
USACE / NAVFAC / AFCEA / NASA UFGS-08 81 00 (February 2011)

Preparing Activity: NAVFAC Superseding
UFGS-08 81 00 (February 2009)
UFGS-08 81 00 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2011

SECTION TABLE OF CONTENTS

DIVISION 08 - OPENINGS

SECTION 08 81 00

GLAZING

02/11

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 SYSTEM DESCRIPTION
- 1.4 DELIVERY, STORAGE, AND HANDLING
- 1.5 ENVIRONMENTAL REQUIREMENTS
- 1.6 SUSTAINABLE DESIGN REQUIREMENTS
 - 1.6.1 Local/Regional Materials
 - 1.6.2 Environmental Data
- 1.7 WARRANTY
 - 1.7.1 Warranty for Insulating Glass Units
 - 1.7.2 Warranty for Polycarbonate Sheet
 - 1.7.3 Monolithic Reflective Glass
 - 1.7.4 Monolithic Opacified Spandrel

PART 2 PRODUCTS

- 2.1 GLASS
 - 2.1.1 Clear Glass
 - 2.1.2 Annealed Glass
 - 2.1.3 Heat-Absorbing Glass
 - 2.1.4 Wired Glass
 - 2.1.5 Patterned Glass
 - 2.1.6 Laminated Glass
 - 2.1.7 Bullet-Resisting Glass
 - 2.1.8 Mirrors
 - 2.1.8.1 Glass Mirrors
 - 2.1.9 One-Way Vision Glass (Transparent Mirrors)
 - 2.1.10 Tempered Glass
 - 2.1.11 Heat-Strengthened Glass
 - 2.1.12 Spandrel Glass
 - 2.1.12.1 Ceramic-Opacified Spandrel Glass
 - 2.1.12.2 Film-Opacified Spandrel Glass
 - 2.1.12.3 Spandrel Glass With Adhered Backing

- 2.1.13 Fire/Safety Rated Glass
- 2.1.14 Tinted (Light-Reducing) Glass
- 2.2 INSULATING GLASS UNITS
 - 2.2.1 Buildings
 - 2.2.2 Control Towers
 - 2.2.2.1 Control Tower Insulating Glass
 - 2.2.2.2 Control Tower Heat-Absorbing Insulating Glass
 - 2.2.2.3 Control Tower Clear Insulating Glass
 - 2.2.2.4 Control Tower Laminated Glass
 - 2.2.3 Low Emissivity Insulating Glass
- 2.3 PLASTIC GLAZING
 - 2.3.1 Acrylic Sheet
 - 2.3.2 Polycarbonate Sheet
 - 2.3.3 Extruded Polycarbonate Profiled Sheet
 - 2.3.4 Bullet-Resistant Plastic Sheet
- 2.4 SETTING AND SEALING MATERIALS
 - 2.4.1 Putty and Glazing Compound
 - 2.4.2 Glazing Compound
 - 2.4.3 Sealants
 - 2.4.3.1 Elastomeric Sealant
 - 2.4.3.2 Structural Sealant
 - 2.4.4 Joint Backer
 - 2.4.5 Preformed Channels
 - 2.4.6 Sealing Tapes
 - 2.4.7 Setting Blocks and Edge Blocks
 - 2.4.8 Glazing Gaskets
 - 2.4.8.1 Fixed Glazing Gaskets
 - 2.4.8.2 Wedge Glazing Gaskets
 - 2.4.8.3 Aluminum Framing Glazing Gaskets
 - 2.4.9 Accessories
- 2.5 MIRROR ACCESSORIES
 - 2.5.1 Mastic
 - 2.5.2 Mirror Frames
 - 2.5.3 Mirror Clips

PART 3 EXECUTION

- 3.1 PREPARATION
- 3.2 GLASS SETTING
 - 3.2.1 Sheet Glass
 - 3.2.2 Patterned Glass
 - 3.2.3 Insulating Glass Units
 - 3.2.4 Installation of Wire Glass
 - 3.2.5 Installation of Heat-Absorbing Glass
 - 3.2.6 Installation of Laminated Glass
 - 3.2.7 Plastic Sheet
- 3.3 ADDITIONAL REQUIREMENTS FOR GLAZING CONTROL TOWER WINDOWS
 - 3.3.1 Materials and Methods of Installation
 - 3.3.2 Tolerances and Clearances of Units
- 3.4 CLEANING
- 3.5 PROTECTION
- 3.6 WASTE MANAGEMENT
- 3.7 SCHEDULE

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEA / NASA UFGS-08 81 00 (February 2011)

Preparing Activity: NAVFAC Superseding
UFGS-08 81 00 (February 2009)
UFGS-08 81 00 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2011

SECTION 08 81 00

GLAZING 02/11

NOTE: This guide specification covers the requirements for normal glazing.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

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

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

NOTE: If special glazing such as leaded glass, laminated transparent mirrors, or plastic glazing for unprotected openings is required, add appropriate paragraphs.

NOTE: TO DOWNLOAD UFGS GRAPHICS

Go to <http://www.wbdg.org/ccb/NAVGRAPH/graphdoc.pdf>.

NOTE: On the drawings, show:

1. Locations of each type of glass, using same terminology as in specification.
2. Thickness of glass, unless glass of each type is same thickness.
3. Frame and rabbet details, indicating method of

glazing.

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 RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

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

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1 (2009; Errata 2010) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-10 (2010) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM C 1036 (2006) Standard Specification for Flat Glass

ASTM C 1048 (2004) Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass

ASTM C 1172 (2009) Standard Specification for Laminated Architectural Flat Glass

ASTM C 1184 (2005) Standard Specification for Structural Silicone Sealants

ASTM C 509 (2006) Elastomeric Cellular Preformed

Gasket and Sealing Material

ASTM C 669	(2000) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash
ASTM C 864	(2005) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C 920	(2010) Standard Specification for Elastomeric Joint Sealants
ASTM D 2287	(1996; R 2010) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D 395	(2003; R 2008) Standard Test Methods for Rubber Property - Compression Set
ASTM D 4802	(2010) Poly(Methyl Methacrylate) Acrylic Plastic Sheet
ASTM D 673	(1993a e1) Mar Resistance of Plastics
ASTM E 119	(2010b) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E 1300	(2009a) Determining Load Resistance of Glass in Buildings
ASTM E 2010	(2001) Positive Pressure Fire Tests of Window Assemblies
ASTM E 2129	(2005) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM E 413	(2010) Rating Sound Insulation
ASTM E 773	(2001) Accelerated Weathering of Sealed Insulating Glass Units
ASTM E 774	(1997) Classification of the Durability of Sealed Insulating Glass Units
ASTM E 90	(2009) Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2004) Glazing Manual
GANA Sealant Manual	(2008) Sealant Manual
GANA Standards Manual	(2001) Tempering Division's Engineering Standards Manual

