

CHAPTER 24

GLASS AND GLAZING

SECTION 2401 GENERAL

2401.1 Scope. The provisions of this chapter shall govern the materials, design, construction and quality of glass, light-transmitting ceramic and light-transmitting plastic panels for exterior and interior use in both vertical and sloped applications in buildings and structures.

Exception: Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Sections 2410 through 2415.

2401.2 Glazing replacement. The installation of replacement glass shall be as required for new installations.

SECTION 2402 DEFINITIONS

2402.1 Definitions. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

DALLE GLASS. A decorative composite glazing material made of individual pieces of glass that are embedded in a cast matrix of concrete or epoxy.

DECORATIVE GLASS. A carved, leaded or Dalle glass or glazing material whose purpose is decorative or artistic, not functional; whose coloring, texture or other design qualities or components cannot be removed without destroying the glazing material and whose surface, or assembly into which it is incorporated, is divided into segments.

SECTION 2403 GENERAL REQUIREMENTS FOR GLASS

2403.1 Identification. Each pane shall bear the manufacturer's *mark* designating the type and thickness of the glass or glazing material. With the exception of tempered glazing materials or laminated materials, the identification shall not be omitted unless *approved* and an affidavit is furnished by the glazing contractor certifying that each light is glazed in accordance with *approved construction documents* that comply with the provisions of this chapter. Safety glazing shall be identified in accordance with Section 2406.2.

Each pane of tempered glass, except tempered spandrel glass, shall be permanently identified by the manufacturer and each pane of laminated glass shall be permanently identified with the laminator, overall glass thickness and trade name of the interlayer. The identification *mark* shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

Tempered or laminated spandrel glass shall be provided with a removable paper marking by the manufacturer.

2403.2 Glass supports. Where one or more sides of any pane of glass are not firmly supported, or are subjected to unusual load conditions, detailed *construction documents*, detailed shop drawings and analysis or test data assuring safe performance for the specific installation shall be prepared by a *registered design professional*.

2403.3 Framing. To be considered firmly supported, the framing members for each individual pane of glass shall be designed so the deflection of the edge of the glass perpendicular to the glass pane shall not exceed $1/175$ of the glass edge length or $3/4$ inch (19.1 mm), whichever is less, when subjected to the larger of the positive or negative load where loads are combined as specified in Section 1605.

2403.4 Interior glazed areas. Where interior glazing is installed adjacent to a walking surface, the differential deflection of two adjacent unsupported edges shall not be greater than the thickness of the panels when a force of 50 pounds per linear foot (plf) (730 N/m) is applied horizontally to one panel at any point up to 42 inches (1067 mm) above the walking surface.

2403.5 Louvered windows or jalousies. Float, wired and patterned glass in louvered windows and jalousies shall be no thinner than nominal $3/16$ inch (4.8 mm) and no longer than 48 inches (1219 mm). Exposed glass edges shall be smooth.

Wired glass with wire exposed on longitudinal edges shall not be used in louvered windows or jalousies.

Where other glass types are used, the design shall be submitted to the *building official* for approval.

SECTION 2404 WIND AND DEAD LOADS ON GLASS

2404.1 Vertical glass. Glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads for components and cladding. The load resistance of glass under uniform load shall be determined in accordance with ASTM E 1300. Design of exterior windows and glass doors in accordance with Section 2404.1 shall utilize the same edition of ASTM E 1300 used for testing in accordance with Section 1715.5.

The design of vertical glazing shall be based on the following equation:

$$F_{gw} \leq F_{ga} \quad \text{(Equation 24-1)}$$

where:

F_{gw} is the wind load on the glass computed in accordance with Section 1609 multiplied by 0.60 and

F_{ga} is the short duration load resistance of the glass as determined in accordance with ASTM E 1300.

2404.2 Sloped glass. Glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunrooms, sloped roofs and

other exterior applications shall be designed to resist the most critical of the following combinations of loads.

$$F_g = W_o - D \quad (\text{Equation 24-2})$$

$$F_g = W_i + D \quad (\text{Equation 24-3})$$

$$F_g = 0.5 W_i + D \quad (\text{Equation 24-4})$$

where:

D = Glass dead load psf (kN/m²).

