
USACE / NAVFAC / AFCEA / NASA UFGS-08 51 13 (August 2009)

Preparing Activity: NAVFAC

Superseding
UFGS-08 51 13 (January 2008)
UFGS-08 51 13.00 20 (July 2006)
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMLR dated October 2009

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ALUMINUM WINDOWS

08/09

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SECTION 08 51 13

ALUMINUM WINDOWS 08/09

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

Note: 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 and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS 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. Calking 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 DAF-45 (2003) 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 (2005) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

AAMA 2605 (2005) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

AAMA 611	(1998) Voluntary Specification for Anodized Architectural Aluminum
AAMA 701	(2004) Voluntary Specification for Pile Weather Strip
AAMA 902	(1999) Voluntary Specification for Sash Balances
AAMA WSG.1	(1995) Window Selection Guide
AAMA/WDMA/CSA 101/I.S.2/A440	(2008; Update 1 2008; Update 2 2008; Update 3 2009) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

ASTM INTERNATIONAL (ASTM)

ASTM A 276	(2008a) Standard Specification for Stainless Steel Bars and Shapes
ASTM D 1972	(1997; R 2005) Standard Practice for Generic Marking of Plastic Products
ASTM E 2129	(2005) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM F 1642	(2004) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings

GREEN SEAL (GS)

GS-36	(2000) 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	(2004) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2004) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2008; Amendment 2009) Life Safety Code
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SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(1989; R 2005) Adhesive and Sealant Applications
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U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star

(1992; R 2006) Energy Star Energy
Efficiency Labeling System

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED

(2002; R 2005) Leadership in Energy and
Environmental Design(tm) Green Building
Rating System for New Construction
(LEED-NC)

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. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" 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.

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.] 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)

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)

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

Thermal performance

Submit documentation for Energy Star qualifications.

[Local/Regional Materials; (LEED)

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 UFC 4-010-01 "DoD Minimum Antiterrorism Standards for Buildings" and paragraph "Minimum Antiterrorism Performance" below. 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 F 1642, 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 calking 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 E 2129 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 E 2129 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 D 1972. 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 Minimum Antiterrorism Performance Criteria

Windows must meet the minimum antiterrorism performance criteria as specified in the paragraphs below.

1.9.1.1 Glazing

Glazing must have laminated glass as specified in Section 08 81 00 GLAZING.

1.9.1.2 Aluminum Window Frames

NOTE: The bracketed blank in the text below should be the value of the equivalent 3-sec duration design loading obtained from Figure 1 of ASTM F 2248 for the explosive weight and standoff distance combination that is being designed for in this project.

Restrict aluminum framing members deflections of edges of glazing they support to $L/160$ under an equivalent 3-second duration loading of [_____] pascal pounds per square foot (psf), where 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 adequate to accept the width of structural silicone sealant or glazing tape as specified in paragraph "Provisions for Glazing" below.

1.9.1.3 Window Frame Anchors

NOTE: The bracketed blank in the text below should be the value of 2 times the loading just determined in paragraph "Aluminum Window Frames".

Fasten window frames to the supporting structure with anchors designed to resist forces generated by a 3-second duration load of [_____] **pascal pounds per square foot (psf)** acting on the entire window unit.

1.9.2 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)**.

[1.9.3 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 criteria of UFC 4-010-01, 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 F 2248 for the explosive weight and standoff distance combination that is being designed for in this project.

Aluminum window framing members shall restrict deflections of edges of glazing they support to $L/160$ under an equivalent 3-second duration loading of [_____] pounds per square foot (psf), where 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 adequate to accept the width of structural silicone sealant or glazing tape as specified in paragraph "Provisions for Glazing" below.

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 forces generated by a 3-second duration load of [_____] pounds per square foot (psf) acting on the entire window unit.