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

IGMA TB-3001	(1990) Guidelines for Sloped Glazing
IGMA TM-3000	(1997) Glazing Guidelines for Sealed Insulating Glass Units
IGMA TR-1200	(1983) Commercial Insulating Glass Dimensional Tolerances

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2010) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2010) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 252	(2008) Standard Methods of Fire Tests of Door Assemblies
NFPA 257	(2007) Standard on Fire Test for Window and Glass Block Assemblies
NFPA 80	(2010; TIA 10-2) Standard for Fire Doors and Other Opening Protectives

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

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

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-378	(Basic; Notice 1) Putty Linseed Oil Type, (for Wood-Sash-Glazing
-------------	--

U.S. GREEN BUILDING COUNCIL (USGBC)

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

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

16 CFR 1201	Safety Standard for Architectural Glazing Materials
-------------	---

UNDERWRITERS LABORATORIES (UL)

UL 752	(2005; Reprint Apr 2010) Standard for Bullet-Resisting Equipment
UL MEAPD	(2003) Mechanical Equipment and Associated

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

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

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

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

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

[Control Tower Insulating Glass]

[Control Tower Laminated Glass]

Drawings showing complete details of the proposed setting

methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

NOTE: Regarding the use of SD-03 Product Data and SD-07 Certificates, only use one of these on complicated and large products. It is preferred to use SD-03 Product Data. If control tower glazing data is only available by certificates, use SD-07 Certificates.

[SD-03 Product Data

Insulating Glass

Documentation for Energy Star qualifications.

Plastic Glazing

Glazing Accessories

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

[Local/Regional Materials; (LEED)

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

[Environmental Data]]

SD-04 Samples

Insulating Glass

Plastic Sheet

Glazing Compound

Glazing Tape

Sealant

Two 203 by 254 mm 8 by 10 inch samples of each of the following: tinted glass, patterned glass, heat-absorbing glass, [_____] and insulating glass units.

Three samples of each indicated material. Samples of plastic sheets shall be minimum 125 by 175 mm 5 by 7 inches.

[SD-07 Certificates

Insulating Glass

Plastic Glazing

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

[Control Tower Insulating Glass]

[Control Tower Laminated Glass]

Glazing Accessories

Certificates from the manufacturer attesting that the units meet the luminous and solar radiant transmission requirements for heat absorbing glass.]

SD-08 Manufacturer's Instructions

Setting and sealing materials

Glass setting

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified. [Include cleaning instructions for plastic sheets.]

SD-11 Closeout Submittals

Local/Regional Materials; LEED

LEED (tm) documentation relative to local/regional materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

NOTE: Use the following paragraph on Army projects.

[1.3 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of [glazing accessories](#), and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with [ANSI Z97.1](#). Glazed panels shall comply with indicated wind/snow loading in accordance with [ASTM E 1300](#).

]1.4 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not start glazing work until the outdoor temperature is above [4 degrees C](#) [40 degrees F](#) and rising, unless procedures recommended by the glass

manufacturer and approved by the Contracting Officer are made to warm the glass and rabbit surfaces. Provide ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

1.6.1 Local/Regional Materials

NOTE: Using local materials can help minimize transportation impacts, including fossil fuel consumption, air pollution, and labor. Using materials harvested and manufactured within a 500 mile radius from the project site contributes to the following LEED credit: MR5. Coordinate with Section 01 33 29 LEED(tm) DOCUMENTATION. Use second option if Contractor is choosing local products in accordance with Section 01 33 29 LEED(tm) DOCUMENTATION. First option shall not be used for USACE projects. Army projects shall include second option only if pursuing this LEED credit.

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

1.6.2 Environmental Data

NOTE: ASTM E 2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products.

[Submit Table 1 of ASTM E 2129 for the following products: [____].]

1.7 WARRANTY

NOTE: The warranty clauses in this guide specification have been approved by a Level I Contracting Officer, and may be used without further approval or request for waiver.

NOTE: Delete inapplicable paragraph[s].

1.7.1 Warranty for Insulating Glass Units

**NOTE: For Air Force installations, select 10 years
for the guarantee period for control tower units.**

Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Government. [For control tower units, the warranty period shall be [10] [_____] years; warranty shall be signed by the manufacturer.]

1.7.2 Warranty for Polycarbonate Sheet

For a 5-year period following acceptance of the work:

- a. Warranty Type I, Class A (UV stabilized) sheets against breakage;
- b. Warranty Type III (coated, mar-resistant) sheets against breakage and against coating delamination;
- c. Warranty Type IV (coated sheet) against breakage and against yellowing;
- d. Warranty extruded polycarbonate profile sheet against breakage.

For a 10-year period following acceptance of the work, warranty Type IV against yellowing and loss of light transmission.

[1.7.3 Monolithic Reflective Glass

Manufacturer shall warrant the monolithic reflective glass to be free of peeling or deteriorating of coating for a period of 10 years after Date of Substantial Completion. Warranty shall be signed by manufacturer.

] [1.7.4 Monolithic Opacified Spandrel

Manufacturer shall warrant the opacifier film on the spandrel to be free of peeling for a period of five years after Date of Substantial Completion. Warranty shall be signed by manufacturer.

] PART 2 PRODUCTS

2.1 GLASS

NOTE: Glazed openings subject to accidental human impact shall be glazed with safety glazing material in accordance with Consumer Products Safety Commission (CPSC) Standard, 16 CFR Part 1201, Safety Standard for Architectural Glazing Materials. Consult applicable building codes for detail requirements.

ASTM C 1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

2.1.1.1 Clear Glass

NOTE: Glass areas and thicknesses are based on 1.20 kilopascals 25 pounds per square foot (psf) design wind load and vertical glazing with annealed glass. For other glass and for wind loads greater than 1.20 kPa 25 psf, thickness will depend upon aspect ratio (length divided by width), area, and design wind load. The thickness and area limitations for each type of glass must be indicated or specified. Do not specify glass less than 3.0 mm 1/8 inch.

Method of Determination for Minimum Glass Thickness:

Refer to UFC 4-010-01 "DoD Minimum Antiterrorism Standards for Buildings", ASTM E 1300, ASTM F 1642 and ASTM F 2248.

1. Determine peak gust wind speed and corresponding design wind loads, considering location, height, shape, and orientation, in accordance with ASCE 7 "Minimum Design Loads for Buildings and Other Structures", latest edition.
2. Determine aspect ratio, area, and type of glass for each opening to be glazed.
3. Select thickness required from glass manufacturer's chart for each type of glass.