For glass sloped 30 degrees (0.52 rad) or less from horizontal,

D = $13 t_g$ (For SI: $0.0245 t_g$).

For glass sloped more than 30 degrees (0.52 rad) from horizontal,

D = $13 t_g \cos \theta$ (For SI: $0.0245 t_g \cos \theta$).

F_g = Total load, psf (kN/m²) on glass.

S = Snow load, psf (kN/m²) as determined in Section 1608.

t_g = Total glass thickness, inches (mm) of glass panes and plies.

W_i = Inward wind force, psf (kN/m²) as calculated in Section 1609 multiplied by 0.60.

W_o = Outward wind force, psf (kN/m²) as calculated in Section 1609 multiplied by 0.60.

θ = Angle of slope from horizontal.

Exception: Unit skylights and tubular daylighting devices (TDDs) shall comply with the requirements of Section 2405.

The design of sloped glazing shall be based on the following equation:

$$F_g \leq F_{ga} \quad (\text{Equation 24-5})$$

where:

F_g = Total load on the glass determined from the load combinations above.

F_{ga} = Short duration load resistance of the glass as determined according to ASTM E 1300 for Equations 24-2 and 24-3; or the long duration load resistance of the glass as determined according to ASTM E 1300 for Equation 24-4.

2404.3 Wired, patterned and sandblasted glass.

2404.3.1 Vertical wired glass. Wired glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$$F_{gw} < 0.5 F_{ge} \quad (\text{Equation 24-6})$$

where:

F_{gw} = The wind load on the glass computed per Section 1609 multiplied by 0.60.

F_{ge} = Nonfactored load from ASTM E 1300 using a thickness designation for monolithic glass that is not greater than the thickness of wired glass.

2404.3.2 Sloped wired glass. Wired glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunspaces, sloped roofs and other exterior applications shall be designed to resist the most critical of the combinations of loads from Section 2404.2.

For Equations 24-2 and 24-3:

$$F_g < 0.5 F_{ge} \quad (\text{Equation 24-7})$$

For Equation 24-4:

$$F_g < 0.3 F_{ge} \quad (\text{Equation 24-8})$$

where:

F_g = Total load on the glass.

F_{ge} = Nonfactored load from ASTM E 1300.

2404.3.3 Vertical patterned glass. Patterned glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$$F_{gw} < 1.0 F_{ge} \quad (\text{Equation 24-9})$$

where:

F_{gw} = Wind load on the glass computed per Section 1609 multiplied by 0.60.

F_{ge} = Nonfactored load from ASTM E 1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between nonfactored load charts in ASTM E 1300 shall be permitted.

2404.3.4 Sloped patterned glass. Patterned glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunspaces, sloped roofs and other exterior applications shall be designed to resist the most critical of the combinations of loads from Section 2404.2.

For Equations 24-2 and 24-3:

$$F_g < 1.0 F_{ge} \quad (\text{Equation 24-10})$$

For Equation 24-4:

$$F_g < 0.6 F_{ge} \quad (\text{Equation 24-11})$$

where

F_g = Total load on the glass.

F_{ge} = Nonfactored load from ASTM E 1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between the nonfactored load charts in ASTM E 1300 shall be permitted.

2404.3.5 Vertical sandblasted glass. Sandblasted glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors, and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$$F_g < 0.5 F_{ge} \quad (\text{Equation 24-12})$$

where:

F_g = The wind load on the glass computed per Section 1609 multiplied by 0.60.

F_{ge} = Nonfactored load from ASTM E 1300. The value for sandblasted glass is for moderate levels of sandblasting.

2404.4 Other designs. For designs outside the scope of this section, an analysis or test data for the specific installation shall be prepared by a *registered design professional*.

