UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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08/20

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USACE / NAVFAC / AFCEC / NASA	**UFGS-08 51 23 (August 2020)**

Preparing Activity: NAVFAC	**Superseding**
	UFGS-08 51 23 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

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SECTION 08 51 23

STEEL WINDOWS
08/20

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NOTE: This guide specification covers the requirements for standard steel windows.

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

Do not use steel windows in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

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).

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NOTE: In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. When security analysis identifies an explosive threat, antiterrorism upgrades for blast resistance in accordance with Appendix B-3 of UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings, may still apply. If the windows are not required to meet these criteria, then requirements for blast rating, blast testing, forced entry, and antiterrorism criteria should be removed.

****

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NOTE: On the drawings, show:

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

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

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

4. Details of non-structural mullions and mullion covers

5. Locations of special glass such as tempered, insulating, heat-absorbing, light-reducing, bullet-resisting, wire, figured, plate, and spandrel glass.

6. Locations of insect screens and storm windows, if any.

7. Locations of fire-rated windows, if required.

8. Number and location of extension crank operators.

9. If motorized operators are required, show on electrical drawings and specify in Division 16.

****

PART 1 GENERAL

1.1 REFERENCES

****

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

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

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

****

The publications listed below form a part of this specification to the

extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.6.3	(2013; R 2017) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2020) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1011/A1011M	(2018a) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM D3656/D3656M	(2013) Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330/E330M	(2014) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2016) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E1300	(2016) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E1886	(2019) Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed

	to Cyclic Pressure Differentials
ASTM E1996	(2017) Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
ASTM F1642/F1642M	(2017) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings
ASTM F2248	(2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass
ASTM F2912	(2017) Standard Specification for Glazing and Glazing Systems Subject to Airblast Loadings

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2017) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2017) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2019) Standard for Fire Doors and Other Opening Protectives
NFPA 101	(2021) Life Safety Code

STEEL WINDOW INSTITUTE (SWI)

SWI SWS	(2017; R 2018) Steel Window Specifications

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-01	(2018;with Change 1, 2020) DoD Minimum Antiterrorism Standards for Buildings

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified 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 Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification 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

SD-03 Product Data

Steel Framing Materials

Recycled Content for Steel Framing Materials; S

Mullions

Hardware

Hardware Materials

Fasteners

Accessories

Operators

Screens

SD-04 Samples

Color Coating; G[, [_____]]

Windows

SD-05 Design Data

Structural Calculations for Deflection; G[, [_____]]

Design Analysis; G[, [_____]]

SD-06 Test Reports

Air Infiltration

Water Infiltration

Mullion and Transom Bar Wind Load

Minimum Condensation Resistance Factor

[Resistance to Forced Entry

][Standard Airblast Test; G[, [_____]]

][Windborne-Debris-Impact Performance

] SD-07 Certificates

[Engineer's Qualifications

] SD-10 Operation and Maintenance Data

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

1.3 QUALITY ASSURANCE

1.3.1 Shop Drawing Information

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

1.3.2 Color Coating Samples Information

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

1.3.3 Windows Samples Information

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

[1.3.4 Engineer's Qualifications for Blast Design

****
NOTE: In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. Include engineer's qualifications and design data requirements subsections below when security analysis identifies an explosive threat and antiterrorism upgrades are required to provide blast resistance in conformance with UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.
****

All blast design calculations must be performed by or under the direct supervision of a registered engineer with a minimum of 5 years experience performing blast design. The engineer performing the blast design must be able to demonstrate experience on similar size projects using similar design methods to meet the requirements outlined in this specification.

][1.3.5 Design Data Requirements

Submit structural calculations for deflection to substantiate compliance requirements[and Antiterrorism Performance Requirements]. A registered Professional Engineer must provide calculations. Submit design analysis with calculations showing that the design of each different size and type of steel window unit and its anchorage to the structure[.][meets the requirements of paragraph ANTITERRORISM PERFORMANCE REQUIREMENTS.] 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 TEST REPORT REQUIREMENTS

1.4.1 Air and Water Infiltration

ASTM E283 and ASTM E331. Do not exceed maximum air infiltration of 0.05 cubic meter per minute per meter one-half cubic foot per minute per foot of crack length when subjected to a static pressure of 75 Pa 1.56 pounds per square foot (equivalent to a wind velocity of 40 kilometers per hour (kph) 25 miles per hour (mph)). Water infiltration must be "zero."