NOTE: Use the following data on Army projects

- a. Category I Products: Doors and glazed panels that contain single piece of glazing material no greater than 0.84 m² 9 ft² in area. The product must be capable of withstanding 203 Nm 150 foot pound impact load test.
- b. Category II Products: Doors and glazed panels that contain any single piece of glazing material greater than 0.84 m² 9 ft² in area. The product must be capable of withstanding a 542 Nm 400-foot-pound impact load test. Category II products may be used in both Category I and Category II situations.
- c. Doors: 16 CFR 1201 applies to all types of interior doors and exterior doors, including storm doors and combination doors. FIRE/SAFETY RATED GLASS: Is not required for openings in doors through which a 76 mm 3 inch diameter sphere is unable to pass. Glazing for fire doors shall be in accordance with NFPA 80, even though this may be at variance with requirements of 16 CFR 1201.
- d. Glazed Panels: 16 CFR 1201 no longer applies to

exterior and interior glazed panels. FIRE/SAFETY RATED GLASS: Glazed panels shall conform to ANSI Z97.1, SAFETY PERFORMANCE SPECIFICATION AND METHODS OF TEST FOR SAFETY GLAZING MATERIALS USED IN BUILDINGS. Since glazed panels may be hazardous, safety glazing should be generally provided as described below:

FIRE/SAFETY RATED GLASS

(1) Glazed panels of any size located adjacent to a doorway, with the nearest vertical edge of panel within 1219 mm (48 inches) of doorway, and with bottom edge of panel below top of door. Safety glazing is not required for panels separated from the doorway by an intervening interior permanent wall.

(2) Glazed panels with a surface area greater than 0.84 m² 9 ft² where there is a walking surface on either side of panel, and the walking surface is within 914 mm 36 inches of the panel. Safety glazing is not required if the lowest edge of the glazing material is 457 mm 18 inches or more above both walking surfaces, or if the panels have a horizontal member, such as a mullion or permanent railing not less than 38 mm 1-1/2 inches in width, capable of withstanding a horizontal load of 75 kg/m (50 plf), on the accessible sides of the glazing and located between 609 mm and 914 mm 24 and 36 inches above the walking surface.

(3) Where insulating glass units are used in locations requiring safety glazing, both panes shall be safety glass.

(4) For exterior applications, safety glazing must also meet the wind and snow load requirements in accordance with ASTM E 1300.

(5) In general, any glazed area subject to human impact should be provided with safety glazing or other acceptable protective devices such as handrails or horizontal mullions.

ASTM C 1036 covers the quality requirements for clear annealed glass, transparent tinted heat-absorbing and light-reducing glass, patterned and wired glass with a series of classification designations such as Types, Classes, Styles, Forms, Qualities, Finishes, and Intended Uses, as defined below:

1. Type designations are: Type 1 - Transparent Flat Glass; Type II - Patterned and Wired Glass.

2. Class designations are: Class 1-clear; Class 2-tinted Heat-Absorbing and Light-Reducing; Class 3-tinted, light-reducing.

3. Style designations are: Style A - Higher light transmittance; Style B - Lower light transmittance.

4. Form designations are: Form 1 - Wired polished both sides; Form 2 - Patterned and wired, Form 3 - Patterned.

5. Quality designations including intended uses for ASTM C 1036 transparent flat glass are:

- a) Quality q1 - Mirror Select Quality: Coated for premium mirrors.
- c) Quality q3 - Glazing Select: For architectural fenestrations or other applications where distant objects are viewed through the glass by the observer.
- d) Quality q4 - Intended for greenhouses or other applications where restrictions on aesthetic conditions are not required.
- e) Quality q5 - Intended for general glazing applications that have lesser aesthetic demands than q3 or q4 quality grade.
- f) Quality q6 - Intended for greenhouses or other applications where restrictions on aesthetic conditions are not required.

6. Quality designations and intended uses for Patterned and Wired Flat Glasses:

- a) Quality q7 - Decorative: For use where design and aesthetic characteristics are major considerations.
- b) Quality q8 - Glazing: For general glazing where functional or aesthetic characteristics are a consideration and where surface blemishes are not a major concern.
- c) Wired Glass: For skylights and general glazing where fire retardation or glass retention in a frame are a consideration.

NOTE: It is critical that skylights be maintainable. Designer must include skylight access devices as a part of the design package where skylights are large or at great heights above floor.

NOTE: Use the following bracketed statement for Army projects only.

[For interior glazing (i.e., pass and observation windows), 6 mm 1/4 inch thick glass should be used.]

Type I, Class 1 (clear), Quality [q4 (A)] [q5 (B)]. Provide for glazing openings not indicated or specified otherwise. Use double-strength sheet glass or 3 mm 1/8 inch float glass for openings up to and including 1.39 square meters 15 square feet, 4.5 mm 3/16 inch for glazing openings over 1.39 square meters 15 square feet but not over 2.79 square meters 30 square feet, and 6 mm 1/4 inch for glazing openings over 2.79 square meters 30 square feet but not over 4.18 square meters 45 square feet.

2.1.2 Annealed Glass

NOTE: Annealed glass is used for general glazing where clear or tinted glass is required. Glass thickness shall be shown on drawings. Under some heavy thermal conditions, tinted glass may require heat strengthening for thermal endurance.

Annealed glass shall be Type I transparent flat type, Class 1 - [clear] [tinted], Quality q3 - glazing select, [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C 1036. Color shall be [gray] [bronze] [_____] .

2.1.3 Heat-Absorbing Glass

NOTE: For Use On Army Projects Only:
Heat-absorbing and light-absorbing glass may be used in accordance with TI 800-01, DESIGN CRITERIA. Tinted (light-reducing) glass may be used where glare is a problem and a reduction of visible light transmission is desired. Visible light transmittance will vary from 15 to 85 percent, depending on color density and thickness. Color density is a function of thickness and increases as the thickness increases; visible light transmittance will decrease as thickness increases. ASTM C 1036 separates Heat-Absorbing and Tinted (light-reducing) glasses into categories, Higher light transmittance, and Lower light transmittance, which is based on the maximum solar energy transmittance by glass thickness.

Refer to ASTM C 1036 for evaluation quality requirements and glass manufacturer's data for color selection, light transmittance and shading coefficient. When specifying performance and color, the available ranges of performance and colors should be specified for glazing units to allow several manufacturers to bid. When matching existing glass, provide existing manufacturer's name, color and acceptable range for shading factor, light transmittance, indoor and outdoor reflectance.

Heat-absorbing and light-reducing glass is affected by thermal stresses which can result in breakage.

Care should be taken to make sure that the glass units will not be thermally overburdened. Glass that will be thermally overburdened should be Heat-Strengthened or, if safety glazing is required, Fully Tempered to resist thermal breakage. Refer to ASTM C 1048 for quality evaluation and refer to manufacturer's data for performance and color selection.

