
USACE / NAVFAC / AFCEC / NASA UFGS-08 51 23 (August 2011)
Change 4 - 11/18

Preparing Activity: NAVFAC Superseding
UFGS-08 51 23 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2019

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08/11

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SECTION 08 51 23

STEEL WINDOWS 08/11

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 \(CCR\)](#).

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; details for anchoring and reinforcing non-structural mullions at windows to receive window cleaners' anchors

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 window cleaners' anchors

9. Number and location of extension crank operators

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

PART 1 GENERAL

1.1 REFERENCES

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

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

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

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

ASME INTERNATIONAL (ASME)

ASME B18.6.3

(2013; 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	(2018) 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	(2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E330/E330M	(2014) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E331	(2000; R 2016) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2016; TIA 16-1) Standard for Fire Doors and Other Opening Protectives
NFPA 101	(2018; TIA 18-1; TIA 18-2; TIA 18-3) Life Safety Code

STEEL WINDOW INSTITUTE (SWI)

SWI SWS	(2005) Steel Window Specifications
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1.2 SUBMITTALS

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

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

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

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

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

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

SD-02 Shop Drawings

Windows

Indicate elevations of windows, full-size sections, thicknesses and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of

glazing, details of operating hardware, [mullion details,] [method and materials for weatherstripping,] [method of attachment of screens,] [metal subframes,] [stools,] [casings,] [sills,] [trim,] [window cleaners' bolts,] other related items, and installation details.

SD-03 Product Data

Steel Framing Materials

Recycled Content for Steel Framing Materials; S

Mullions

Hardware

Hardware Materials

Fasteners

Accessories

Operators

Screens

SD-04 Samples

Color Coating; G[, [_____]]

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

Windows

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

SD-06 Test Reports

Air Infiltration

Water Infiltration

Mullion and Transom Bar Wind Load

SD-10 Operation and Maintenance Data

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

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

1.3 TEST REPORT REQUIREMENTS

1.3.1 Air and Water Infiltration

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

1.3.2 Mullion and Transom Bar Wind Load Tests

NOTE: 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 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.

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.

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

2.1.2 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 cadmium plated or 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.

NOTE: Inside glazing is preferred, especially for windows above first floor and other locations where access is difficult. Windows designed for inside

glazing may not be available in double-hung type. Check manufacturers' literature. Where project requires insulated glass, specify sash members, glazing beads, and hardware of sufficient size and weight to receive and support glass of thickness shown. Allow 3 mm 1/8 inch minimum between each side of insulating glass and metal frame for glazing compound and expansion. Also allow 3 mm 1/8 inch between edges of glass and frame. Drawings should indicate method for securing insulating glass.

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

2.5 MULLIONS AND TRANSOM BARS

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

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

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

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

2.7.3 Weatherstripping

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

2.7.4 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.

2.7.4.1 Hardware Materials and Finish

NOTE: Select finish desired and delete others; or allow options listed. Other finishes available include chromium, nickel, cadmium 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; yellow bronze with dull (oxidized) finish. Use steel or malleable iron hinges, with nonferrous pins, or with steel pins and non-ferrous bushings or washers.

2.7.5 Fasteners

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

2.7.6 Metal Sub-frames and Stools

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

2.8 WINDOW FINISH

NOTE: On most projects, phosphate treatment and factory-applied prime coat is satisfactory. Specify hot-dip galvanized, phosphate treated, and prime coat finish only for hot-rolled solid-section windows in areas where corrosion is prevalent. Optional factory applied color coat is acceptable for all locations. Include field coats under Section 09 90 00 PAINTS AND COATINGS.

2.8.1 Shop Primed Finish

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

2.8.2 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.

2.9 WINDOW TYPES

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

2.9.1 Awning Windows

Provide compression-type weatherstripping. Heavy Intermediate materials

in group of top-hinged or projected out-swinging ventilators:

2.9.1.1 Operators

NOTE: Select applicable paragraph(s) from the
following:

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.

2.9.1.2 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.

2.9.2 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.

2.9.2.1 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.

2.9.2.2 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.

2.9.2.3 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.

2.9.3 Continuous Windows

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.

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

2.9.4 Fixed Windows

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

2.9.5 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.

2.9.5.1 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.

2.9.6 Projected Windows

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

2.9.6.1 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.

2.9.7 Security Windows

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

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

2.10 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.

2.10.1 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.

2.10.2 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.

2.11 SPECIAL OPERATORS

2.11.1 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.

2.11.2 Extension Crank Operators

NOTE: Delete when not applicable.

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

2.11.3 Mechanical Operators

NOTE: Delete when not applicable.

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

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

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

2.11.3.1 Operating Arms and Racks

NOTE: Delete when not applicable.

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.

2.11.3.2 Chain Control

NOTE: Delete when not applicable.

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.

2.11.3.3 Steel Shaft Control

NOTE: Delete when not applicable.

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 --