1.4.2 Mullion and Transom Bar Wind Load Tests

****
NOTE: Specify wind loading requirements in areas subject to wind velocities above 113 kph 70 mph; otherwise delete. The wind loading of 958 Pa 20 psf is based on a 145 kph 90 mph wind velocity at 61 meters 200 feet above grade.
****

****
NOTE: Delete when not applicable.
****

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

of the span.

1.4.3 Blast Testing

****

NOTE: In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. Include the following section when security analysis identifies an explosive threat and windows are required to resist blast loads required by Appendix B-3 of UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings.

****

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

1.5 WINDOW PERFORMANCE

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

1.5.1 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.

1.5.2 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.

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

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

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

][1.5.3 Windborne-Debris-Impact Performance

****
NOTE: Retain WINDBORNE-DEBRIS-IMPACT RESISTANCE paragraph if required by Project. The UFC 1-200-01 DoD Building Code cited IBC defines windborne debris regions. Enhanced protection applies to essential facilities. Verify site specific requirements with the AHJ. Delete items not required.
****

Exterior window system including glazing must comply with indicated basis or enhanced protection testing requirements in ASTM E1996 for [Wind Zone 1] [Wind Zone 2] [Wind Zone 3] [Wind Zone 4] when tested according to ASTM E1886. Test specimens must be no smaller in width and length than glazing indicated for use on Project and must be installed in same manner as glazing indicated for use on Project.

a. Refer to drawings for classification of window requiring basic or enhanced protection.

[b. Large-Missile Test: For glazing located within 9.1 m 30 feet of grade.

][c. Small-Missile Test: For glazing located more than 9.1 m 30 feet above grade.

]][1.5.4 Antiterrorism Performance Requirements

****
NOTE: ANTITERRORISM PERFORMANCE REQUIREMENTS section below is optional to designer, and must be omitted or revised as needed to meet project requirements.

Applicability of UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings:

In most projects, window upgrades for antiterrorism other than glazing requirements do not apply. When security analysis identifies an explosive threat, antiterrorism upgrades for blast resistance in accordance with Appendix B-3 of UFC 4-010-01, DoD Minimum Antiterrorism Requirements for Buildings, may still apply. If the windows are not required to meet these criteria, then this section and subsections for design analyses and airblast testing should be removed.

A structural analysis will need to be performed to determine if the most stringent loading on window assembly is from antiterrorism blast loads or windborne debris in high wind regions.
****

Windows must meet the antiterrorism performance criteria as specified in the paragraphs below in accordance with UFC 4-010-01. Conformance to the performance requirements must be validated by one of the following methods.

1.5.4.1 Computational Design Analysis Method

Design window assembly to the criteria listed herein. Include computational design analysis calculations verifying the structural performance of each window assembly proposed for use, under the given static equivalent loads.

Design window frames, mullions, sashes, and glazing to the criteria listed herein. Include computational design analysis calculations verifying the structural performance of each window system proposed for use, under the given static equivalent loads.

****
NOTE: The blanks 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 (based on the established DBT/LOP) that is being designed for in this project. This section must be completed by an engineer experienced in blast-resistant design.
****

Glazing resistance must be greater than equivalent 3-second duration loading of [_____] Pascal pounds per square foot (psf) for type [_____] window[and [_____] Pascal psf for the remaining window types]. The glazing frame bite for the window frames must be in accordance with ASTM F2248.

Design Steel window framing members to 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.

****
NOTE: Connection Design: For mullion and framing members designed using dynamic analysis or shown to work through airblast testing, all connections between mullions and/or framing members and all connections of storefront systems to the supporting structure must be designed for the full dynamic capacity of the attached member or the maximum calculated dynamic reaction with a load factor equal to 1.0. Use ultimate capacity of fasteners as recommended by the fastener manufacturer with a capacity reduction factor of 0.75. Use Load and Resistance Factor Design (LRFD) with appropriate reduction (phi) factors per material specific code for design of connections components into supporting

structure. All dynamic and static material strength increase factors for the connection components must be equal to 1.0. All connection designs must be performed checking all conventional failure mechanisms. See Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: pdc.usace.army.mil/library/tr/10-02) for additional information. Calculations/Design Analysis for the connection design as stated above must be completed by an engineer experienced in blast-resistant design.

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NOTE: Use the first bracketed requirement below if the maximum air blast pressure is greater than one-half the magnitude of the load resistance of the blast resistant glazing.

Use the second bracketed requirement below if the maximum air blast pressure is less than one-half the magnitude of the load resistance of the blast resistant glazing.