Factors which increase the risk of breakage include building orientation, unusual shapes of lites, large lites, indoor shading devices, heating registers, and outdoor shading by trees, structure or exterior shading devices.

NOTE: NOTE for Navy Projects: Consult manufacturer's literature for colors, thicknesses, and transmittance values available. Coordinate with safety glazing requirements and paragraph entitled "Tempered Glass."

Type I, Class 2 (heat absorbing and light reducing), Quality [q3 (select)] [q4 (A)], [] mm inch thick, [blue][green] in color, [] percent light transmittance, [] percent shading coefficient, conforming to ASTM C 1036. Color shall be [[gray] [bronze] []]] for 6 mm 1/4 inch thickness.

2.1.4 Wired Glass

NOTE: Wired glass is no longer produced in the United States. On 17 March 1992 (effective for a five year period) OSD determined that the Buy America Act does not apply to the procurement of wired glass and added the product to the list of excepted materials under FAR 25.108(d)(1). Accordingly, wired glass furnished in compliance with Section 08 81 00 GLAZING does not violate the Buy America Act.

Types of wired glass available are polished, patterned, and tinted/heat-absorbing wired glass. Wired glass cannot be tempered. Wired Glass does not meet the requirements of 16 CFR 1201 and cannot be used as safety glazing materials in situations governed by that regulation.

Typically 6 mm 1/4 inch thick wired glass is used for fire-rated windows and doors where required by building codes and other fire-protection criteria.

Only wired glass in Mesh 1 - Diamond and Mesh 2 - Square are acceptable for fire rated door and window openings. Mesh 3 - Parallel is not acceptable for fire rated openings.

Wired glass, because of the wire mesh and edge damage from cutting, is very susceptible to thermal breakage. Heat absorbing wired glass increases the tendency for breakage. Wired glass is also susceptible to edge breakage from water penetrating the capillary in which the wires reside. The glazing system should insure that the edges are kept dry by sealing the edges with silicone.

Glass for fire-rated windows shall be UL listed and shall be rated for [45] [20] minutes when tested in accordance with [ASTM E 2010](#). Wired glass shall be Type II flat type, Class [1 - translucent] [2 - tinted, heat-absorbing] [3 - tinted, light-reducing], Quality [q7 - decorative] [q8 - glazing], Form [1 - wired and polished both sides] [2 - patterned and wired], [] percent light transmittance, [] percent shading coefficient, conforming to [ASTM C 1036](#). Wire mesh shall be polished stainless steel Mesh [1 - diamond] [2 - square] [3 - parallel]. Wired glass for fire-rated windows shall bear an identifying UL label or the label of a nationally recognized testing agency, and shall be rated for [20] [45] minutes when tested in accordance with [NFPA 257](#). Wired glass for fire-rated doors shall be tested as part of a door assembly in accordance with [NFPA 252](#).

2.1.5 Patterned Glass

NOTE: Patterned glass is normally provided for windows of toilet rooms, vertical sliding sash in post offices borrowed light sash at entrances, etc. Patterned glass is available in various thicknesses, with a pattern embossed on one or both sides. This glass is frequently called "figured", "obscure", or "decorative" glass. The degree of diffusion achieved is a function of the pattern and whether the pattern is on one or both sides. Some patterned glass cannot be heat-strengthened or tempered because of the pattern depth. Pattern glass does not offer complete obscurity and must be used with caution in very private areas such as toilets. The appropriate pattern designation should be selected from ASTM C 1036. If a more specific pattern designation is desired, a manufacturer's name and pattern may be specified. When specific manufacturer's names and patterns are specified, the designer should add the following note to the spec: "Manufacturer's name and patterns indicated are for identification purposes only; the listing is not intended to limit selection of similar patterns from other manufacturers." Refer to GANA GLAZING MANUAL, and glass manufacturer's performance tables for proper evaluation of patterned glass thickness and size of opening to be glazed. Patterned glass **3 mm** **1/8 inch** thick should not be larger than **2.15 square meters** **6 square feet**.

Type II, Class 1 (translucent), Form 3 (patterned), Quality q7 (decorative), Finish [f1 (patterned one side)] [f2 (patterned two sides)],

Pattern [p1 (linear)] [p2 (geometric)] [p3 (random)] [p4 (special)],
[[_____] percent light transmittance, [_____] percent shading coefficient.]
[3] [6] mm [1/8] [7/32] inch thick. [Provide [_____] .]

2.1.6 Laminated Glass

NOTE: For Antiterrorism/force protection (ATFP)
criteria, refer to UFC 4-010-01 "DoD Minimum
Antiterrorism Standards for Buildings." Laminated
annealed flat glass shall be provided at exterior
window and door glazing. When force protection
minimum measures are required, use the first
bracketed option below.

[ASTM C 1172, Kind LA fabricated from two nominal [3] [_____] mm [1/8] [_____] inch
pieces of Type I, Class 1, Quality q3, flat annealed transparent glass
conforming to ASTM C 1036. Flat glass shall be laminated together with a
minimum of 0.75 mm 0.030 inchthick, clear polyvinyl butyral interlayer.
The total thickness shall be nominally 6 [_____] mm 1/4 [_____] inch.] [Fabricated
from two pieces of Type I, Class 1, Quality q3 glass laminated together
with a clear [_____] [0.38] mm [0.015] inch thick polyvinyl butyral
interlayer or alternatives such as resin laminates, conforming to
requirements of 16 CFR 1201 and ASTM C 1172. Color shall be [[clear]
[gray] [bronze] [_____] . The total thickness shall be nominally [_____]
mm inch. [Provide [_____] .]]

2.1.7 Bullet-Resisting Glass

NOTE: Bullet-resisting glazing material is
available in four power ratings to resist scattered
shots from (1) medium-power small arms (MSA); (2)
high-power small arms (HSA); (3) super-power small
arms (SSA); and (4) high-power rifles (HR).
Bullet-resisting glass is available in thicknesses of
30.2, 38.1, 44.5 and 50.8 mm 1 3/16, 1 1/2, 1 3/4
and 2 inches to meet those power ratings.

Fabricated from Type I, Class 1, Quality q3 glass with polyvinyl butyral
plastic interlayers between the layers of glass and listed by UL MEAPD as
bullet resisting, with a power rating of [Medium--Small Arms] [High--Small
Arms] [Super--Small Arms] [High--Rifle] in accordance with UL 752. Provide
[_____] [where indicated].

[2.1.8 Mirrors

NOTE: For Army projects only. Navy projects will
specify mirrors in Division 10, Specialties. Select
the frames (J-Mold channels) or clips to secure
mirror to wall. Mastic is required with each type
of installation. Mirror sizes will be shown on the
drawings. Coordinate with Section 05 50 13
MISCELLANEOUS METAL FABRICATIONS, section 05 51 00
METAL STAIRS or section 05 51 33 METAL LADDERS and
Section 10 28 13 TOILET ACCESSORIES to ensure that

frames are specified for these mirrors.