SECTION 2405 SLOPED GLAZING AND SKYLIGHTS

2405.1 Scope. This section applies to the installation of glass and other transparent, translucent or opaque glazing material installed at a slope more than 15 degrees (0.26 rad) from the vertical plane, including glazing materials in skylights, roofs and sloped walls.

2405.2 Allowable glazing materials and limitations. Sloped glazing shall be any of the following materials, subject to the listed limitations.

1. For monolithic glazing systems, the glazing material of the single light or layer shall be laminated glass with a minimum 30-mil (0.76 mm) polyvinyl butyral (or equivalent) interlayer, wired glass, light-transmitting plastic materials meeting the requirements of Section 2607, heat-strengthened glass or fully tempered glass.
2. For multiple-layer glazing systems, each light or layer shall consist of any of the glazing materials specified in Item 1 above.

Annealed glass is permitted to be used as specified within Exceptions 2 and 3 of Section 2405.3.

For additional requirements for plastic skylights, see Section 2610. Glass-block construction shall conform to the requirements of Section 2101.2.5.

2405.3 Screening. Where used in monolithic glazing systems, heat-strengthened glass and fully tempered glass shall have screens installed below the glazing material. The screens and their fastenings shall: (1) be capable of supporting twice the weight of the glazing; (2) be firmly and substantially fastened to the framing members and (3) be installed within 4 inches (102 mm) of the glass. The screens shall be constructed of a noncombustible material not thinner than No. 12 B&S gage (0.0808 inch) with mesh not larger than 1 inch by 1 inch (25 mm by 25 mm). In a corrosive atmosphere, structurally equivalent noncorrosive screen materials shall be used. Heat-strengthened glass, fully tempered glass and wired glass, when used in multiple-layer glazing systems as the bottom glass layer over the walking surface, shall be equipped with screening that conforms to the requirements for monolithic glazing systems.

Exception: In monolithic and multiple-layer sloped glazing systems, the following applies:

1. Fully tempered glass installed without protective screens where glazed between intervening floors at a slope of 30 degrees (0.52 rad) or less from the vertical plane shall have the highest point of the glass 10 feet (3048 mm) or less above the walking surface.
2. Screens are not required below any glazing material, including annealed glass, where the walking surface below the glazing material is permanently protected from the risk of falling glass or the area below the glazing material is not a walking surface.
3. Any glazing material, including annealed glass, is permitted to be installed without screens in the sloped glazing systems of commercial or detached noncombustible greenhouses used exclusively for growing plants and not open to the public, provided that the height of the greenhouse at the ridge does not exceed 30 feet (9144 mm) above grade.
4. Screens shall not be required within individual *dwelling units* in Groups R-2, R-3 and R-4 where fully tempered glass is used as single glazing or as both panes in an insulating glass unit, and the following conditions are met:
 - 4.1. Each pane of the glass is 16 square feet (1.5 m²) or less in area.
 - 4.2. The highest point of the glass is 12 feet (3658 mm) or less above any walking surface or other accessible area.
 - 4.3. The glass thickness is ³/₁₆ inch (4.8 mm) or less.
5. Screens shall not be required for laminated glass with a 15-mil (0.38 mm) polyvinyl butyral (or equivalent) interlayer used within individual *dwelling units* in Groups R-2, R-3 and R-4 within the following limits:
 - 5.1. Each pane of glass is 16 square feet (1.5 m²) or less in area.
 - 5.2. The highest point of the glass is 12 feet (3658 mm) or less above a walking surface or other accessible area.

2405.4 Framing. In Type I and II construction, sloped glazing and skylight frames shall be constructed of noncombustible materials. In structures where acid fumes deleterious to metal are incidental to the use of the buildings, *approved* pressure-treated wood or other *approved* noncorrosive materials are permitted to be used for sash and frames. Framing supporting sloped glazing and skylights shall be designed to resist the tributary roof loads in Chapter 16. Skylights set at an angle of less than 45 degrees (0.79 rad) from the horizontal plane shall be mounted at least 4 inches (102 mm) above the plane of the roof on a curb constructed as required for the frame. Skylights shall not be installed in the plane of the roof where the roof pitch is less than 45 degrees (0.79 rad) from the horizontal.