****

[Anchor window frames to the supporting structure with anchors designed to resist [two times (2X)][one time (1X)] the glazing resistance in accordance with ASTM F2248 and ASTM E1300.

]1.5.4.2 Dynamic Design Analysis Method

****

NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01 (Table B-1). Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering/billeting building occupancy as defined in UFC 4-010-01 (Table B-1). Dynamic analysis is preferred because it typically yields a more appropriate and economical / efficient design. The values for input into the blanks in the following paragraph related to 'ductility ratio' and 'maximum support rotation' (for the appropriate level of protection - very low, low) for framing/mullions can be found in Engineering Technical Report (PDC TR-10-02) titled Blast Resistant Design Methodology for Window Systems Designed Statically and Dynamically at USACE Protective Design Center (Website link: pdc.usace.army.mil/library/tr/10-02). This section must be completed by an engineer experienced in

blast-resistant design.
****

Design window assembly using a dynamic analysis to prove the system will provide performance equivalent to or better than a [low;] [very low;] [_____] hazard rating in accordance with ASTM F2912 for the peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). Use a triangular blast load using the applicable pressure and impulse indicated above. The allowable response limits of [aluminum] [steel] frame elements are as follows: Maximum ductility ratio of [_____] and maximum support rotation of [_____] degrees.

1.5.4.3 Standard Airblast Test Method

****
NOTE: The blanks in the following paragraph should be the value of the peak positive pressure and impulse for the explosive weight and standoff distance combination (based on the established DBT/LOP) that is being designed for in this project. Choose the first bracketed items, low hazard rating/very low level of protection for inhabited building occupancy as defined in UFC 4-010-01. Choose the second bracketed items, very low hazard rating/low level of protection for primary gathering building occupancy as defined in UFC 4-010-01. This section must be completed by an engineer experienced in blast-resistant design.
****

As an alternative to the 'Computational Design Analysis Method' and 'Dynamic Design Analysis Method' indicated above, window [_____] assembly may be tested for evaluation of hazards generated from airblast loading in accordance with ASTM F1642/F1642M by an independent testing agency regularly engaged in blast testing. For proposed window systems that are of the same type as the tested system but of different size, the test results may be accepted provided the proposed window size is within the range from 25 percent smaller to 10 percent larger in area and aspect ratio of the original qualified tested glazing systems in accordance with ASTM F2912. Proposed window system/assembly of a size outside this range will require testing to evaluate their hazard rating or are certified by the 'Dynamic Design Analysis Method' indicated above. Testing may be by shock tube or arena test. Perform the test on the entire proposed window system/assembly, including, the glazing, its framing/support system, operating devices, and all anchorage devices. Window support system replicate anchorage of the window support system with the method of installation to be used for the project. The minimum airblast loading parameters for the test will be as follows: peak positive pressure of [_____] kilopascals (kPa) [_____] pounds per square inch (psi) and peak positive phase impulse of [_____] kilopascal-millisecond (kPa-msec) [_____] pounds per square inch - millisecond (psi-msec). The hazard rating for the proposed window systems, as determined by the rating criteria of ASTM F2912, to provide performance equivalent to or better than a [low;] [very low;] [_____] hazard rating (i.e. the "No Break", "No Hazard", "Minimal Hazard", "Very Low Hazard" and "Low Hazard" ratings are acceptable. "High Hazard" ratings are unacceptable. Results of window systems previously tested by test protocols other than ASTM F1642/F1642M

may be accepted provided the required loading, hazard level rating, and size limitations stated herein are met.

]1.6 WARRANTY

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

1.7 DELIVERY AND STORAGE

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

PART 2 PRODUCTS

****
NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition before specifying product recycled content requirements.

Steel window framing typically contains up to 100 percent recycled material coming from recycled steel billets.
****

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

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

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

2.1 MATERIALS

2.1.1 General System Requirements

Steel framing materials must contain a minimum of 40 percent total recycled content. Provide data identifying percentage of recycled content for steel framing materials.

2.1.2 Steel Bars

SWI SWS.

2.1.3 Sheet Steel

ASTM A1011/A1011M.

2.1.4 Zinc-Coated Sheet Steel

ASTM A653/A653M.

2.1.5 Zinc Coating

ASTM A123/A123M.

2.1.6 Screws and Bolts

ASME B18.6.3 as applicable.