One-way vision glass should be used for psychiatric and security observation windows. Where safety glazing is required, specify either laminated glass or tempered glass.

2.1.8.1 Glass Mirrors

Glass for mirrors shall be Type I transparent flat type, Class 1-clear, Glazing Quality q1 6 mm 1/4 inch thick conforming to ASTM C 1036. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 6 mm 1/4 inch thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint, and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

]2.1.9 One-Way Vision Glass (Transparent Mirrors)

Type I, Class 1, Quality q1, 6 mm 1/4 inch thick, coated on one face with a hard, adherent film of chromium or other approved coating of equal durability. Glass shall transmit not less than 5 percent or more than 11 percent of total incident visible light and shall reflect from the front surface of the coating not less than 45 percent of the total incident visible light. [Provide [____].]

2.1.10 Tempered Glass

NOTE: Tempered glass is the preferred material for areas requiring safety glazing materials. Laminated glass, organic-coated glass, wire glass, and plastic sheet are permitted if they conform to the requirements of the CPSC 16 CFR Part 1201.

ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class [1 (transparent)] [2 (tinted heat absorbing)], Quality q3, [____] mm inch thick, [____] percent light transmittance, [____] percent shading coefficient conforming to ASTM C 1048 and GANA Standards Manual. Color shall be [[clear] [bronze] [gray] [____]]. [Provide [____]] [and wherever safety glazing material is indicated or specified].

2.1.11 Heat-Strengthened Glass

ASTM C 1048, Kind HS (heat strengthened), Condition A (uncoated), Type I, Class [1 (clear)] [2 (tinted heat absorbing)], Quality q3, [____] mm inch thick. [Provide [____].]

2.1.12 Spandrel Glass

2.1.12.1 Ceramic-Opacified Spandrel Glass

Ceramic-opacified spandrel glass shall be Kind HS heat-strengthened transparent flat type, Condition B, coated with a colored ceramic material on No. 2 surface, Quality q3 - glazing select, [_____] mm [_____] inch thick, conforming to ASTM C 1048. Glass performance shall be K-Value/Winter Nighttime [_____] , R-Value/Winter Nighttime [_____] , shading coefficient [_____] . Color shall be [_____] .

2.1.12.2 Film-Opacified Spandrel Glass

Film-opacified spandrel glass shall be Kind HS heat-strengthened transparent flat type, Quality q3 - glazing select, Condition C glass with a polyester or polyethylene film 0.025 mm to 0.127 mm 2 mils to 5 mils thick attached to No. 2 surface of a sputtered solar-reflective film, conforming to ASTM C 1048. Film opacification shall be compatible to and specifically developed for application to solar reflective films. Glass performance shall be K-Value/Winter Nighttime [_____] , R-Value/Winter Nighttime [_____] , shading coefficient [_____] . Color shall be [_____] .

2.1.12.3 Spandrel Glass With Adhered Backing

NOTE: Spandrel glass with adhered backing is required wherever glass spandrels are located above sidewalks, pedestrian or vehicular ramps, paved plazas, entrances not covered by a protective canopy, and other locations where glass could fall onto an area used by the public.

ASTM C 1048, Kind HS or FT, Condition B (ceramic coated), Type I, Quality q5, [_____] mm inch thick and shall pass the fallout resistance test specified in ASTM C 1048. [Provide [_____] .]

2.1.13 Fire/Safety Rated Glass

Fire/safety rated glass shall be laminated Type I transparent flat type, Class 1-clear. Glass shall have a [20] [45] [60] [_____] minute rating when tested in accordance with ASTM E 119. Glass shall be permanently labeled with appropriate markings.

2.1.14 Tinted (Light-Reducing) Glass

NOTE: Reference to Section 09 06 90 COLOR SCHEDULE is intended for use on Army projects only.

Tinted (light-reducing) glass shall be Type I transparent flat type, Class 3-tinted, Quality q3 - glazing select, [_____] percent light transmittance, [_____] percent shading coefficient, conforming to ASTM C 1036. [Color shall be [gray] [bronze] [_____]] [as shown in Section 09 06 90 COLOR SCHEDULE] .]

2.2 INSULATING GLASS UNITS

NOTE: Where safety glazing is required, both lights of insulating units must be safety glass, and each light must have a permanent label.

NOTE: Window properties are critical to energy performance and comfort.

U value (rate of heat transfer) and SHGC (how much heat the building gains from the sun) are determined on a whole-opening basis (glazing and frame). Energy Star labeling is applicable to residential units only. Specify U value and SHGC in the appropriate exterior opening (window, door, curtain wall) sections and coordinate insulated glass description with energy performance requirements specified in those sections. Include bracketed U value and SHGC requirements here only if not specified elsewhere as a whole-opening rating for frame and glass. Determine appropriate values by consulting **ASHRAE 90.1 - SI** **ASHRAE 90.1 - IP**.

Specify low U value (rate of heat transfer) to reduce winter heat loss and summer heat gain. Windows on the west and east sides experience maximum solar gain in summer and should have a low SHGC (how much heat the building gains from the sun). Low SHGC is achieved with selective glass, tinted glass, or reflective coating. Specify selective glass for clear appearance or when high visible transmittance is required for daylighting goals. In the Northern Hemisphere, south side glass may be protected from summer sun by an overhang and have a high SHGC if winter heat is useful. Specify a low SHGC for south-side glass if the building is dominated by internal heat gain and solar heat is unwelcome even in winter. North side receives very little sun and requires no special treatment.

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

NOTE: STC levels higher than 35 may require costly design modifications and special glazing. STC addresses construction subject to interior sound frequencies and does not include all typical outdoor frequencies; Outside-Inside Transmission Class (OITC) was developed to evaluate an expanded sound-frequency range generally considered to be more reflective of exterior noise conditions imposed on the building envelope such as road, rail, and airplane traffic.

Two panes of glass separated by [a dehydrated [13 mm 1/2 inch airspace, filled with argon] [10 mm 3/8 inch airspace, filled with krypton] gas,][[16] [32] [_____] mm [0.63] [1.26] [_____] inches of aerogel] and hermetically sealed. [Residential windows (including frames and glass) shall be Energy Star qualified products as appropriate to [Northern] [North/Central] [South/Central] [Southern] climate zone.] [Non-residential glazed systems (including frames and glass) shall be certified by the National Fenestration Rating Council with a whole-window Solar Heat Gain Coefficient (SHGC) maximum of [_____] determined according to NFRC 200 procedures and a U-factor maximum of [_____] [W/m2-K] [Btu/hr-ft2-F] in accordance with NFRC 100.] Glazing shall meet or exceed a luminous efficacy of 1.0. Glazed panels shall be rated for not less than [26] [30] [35] [_____] Sound Transmission Class (STC) when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413. Dimensional tolerances shall be as specified in IGMA TR-1200. The units shall meet CBA Grade requirement when tested in accordance with ASTM E 773 and ASTM E 774, Class A. Spacer shall be black, roll-formed, [thin-gauge, C-section steel] [steel-reinforced butyl rubber] [thermally broken aluminum] [polyurethane and silicon foams], with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone.