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 the hazard rating associated with the applicable 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 F 1642 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 F 1642 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 F 1642, 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 F 1642 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: A U-factor of up to $4.3 \text{ W/m}^2\text{K}$ (0.75 Btu/hr-ft^2 -F) may be acceptable for particular climate zones in the United States for aluminum window products

and thermally improved aluminum window products. Solar heat gain coefficient (SHGC) ratings should be equal to or less than 2.3 W/m²K (0.40 Btu/hr-ft²-F). Selection and use of the window products in this category should be used only in cooling dominated climates and be dependent upon qualifying for the Southern climate zone as determined by the DOE Energy Star Windows program. Certain products that have aluminum frames and/or thermally improved aluminum frames may qualify per the Energy Star Windows program for the Central and Northern Climate Zones.

Thermal transmittance for thermally broken aluminum windows with insulating glass must not exceed a U-factor of [4.3 W/m²K 0.75 Btu/hr-ft²-F determined according to NFRC 100, and a solar heat gain coefficient (SHGC) of 2.3 W/m²K 0.40 Btu/hr-ft²-F determined according to NFRC 200. Provide window units that comply with the U.S. Department of Energy, Energy Star Window Program for the Southern Climate Zone.][2.3 W/m²K 0.40 Btu/hr-ft²-F determined according to NFRC 100, and a solar heat gain coefficient (SHGC) of 3.1 W/m²K 0.55 Btu/hr-ft²-F determined according to NFRC 200. Provide window units that comply with the U.S. Department of Energy, Energy Star Window Program for the Central Climate Zone.][2.0 W/m²K 0.35 Btu/hr-ft²-F determined according to NFRC 100. Provide window units that comply with the U.S. Department of Energy, Energy Star Window Program for the Northern Climate Zone.]

[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: Designation system consists of 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, C30 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, C, HC, 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 C (corresponding to a design pressure of 1440 Pa 30 psf); 40 for HC (corresponding to a design pressure of 1920 Pa 40 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.

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.

In southern states, windows must have a U factor of 0.75 or lower and a SHGC of 0.40 or lower; in the middle states, windows must have a U factor of 0.40 or lower and SHGC of 0.55 or lower; and in northern states, windows must have a U factor of 0.35 or lower with any SHGC.

Energy-efficient windows contribute to the following LEED credits: EA Prerequisite 2; EA1.

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. Glazed systems (including frames and glass) will be Energy Star labeled products as appropriate to climate zone and as applicable to window type, with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [_____] determined according to NFRC 200 procedures. Glazed systems must have a U-factor maximum of [_____] W per square m times K Btu per square foot times hr times degree F in accordance with NFRC 100.

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][C30][HC40][[C][HC][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][C30][HC40][[C][HC][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.]

2.1.3 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][C30][HC40][[C][HC][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.

2.1.3.1 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, 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.

2.1.4 Horizontal Sliding Windows (HS)

Type HS-[R15][LC25][C30][HC40][[C][HC][AW]- [_____] (Optional Performance Grade)].

2.1.5 Projected Windows (AP)

Type AP-[R15][LC25][C30][HC40][[C][HC][AW]- [_____] (Optional Performance Grade)]. Provide projected windows with concealed four bar friction hinges only.

2.1.6 Top-Hinged Windows (TH)

Type TH-[C30][HC40][[C][HC][AW]- [_____] (Optional Performance Grade)]. Top-hinged windows must be[inswinging][outswinging].

2.1.7 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][C30][HC40][[_____] (Optional Performance Grade)].[Provide window with remotely operated venetian blind mounted between an access sash and the main sash.]

2.1.8 Fixed Windows (F)

Type F-[R15][LC25][C30][HC40][[C][HC][AW]- [_____] (Optional Performance Grade)].

2.1.9 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.

2.1.10 Glass and Glazing

Materials are specified in Section 08 81 00 GLAZING.

2.1.11 Calking and Sealing

Are specified in Section 07 92 00 JOINT SEALANTS.

2.1.12 Weatherstripping

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

2.1.13 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. The width of the structural silicone sealant bead must be at least
equal to, but not larger than two times the thickness designation of the
glass to which it adheres. The width of the adhesive glazing tape will be
at least equal to two times, but not more than four times the thickness
designation of the glass to which it adheres.]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 which meet the design pressure of [720] [1440] [1920] [_____] Pa [15] [30] [40] [_____] psf.]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 A 276. 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 DAF-45 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 inch	1.59 mm 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 --