Exception: Installation of a skylight without a curb shall be permitted on roofs with a minimum slope of 14 degrees (three units vertical in 12 units horizontal) in Group R-3 occupancies. All unit skylights installed in a roof with a pitch flatter than 14 degrees (0.25 rad) shall be mounted at

least 4 inches (102 mm) above the plane of the roof on a curb constructed as required for the frame unless otherwise specified in the manufacturer’s installation instructions.

2405.5 Unit skylights. Unit skylights shall be tested and labeled as complying with AAMA/WDMA/CSA 101/I.S.2/A440. The *label* shall state the name of the manufacturer, the *approved* labeling agency, the product designation and the performance grade rating as specified in AAMA/WDMA/CSA 101/I.S.2/A440. If the product manufacturer has chosen to have the performance grade of the skylight rated separately for positive and negative design pressure, then the *label* shall state both performance grade ratings as specified in AAMA/WDMA/CSA 101/I.S.2/A440 and the skylight shall comply with Section 2405.5.2. If the skylight is not rated separately for positive and negative pressure, then the performance grade rating shown on the *label* shall be the performance grade rating determined in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for both positive and negative design pressure and the skylight shall conform to Section 2405.5.1.

2405.5.1 Unit skylights rated for the same performance grade for both positive and negative design pressure. The design of unit skylights shall be based on the following equation:

$$F_g \leq PG \quad \text{(Equation 24-13)}$$

where:

F_g = Maximum load on the skylight determined from Equations 24-2 through 24-4 in Section 2404.2.

PG = Performance grade rating of the skylight.

2405.5.2 Unit skylights rated for separate performance grades for positive and negative design pressure. The design of unit skylights rated for performance grade for both positive and negative design pressures shall be based on the following equations:

$$F_{gi} \leq PG_{Pos} \quad \text{(Equation 24-14)}$$

$$F_{go} \leq PG_{Neg} \quad \text{(Equation 24-15)}$$

where:

PG_{Pos} = Performance grade rating of the skylight under positive design pressure;

PG_{Neg} = Performance grade rating of the skylight under negative design pressure; and

F_{gi} and F_{go} are determined in accordance with the following:

For $W_o \geq D$,
where:

W_o = Outward wind force, psf (kN/m²) as calculated in Section 1609 multiplied by 0.60.

D = The dead weight of the glazing, psf (kN/m²) as determined in Section 2404.2 for glass, or by the weight of the plastic, psf (kN/m²) for plastic glazing.

F_{gi} = Maximum load on the skylight determined from Equations 24-3 and 24-4 in Section 2404.2.

F_{go} = Maximum load on the skylight determined from Equation 24-2.

For $W_o < D$,

where:

W_o = The outward wind force, psf (kN/m²) as calculated in Section 1609 multiplied by 0.60.

D = The dead weight of the glazing, psf (kN/m²) as determined in Section 2404.2 for glass, or by the weight of the plastic for plastic glazing.

F_{gi} = Maximum load on the skylight determined from Equations 24-2 through 24-4 in Section 2404.2.

F_{go} = 0.

SECTION 2406 SAFETY GLAZING

2406.1 Human impact loads. Individual glazed areas, including glass mirrors, in hazardous locations as defined in Section 2406.4 shall comply with Sections 2406.1.1 through 2406.1.4.

2406.1.1 Impact test. Except as provided in Sections 2406.1.2 through 2406.1.4, all glazing shall pass the impact test requirements of Section 2406.2.