Two panes of glass separated by a dehydrated airspace and hermetically sealed. Dimensional tolerances shall be as specified in IGMA TR-1200. The units shall conform to ASTM E 773 and ASTM E 774, Class A. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone.

2.2.1 Buildings

NOTE: When antiterrorism/force protection requirements apply, specify laminated annealed flat glass for interior light. Use the bracketed option regarding ASTM C 1172 in the paragraph below.

NOTE: Where safety glazing is required, both lights of insulating units must be safety glass, and each light must have a permanent label.

NOTE: U value (rate of heat transfer) and SHGC (how much heat the building gains from the sun) are determined on a whole-opening basis (glazing and frame). Specify U value and SHGC in the appropriate exterior opening (window, door, curtain wall) sections and coordinate insulated glass description with energy performance requirements specified in those sections. Include bracketed U value and SHGC requirements here only if not specified elsewhere as a whole-opening rating for frame and glass. Determine appropriate values by consulting ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

Window properties are critical to energy performance and visual satisfaction. Low SHGC is achieved with selective glass, tinted glass, or reflective coating. Specify selective glass for clear appearance or when high visible transmittance is required for daylighting goals. In the Northern Hemisphere, south side glass may be protected from summer sun by an overhang and have a high SHGC if winter heat is useful. Specify a low SHGC for south-side glass if the building is dominated by internal heat gain and solar heat is unwelcome even in winter. North side receives very little sun and requires no special treatment.

Consider glazing with aerogel insulation between 2 panels of glass, producing the highest visual transmittance with the highest insulation values currently available. Verify availability and cost before specifying aerogel.

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

Designer must verify availability and adequate competition for products energy performance requirements before specifying and edit as needed.

NOTE: STC levels higher than 35 may require costly design modifications and special glazing. STC addresses construction subject to interior sound frequencies and does not include all typical outdoor frequencies; Outside-Inside Transmission Class (OITC) was developed to evaluate an expanded sound-frequency range generally considered to be more reflective of exterior noise conditions imposed on the building envelope such as road, rail, and airplane traffic.

Two panes of glass separated by a dehydrated airspace[, filled with argon gas][, filled with krypton gas,][, filled with aerogel] and hermetically sealed.

[Insulated glass units shall have a Solar Heat Gain Coefficient (SHGC) maximum of [_____]and a U-factor maximum of [_____] W per square m by K Btu per square foot by hr by degree F.]

[Glazing shall meet or exceed a luminous efficacy of 1.0.] [See section[s][] for energy performance requirements for glazed systems (glazing and frames).] [Glazed panels shall be rated for not less than [26] [30] [35] [_____] Sound Transmission Class (STC) when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.]

Dimensional tolerances shall be as specified in IGMA TR-1200. The units shall conform to meet CBA Grade requirement when tested in accordance with ASTM E 773 and ASTM E 774, Class A. Spacer shall be black, roll-formed, [thin-gauge, C-section steel] [steel-reinforced butyl rubber] [thermally

broken aluminum] [polyurethane and silicon foams], with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone.

The inner light shall be [ASTM C 1172, clear annealed flat glass Type I, Class I, Quality q3] [ASTM C 1036, Type I, Class 1, Quality q4, [_____] mm inch thick] [ASTM C 1048, Grade B (fully tempered), Style I (uncoated), Type I, Class 1 (transparent), Quality q4, [_____] mm inch thick]. The outer light shall be [ASTM C 1036, Type I, Class [1 (transparent)] [2 (tinted heat absorbing)], [2 (solar-reflective)], Quality q4, [_____] mm inch thick] [ASTM C 1048, Grade B (fully tempered), Style I (uncoated), Type I, Class [1 (clear)] [2 (tinted heat absorbing)] [solar-reflective], Quality q4, [_____] mm inch thick].

2.2.2 Control Towers

NOTE: For Air Force installations, do not modify these requirements without approval of Headquarters, U.S. Air Force. Where design wind speed is more than 225 kilometers 140 miles per hour, delete the first and use the second bracketed sentence. Coordinate term of warranty with paragraph entitled "Warranty."

NOTE: Requirements for control tower cab windows will be included in the project specification for Air Force construction. The use of these requirements by other agencies should be governed by agency criteria. Requirements for control tower cab windows are for the sizes and details on the current standard Air Force control tower drawings. Any modification from Air Force installations will be made only with the approval of Headquarters, U.S. Air Force. Edit this paragraph to include only the heat-absorbing insulating glass or the clear insulating glass.

Wind load requirements must be determined by the designer and the blanks filled in for each project.

If spare units are required for a particular project an "Extra Materials" paragraph must be developed for PART 1 which identifies the items, states quantities, and indicates to whom, when and where to be delivered.

For overseas work the following subparagraph will also be added:

1. When units other than United States manufacturer are proposed for use, the manufacturer shall prove successful use of the insulating window units in aircraft control tower cabs.

Control tower glass units shall be of sizes required to properly fit aluminum frames. Tolerances and clearances for units shall be designed to prevent the transfer of stress in aluminum frames to the glass. Resilient setting blocks, spacer strips, clips, bolts, washers, angles, glazing sealants, and resilient channels or cemented-on-materials shall be of the type recommended in the glass manufacturer's approved written instructions. Edges and corners of units shall not be ground, nipped, cut, or fitted after leaving the factory.

NOTE: The insulated glass system should be used for clarity and insulation, unless structural loadings dictate laminated glass be used. Navy/Marine Corps Air Traffic Control Towers shall normally use laminated glass in hurricane prone or high wind areas and for large panes of glass where it would be difficult to maintain the 1/2 inch separation evenly in an insulated glass system. Refer to UFC 4-133-01N, "Navy Air Traffic Control Facilities" for guidance.

