(tm) DOCUMENTATION.

[Comply with applicable regulations regarding toxic and hazardous materials, GS-36, [SCAQMD Rule 1168], and as specified in Section 07 92 00 JOINT SEALANTS.]

2.2.5 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.

2.2.6 Combination Windows

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

2.2.7 Mullions and Transom Bars

NOTE: Specify the design pressure used to specify the Performance Grade or the Optional Performance Grade for the adjoining windows.

NOTE: Include the bracketed paragraph included under the "WINDOWS" heading for static loads when minimum measures of antiterrorism/force protection (ATFP) are required and delete the first bracketed sentence in the following paragraph.

[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.]

2.2.8 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.]

2.2.8.1 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.

2.2.8.2 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.

2.2.8.3 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.

2.2.8.4 Window Anchors

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

2.2.9 Finishes

NOTE: Specify anodic and organic coatings as Contractor's option when these finishes are determined to be economically competitive in the project area, unless the project requires use of one or the other to match an existing condition.

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

2.2.9.1 Anodic Coating

NOTE: Specify Architectural Class I for highly corrosive industrial atmospheres where dust, gases, salts, and other destructive elements that attack metal exist. Specify Architectural Class II for all atmospheric conditions not requiring Class I.

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.]

2.2.9.2 Organic Coating

NOTE: When anodic and organic coatings are determined to be economically competitive in the project area, specify baked enamel finish (AAMA 2603) as an option to Architectural Class II, anodic coating or high-performance finish (AAMA 2604 or AAMA 2605) as an option to Architectural Class I, anodic 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].

2.2.10 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.

2.3 SPECIAL OPERATORS

**NOTE: Remote and group operated windows will
require special operators. Identify these windows
on the drawings and show method of operation.**

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.

2.3.1 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.

2.3.2 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.

2.3.3 Mechanical Operators

**NOTE: When motor driven operators are specified,
specify electrical characteristics in Section
26 20 00, INTERIOR DISTRIBUTION SYSTEM.**

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. Operators will control window units in groups [as recommended by the window manufacturer] [or] [as indicated].

2.4 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 will 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 will be factory-glazed with the type of glass indicated and of the quality specified in Section 08 81 00 GLAZING.

2.5 MULLIONS

NOTE: Drawings must indicate the profile and dimensions of mullions, anchorage and reinforcing members as required for wind loading, and the type, profile, and fastening system for the mullion cover (screw-fastened or snap-on).

Provide mullions between multiple-window units where indicated.

Mullions and mullion covers must be the profile indicated, 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 shall be fabricated of the materials specified in AAMA/WDMA/CSA 101/I.S.2/A440 and meet the specified design loading.

2.6 WINDOW CLEANERS' BOLTS

Provide window cleaners' bolts for all windows 2100 millimeter 7 feet or higher above finished grade, except windows located so they may be removed for cleaning or 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 and must be located 1120 millimeter 44 inches above the window sill.

Window cleaners' bolts must be double-head type, AISI Series 300 corrosion-resistant steel, size and design complying with IWCA I-14.1. Contact side of the bolts will be ground to fit flat against window jambs. Bolts may 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 corrosion-resistant 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:

<u>PRODUCTS</u>	<u>INCH-POUND</u>	<u>METRIC</u>
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.

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.

3.4 WASTE MANAGEMENT

**NOTE: Diverting waste from the landfill contributes
to the following LEED credit: MR2. Coordinate with
Section 01 74 19 CONSTRUCTION AND DEMOLITION WASTE
MANAGEMENT.**

Separate corrugated cardboard and protective materials in accordance with the Waste Management Plan and place in designated areas for reuse or recycling. Place materials defined as hazardous or toxic waste in designated containers. Close and seal tightly all partly used sealant containers and store protected in well ventilated fire-safe area at moderate temperature. Place used sealant tubes and containers in areas designated for hazardous materials.

-- End of Section --