2.2 FABRICATION OF WINDOWS

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

a. Where fixed window sections adjoin ventilator sections, provide fixed sash, fabricated from similar frame members, and of manufacturer's standard type suitable for the purpose.

b. Roll weathering surfaces integrally to provide two-point parallel-surface contact with overlap at both inside and outside points of closure.

c. Provide drips and weep holes as required to return water to outside.

d. Design glazed windows and rabbets suitable for glass thickness shown on drawings [or specified].

e. Use flathead, cross recessed type, exposed head screws and bolts with standard threads on windows, trim and accessories. Screw heads must finish flush with adjoining surfaces. Self tapping sheet-metal screws are not acceptable.

f. For hot-dipped galvanized windows, use stainless steel or hot-spun galvanized steel fasteners. For windows with painted finish use electro-galvanized fasteners. Finish exposed heads to match finish of windows.

2.3 FIRE RATED WINDOWS

****

NOTE: Windows requiring an Underwriters Laboratories fire rating must be steel. Aluminum windows cannot be approved for this use.

****

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

2.4 PROVISIONS FOR GLAZING

****

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

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

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NOTE: Include the last bracketed sentence where the antiterrorism requirements of UFC 4-010-01 apply based on the facility's occupancy classification and occupancy load.

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Design sash for [inside] [outside] glazing and for securing glass with [metal beads] [glazing clips] and glazing compound.[Where insulating glass is indicated, use rabbets of adequate weight and depth to receive and properly support glass and glazing accessories.][For windows required to comply with antiterrorism provisions, design in accordance

with Standard 10 of UFC 4-010-01.]

2.5 MULLIONS AND TRANSOM BARS

Provide mullions between multiple window units designed to withstand specified wind load requirements.[Provide mullions with a thermal break.] Secure mullions and transom bars to adjoining construction and window units in such a manner as to permit expansion and contraction and to form weathertight joint. Provide mullion covers of manufacturer's stock design on the interior and exterior to completely cover exposed joints and recesses between window units and for neat appearance.[Provide special covers over structural supports at mullions as indicated.]

2.6 METAL-TO-METAL JOINTS

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

2.7 ACCESSORIES

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

2.7.1 Anchors

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

2.7.2 Weatherstripping

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

2.7.3 Hardware

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

2.7.3.1 Hardware Materials and Finish

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NOTE: Select finish desired and delete others; or allow options listed. Other finishes available include chromium, nickel, and zinc-coated malleable iron and steel. Hardware for shops, boiler rooms, and similar industrial applications may be malleable iron or hot-dip, zinc-coated steel.
****

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

2.7.4 Fasteners

Stainless steel or aluminum materials[; zinc-coated steel elsewhere as shown on Drawing Sheet No. [_____.]] Prime exposed heads of coated or plated fasteners and finish to match adjacent material.

2.7.5 Metal Sub-frames and Stools

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

2.8 GLASS AND GLAZING

Provide materials in accordance with Section 08 81 00 GLAZING.

2.9 WINDOW FINISH

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NOTE: An upgraded hot-dip galvanized, phosphate treated, and prime coat finish is specified here on a shop primed finish product for long-term performance on DoD projects. Optional factory applied color coat is acceptable for all locations. Include field coats under Section 09 90 00 PAINTS AND COATINGS.
****

2.9.1 Shop Primed Finish

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

2.9.2 Factory Finish

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

a. Chemically clean and bonderize windows. Apply dip coat of epoxy primer baked on for not less than 15 minutes at not less than 149 degrees C 300 degrees F, followed by finish coat of alkyd-amine enamel of not less than 0.025 mm one mil thickness, baked on for 15 minutes at not less than 149 degrees C 300 degrees F.

b. Finish color coating to be selected from manufacturer's standard color chart.

c. Touch up abraded surfaces with enamel as specified for factory finish.

2.10 WINDOW TYPES

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NOTE: For the paragraphs in this Article representing window types, only include the window types used on the project and delete those that do not apply.
****

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

2.10.1 Awning Windows

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

2.10.1.1 Operators

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NOTE: Select applicable paragraph(s) from the following:
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NOTE: Specify push-bar operators in lieu of rotary hand crank operation wherever feasible. Experience indicates that rotary hand cranks require excessive maintenance and, in most cases, will not withstand continued hard usage. In the event push-bar operation is not feasible, specify removable crankhandles. Remote and group operation of windows may require rotary crankhandle operation. See paragraph SPECIAL OPERATORS.
****

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

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

]2.10.1.2 Ventilators

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

2.10.2 Casement Windows

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

2.10.2.1 Sash Operators

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

2.10.2.2 Hopper or Sill Type Ventilators

For hopper or sill type ventilators occurring under casement or fixed sash, provide cam-acting locking handle. For hinged type, provide one pair of hinges and two concealed friction stay arms; for projected type, use two friction shoes with nonfriction stay arms to hold ventilator in any position, up to 45 degrees. For hopper vents over 1220 mm 48 inches wide, use two locking handles.