2.2.2.1 Control Tower Insulating Glass

Insulating glass units for air traffic control towers shall meet the wind load design requirement of [] kPa [] psi, as determined in accordance with ASCE 7-10. Insulating glass shall be Class A preassembled units of dual-seal construction consisting of two lites of glass separated by a dark bronze aluminum, steel, or stainless steel, spacer with desiccant and dehydrated space conforming to ASTM E 773 and ASTM E 774. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints, to completely seal the spacer periphery to eliminate moisture and hydrocarbon vapor transmission into airspace through corners. Primary seal shall be compressed polyisobutylene. Secondary seal shall be silicone. Insulating glass units shall be fabricated for use at an elevation of [] meters [] feet above mean sea level and [] meters [] feet above grade. Within bottom 1/3 of one of the vertical edges of each unit, the manufacturer shall install an open 305 mm 12 inch long capillary/breather tube for pressure equalization. The insulating glass units shall be free of parallax or optical distortions. The manufacturer's identifying label shall be permanently affixed to both exterior surfaces of the glass units. The insulating glass units shall be a total thickness of 26 mm 1 inch consisting of two 6 mm 1/4 inch thick panels and air space, or a total thickness of 32 mm 1-1/4 inch consisting of two 10 mm 3/8 inch thick panels and air space, or a total thickness of 38 mm 1-1/2 inch consisting of two 13 mm 1/2 inch thick panels and an air space, as required to meet the wind loads indicated. Glass type shall be as follows.

2.2.2.2 Control Tower Heat-Absorbing Insulating Glass

NOTE: Coordinate with paragraph Heat Absorbing Glass.

Heat-absorbing insulating glass shall consist of two glass panels separated by an air space and shall conform to ASTM C 1036, Type I, transparent flat glass, Style A, Quality q3 - glazing select. Interior glass shall be Class 1-clear and exterior glass shall be Class 2-tinted green. Glass

performance shall be minimum Visible Transmittance of [70.8] [_____] percent for each panel and K-Value of 3.07 R-Value of 1.85 for the unit.

2.2.2.3 Control Tower Clear Insulating Glass

Clear insulating glass shall consist of two float glass panels separated by an air space and shall conform to ASTM C 1036, Type I transparent flat glass, Quality q3-glazing select. Interior glass and exterior glass shall be Class 1-clear. Glass performance shall be minimum Visible Transmittance of [87.3] [_____] percent for each panel and K-Value of 3.07 R-Value of 1.85 for each unit.

2.2.2.4 Control Tower Laminated Glass

Laminated glass units for air traffic control towers shall meet the wind load design requirement of [_____] kPa [_____] psi, as determined in accordance with ASCE 7-10. ASTM C 1172, Kind LA fabricated from two nominal 12.5 mm 1/2 inch pieces of Type I, Class 1, Quality q3, flat annealed transparent glass conforming to ASTM C 1036. Flat glass shall be laminated together with a minimum of 0.75 mm 0.030 inch thick, clear polyvinyl butyral interlayer or alternatives such as resin laminates, conforming to requirements of 16 CFR 1201 and ASTM C 1172. The total thickness shall be nominally 25 mm 1 inch. Color shall be [[clear] [gray] [bronze] [_____]]. [Provide [_____]].]

2.2.3 Low Emissivity Insulating Glass

NOTE: Low emissivity coating should be on the air space surface of the inner pane of glass (the number 3 surface) in heating-dominated buildings, and on the number 2 surface (inside surface of the exterior pane) in cooling-dominated buildings.

Interior and exterior glass panes for Low-E insulating units shall be Type I annealed flat glass, Class [1-clear] [2-tinted] with anti-reflective low-emissivity coating on [No. 2 surface (inside surface of exterior pane)] [No. 3 surface (inside surface of interior pane)], Quality q3 - glazing select, conforming to ASTM C 1036. Glass performance shall be U value maximum of [_____] [W/m2-K] [Btu/hr-ft2-F], Solar Heat Gain Coefficient (SHGC) maximum of [_____] . Color shall be [[green] [gray] [bronze] [blue] [_____]] [as shown in Section 09 06 90 COLOR SCHEDULE].

2.3 PLASTIC GLAZING

NOTE: Plastic glazing may be used in some areas where high resistance to breakage is required, but combustibility must be considered in the design. See manufacturers' literature for many types available. Do not specify plastic for glazing unprotected openings, for roof panels, or for skylights without consulting UFC 3-600-01, "Fire Protection Engineering for Facilities" and NAVFACENGCOM Code 04F.

NOTE: Polycarbonate is more expensive than acrylic

and should only be selected for locations which are highly vulnerable to vandalism or other types of abuse. Avoid polycarbonate if possible due to potentially hazardous constituent chemicals (including Bisphenol A). Where only one material is used in the project, the other one should be deleted.

Where translucent plastic sheets are required, locations will be shown on the contract drawings. The following will be added at the end of the paragraph:

"Translucent sheets, where shown, shall be white having light transmission of [_____] percent for sheets [_____] mm inches thick, or clear with matt finish."

The light transmission required for a particular sheet thickness will be selected from plastic sheet manufacturer's catalogs.

Acrylic-plastic is a combustible material and should not be used in areas where exposure to fire would create a hazard condition.

Consider glazing with aerogel insulation between 2 panels of plastic, producing the highest visual transmittance with the highest insulation values currently available. Plastic glazing shall have a U-factor maximum of the specified U-factor for insulating glass units. Verify availability and cost before specifying aerogel.

Plastic glazing shall have a U-factor maximum of [_____] W per square m by K Btu per square foot by hr by degree F. [Plastic glazing shall include a [16] [32] [_____] mm [0.63] [1.26] [_____] inch layer of aerogel between panels.]

2.3.1 Acrylic Sheet

ASTM D 4802, [Type I, regular] [Type II, heat resistant,] [clear and smooth on both sides] [translucent, textured on both sides,] [gray tint,] [bronze tint,] ultraviolet stabilized, [scratch resistant,] [_____] [6] [_____] mm [0.236] [_____] in. thick.

2.3.2 Polycarbonate Sheet

ANSI Z97.1, [Clear and smooth both sides] [Translucent, textured both sides] [Gray tint] [Bronze tint] [mar-resistant] [high abrasion resistant], ultraviolet stabilized, [_____] mm inch thick and listed in UL MEAPD as burglar resisting. [Mar-resistant sheet shall have a change in haze of between 5 and 8 percent under silica carbide test, 1600 grams, ASTM D 673.]

2.3.3 Extruded Polycarbonate Profiled Sheet

Provide [double] [triple] walled, surface treated for improved UV resistance, offering thermal efficiency and impact strength.

2.3.4 Bullet-Resistant Plastic Sheet

NOTE: Bullet-resisting glazing material is available in four power ratings to resist scattered shots from (1) medium-power small arms (MSA); (2) high-power small arms (HSA); (3) super-power small arms (SSA); and (4) high-power rifles (HR). Bullet-resisting acrylic sheet is listed by UL for MSA rating only and is 25.4 mm one inch thick. Bullet-resisting polycarbonate sheet is listed for MSA 25.4 mm one inch and for HSA and SSA ratings 31.8 mm 1 1/4 inch. Consult manufacturers for exact thicknesses and availability.

Cast acrylic sheet or mar-resistant polycarbonate sheet laminated with a special interlayer, and listed in UL 752 as bullet resisting, Class [I] [II] [III], [clear] [_____] in color. [Provide [_____] .]

2.4 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted shall be gray or neutral color.

2.4.1 Putty and Glazing Compound

Glazing compound shall conform to ASTM C 669 for face-glazing metal sash. Putty shall be linseed oil type conforming to CID A-A-378 for face-glazing primed wood sash. Putty and glazing compounds shall not be used with insulating glass or laminated glass.

2.4.2 Glazing Compound

ASTM C 669. Use for face glazing metal sash. Do not use with insulating glass units or laminated glass.

2.4.3 Sealants

Provide elastomeric [and structural] sealants.

2.4.3.1 Elastomeric Sealant

ASTM C 920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing [wood] [and] [metal] sash. Sealant shall be chemically compatible with setting blocks, edge blocks, and sealing tapes[, with sealants used in manufacture of insulating glass units] [, and with plastic sheet]. Color of sealant shall be white.

2.4.3.2 Structural Sealant

ASTM C 1184, Type S.

2.4.4 Joint Backer

Joint backer shall have a diameter size at least 25 percent larger than

joint width; type and material as recommended in writing by glass and sealant manufacturer.

2.4.5 Preformed Channels

Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the particular condition. [Channels for bullet-resistant glass shall be synthetic rubber, [ASTM C 864](#), not less than 6 mm 1/4 inch thick and sufficiently resilient to accommodate expansion and contraction while maintaining a vaportight seal between glass and frame.] [Channels shall be chemically compatible with plastic sheet.]

2.4.6 Sealing Tapes

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with [ASTM D 2287](#). Use only where glazing rabbet is designed for tape and [tape](#) is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes shall be chemically compatible with the product being set.

2.4.7 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks shall be dense extruded type conforming to [ASTM C 509](#) and [ASTM D 395](#), Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (+ or - 5). Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by glass manufacturer. Block color shall be black.

2.4.8 Glazing Gaskets

Glazing gaskets shall be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Glazing gasket profiles shall be as indicated on drawings.

2.4.8.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to [ASTM C 509](#), Type 2, Option 1.

2.4.8.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to [ASTM C 864](#), Option 1, Shore A durometer between 65 and 75.

2.4.8.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.4.9 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

[2.5 MIRROR ACCESSORIES

**NOTE: Use for Army projects only. Navy projects
will specify Mirrors and Accessories in Division 10,
Specialties.**

2.5.1 Mastic

Mastic for setting mirrors shall be a [polymer] [_____] type mirror mastic resistant to water, shock, cracking, vibration and thermal expansion. Mastic shall be compatible with mirror backing paint, and shall be approved by mirror manufacturer.

2.5.2 Mirror Frames

Mirrors shall be provided with mirror frames (J-mold channels) fabricated of one-piece roll-formed Type 304 stainless steel with No. 4 brushed satin finish and concealed fasteners which will keep mirrors snug to wall. Frames shall be 32 by 6 by 6 mm 1-1/4 by 1/4 by 1/4 inch continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material shall be provided with mirror frames.

2.5.3 Mirror Clips

Concealed fasteners of type to suit wall construction material shall be provided with clips.

]PART 3 EXECUTION

3.1 PREPARATION

Preparation, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 GLASS SETTING

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Aluminum windows, wood doors, and wood windows may be glazed in conformance with one of the glazing methods

described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

3.2.1 Sheet Glass

Cut and set with the visible lines or waves horizontal.

3.2.2 Patterned Glass

Set glass with one patterned surface with smooth surface on the weather side. When used for interior partitions, place the patterned surface in same direction in all openings.

3.2.3 Insulating Glass Units

Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation shall conform to applicable recommendations of [IGMA TB-3001](#) and [IGMA TM-3000](#).

3.2.4 Installation of Wire Glass

Install glass for fire doors in accordance with installation requirements of [NFPA 80](#).

3.2.5 Installation of Heat-Absorbing Glass

Glass shall have clean-cut, factory-fabricated edges. Field cutting will not be permitted.

3.2.6 Installation of Laminated Glass

Sashes which are to receive laminated glass shall be weeped to the outside to allow water drainage into the channel.

3.2.7 Plastic Sheet

Conform to manufacturer's recommendations for edge clearance, type of sealant and tape, and method of installation.

3.3 ADDITIONAL REQUIREMENTS FOR GLAZING CONTROL TOWER WINDOWS

NOTE: For Air Force installations, do not modify these requirements without approval of Headquarters, U.S. Air Force. Where design wind speed is more than **225 kilometers 140 miles** per hour, delete the last sentence.

3.3.1 Materials and Methods of [Installation](#)

Comply with the manufacturer's warranty and written instructions, except as indicated. Install units with the heat-absorbing glass to the exterior. Secure glass in place with bolts and spring clips. The minimum clearance

between bolts and edge of glass unit shall be 4.75 mm 3/16 inch. The glass shall be edged with 4.75 mm 3/16 inch thick continuous neoprene, vinyl, or other approved material. Trim edging after installation. The channel shapes or strips shall be firmly held against the glass by the spring action of the extruded metal moldings. Resilient setting blocks, spacer strips, clips, bolts, washers, angles, applicable glazing compound, and resilient channels or cemented-on materials shall be as recommended in the written instructions of the glass manufacturer, as approved.

3.3.2 Tolerances and Clearances of Units

Design to prevent the transfer of stress in the setting frames to the glass. Springing, twisting, or forcing of units during setting will not be permitted.

3.4 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass shall be clean at the time the work is accepted. [Clean plastic sheet in accordance with manufacturer's instructions.]

3.5 PROTECTION

Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Upon removal, separate protective materials for reuse or recycling. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

3.6 WASTE MANAGEMENT

NOTE: Float glass cannot be recycled with beverage-container glass. Diverting waste from the landfill contributes to the following LEED credit: MR2. Coordinate with Section 01 74 19 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT. Designer shall verify that items are able to be disposed of as specified.

Disposal and recycling of waste materials, including corrugated cardboard recycling, shall be in accordance with the Waste Management Plan. [Separate float glass and reuse or recycle.] [Upon removal, separate protective materials and reuse or recycle.] [Separate tempered glass for use as aggregate or nonstructural fill.] Close and seal tightly all partly used sealant containers and store protected in well-ventilated, fire-safe area at moderate temperature.

3.7 SCHEDULE

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

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

<u>PRODUCTS</u>	<u>INCH-POUND</u>	<u>METRIC</u>
Glass	1/8 inch	3 mm
	3/16 inch	4.5 mm
	7/32 inch	6 mm
	1/4 inch	6 mm
	3/8 inch	10 mm
Interlayer	0.015 inch	0.38 mm
Glazing Channels	1/4 inch	6 mm

-- End of Section --