2.10.2.3 Transom Ventilators

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

2.10.3 Continuous Windows

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NOTE: Select desired operation and describe in detail under paragraph SPECIAL OPERATORS. Specify motorized operators under Division 16 and include uniform wind load (in areas subject to high wind velocity) against which motorized equipment must operate ventilators noiselessly without chattering.

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

2.10.4 Fixed Windows

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

2.10.5 Horizontally Pivoted Windows

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

2.10.5.1 Operators

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

2.10.6 Projected Windows

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

2.10.6.1 Operators

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

2.10.7 Security Windows

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

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

2.11 SCREENS

Provide one insect screen for each operable exterior sash or ventilator. Locate screen units either inside or outside, depending upon window type

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

2.11.1 Construction

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

2.11.2 Insect Screening

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

2.12 SPECIAL OPERATORS

2.12.1 Pole Operators

Provide for windows having operating hardware or locking rails more than 2 meters 6 feet above floor. Provide window manufacturer's standard pole design of length to provide operation from 1.67 meters 5 feet above floor, and with push-pull hooks of proper shape and length. Provide one pole operator for each room, and one pole hanger for each pole in location as directed.

[2.12.2 Extension Crank Operators

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NOTE: Delete when not applicable.
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Provide removable handles for crank operated rotary operators located more than 2 meters 6 feet above floor. Provide one removable handle for each room.

]2.12.3 Mechanical Operators

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NOTE: Delete when not applicable.
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Provide [manual] [motorized] operators for group operation of continuous rows of windows, and for windows located at unusual heights, where other types of remote operation are not feasible. Provide operators that open

and close windows without appreciable deflection, vibration or rattle. Provide transmission lines equipped with means of adjustment. Control window units in groups with operators as recommended by window manufacturer for the particular window arrangement shown, unless specifically indicated otherwise. Use mechanical operators of one of the following types:

a. On-Sill Operators: Centrally located, manually controlled mechanisms for adjusting ventilators, assembled of bronze telescoping shafts with machine cut threads. Conceal, except for linkage members, by appropriate covers. Provide one operator, secured to sill, for each window. Finish operators exposed to view to match hardware finish. Finish covers to match window casings.

b. Geared Lever-Arm Operator: Provide power unit with machine-cut gears and machined thrust bearings housed in dustproof oil-tight case, with provision for lubrication. Provide torsion shaft of standard black iron pipe not less than 25 mm one inchinside diameter. Rigidly clamp steel or malleable iron operating arms to shaft and connect to ventilator by push bar and hinge bracket. Support operating mechanism on brackets securely attached to building structure or mullions. No single line is allowed to extend more than 9 meters 30 feet from either or both sides of power unit.

c. Geared Rack-and-Pinion Operator: Provide power unit with machine-cut gears and machined thrust bearings housed in dustproof oil-tight case, with provision for lubrication. Provide torsion shaft of standard black iron pipe not less than 25 mm one inchinside diameter. Cut steel rack to a pitch that will mesh accurately with the cut teeth on a steel or cast iron pinion. Fasten pinion securely to torsion shaft. Provide steel rack with a hinged bracket for attaching to ventilator. Hold rack in mesh with pinion by steel yoke with bearing rollers of solid brass. Support operating mechanism on steel brackets securely attached to building structure or mullions. No single line is allowed to extend more than 15 meters 50 feet from either or both sides of power unit.

[2.12.3.1 Operating Arms and Racks

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

][2.12.3.2 Chain Control

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NOTE: Delete when not applicable.
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Provide power unit with hand chain, operating over chain wheel with chain guard. Drill and secure wheel to worm shaft by key. Terminate chain approximately 600 mm 2 feet above floor. Where building construction makes it impracticable to hang chain vertically from power unit, furnish single or double chain idlers to convey chain to point shown or directed.

][2.12.3.3 Steel Shaft Control

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

]PART 3 EXECUTION

3.1 INSTALLATION

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

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

3.2 ANCHORS AND FASTENINGS

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

3.3 OPERATORS

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

3.4 WEATHERSTRIPPING

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

3.5 ADJUSTMENTS AFTER INSTALLATION

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

3.6 CLEANING

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

-- End of Section --