2406.1.2 Plastic glazing. Plastic glazing shall meet the weathering requirements of ANSI Z97.1.

2406.1.3 Glass block. Glass-block walls shall comply with Section 2101.2.5.

2406.1.4 Louvered windows and jalousies. Louvered windows and jalousies shall comply with Section 2403.5.

TABLE 2406.2(1)
MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING CPSC 16 CFR 1201

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZING IN STORM OR COMBINATION DOORS (Category class)	GLAZING IN DOORS (Category class)	GLAZED PANELS REGULATED BY ITEM 7 OF SECTION 2406.4 (Category class)	GLAZED PANELS REGULATED BY ITEM 6 OF SECTION 2406.4 (Category class)	DOORS AND ENCLOSURES REGULATED BY ITEM 5 OF SECTION 2406.4 (Category class)	SLIDING GLASS DOORS PATIO TYPE (Category class)
9 square feet or less	I	I	No requirement	I	II	II
More than 9 square feet	II	II	II	II	II	II

For SI: 1 square foot = 0.0929 m².

TABLE 2406.2(2)
MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING ANSI Z97.1

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZED PANELS REGULATED BY ITEM 7 OF SECTION 2406.4 (Category class)	GLAZED PANELS REGULATED BY ITEM 6 OF SECTION 2406.4 (Category class)	DOORS AND ENCLOSURES REGULATED BY ITEM 5 OF SECTION 2406.4 ^a (Category class)
9 square feet or less	No requirement	B	A
More than 9 square feet	A	A	A

For SI: 1 square foot = 0.0929 m².

a. Use is only permitted by the exception to Section 2406.2.

2406.2 Impact test. Where required by other sections of this code, glazing shall be tested in accordance with CPSC 16 CFR 1201. Glazing shall comply with the test criteria for Category I or II as indicated in Table 2406.2(1).

Exception: Glazing not in doors or enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers shall be permitted to be tested in accordance with ANSI Z97.1. Glazing shall comply with the test criteria for Class A or B as indicated in Table 2406.2(2).

2406.3 Identification of safety glazing. Except as indicated in Section 2406.3.1, each pane of safety glazing installed in hazardous locations shall be identified by a manufacturer's designation specifying who applied the designation, the manufacturer or installer and the safety glazing standard with which it complies, as well as the information specified in Section 2403.1. The designation shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that once applied, cannot be removed without being destroyed. A label as defined in Section 202.1 and meeting the requirements of this section shall be permitted in lieu of the manufacturer's designation.

Exceptions:

- For other than tempered glass, manufacturer's designations are not required, provided the *building official* approves the use of a certificate, affidavit or other evidence confirming compliance with this code.
- Tempered spandrel glass is permitted to be identified by the manufacturer with a removable paper designation

2406.3.1 Multi-pane assemblies. Multi-pane glazed assemblies having individual panes not exceeding 1 square foot (0.09 m²) in exposed areas shall have at least one pane in the assembly marked as indicated in Section 2406.3. Other panes in the assembly shall be marked "CPSC 16 CFR 1201" or "ANSI Z97.1," as appropriate.

2406.4 Hazardous locations. The following shall be considered specific hazardous locations requiring safety glazing materials:

- Glazing in swinging doors except jalousies (see Section 2406.4.1).
- Glazing in fixed and sliding panels of sliding door assemblies and panels in sliding and bifold closet door assemblies.
- Glazing in storm doors.
- Glazing in unframed swinging doors.

- Glazing in doors and enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers. Glazing in any portion of a building wall enclosing these compartments where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above a standing surface.
- Glazing in an individual fixed or operable panel adjacent to a door where the nearest exposed edge of the glazing is within a 24-inch (610 mm) arc of either vertical edge of the door in a closed position and where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above the walking surface.

Exceptions:

- Panels where there is an intervening wall or other permanent barrier between the door and glazing.
- Where access through the door is to a closet or storage area 3 feet (914 mm) or less in depth. Glazing in this application shall comply with Section 2406.4, Item 7.
- Glazing in walls perpendicular to the plane of the door in a closed position, other than the wall towards which the door swings when opened, in one- and two-family *dwelling*s or within *dwelling units* in Group R-2.
- Glazing in an individual fixed or operable panel, other than in those locations described in preceding Items 5 and 6, which meets all of the following conditions:
 - Exposed area of an individual pane greater than 9 square feet (0.84 m²);
 - Exposed bottom edge less than 18 inches (457 mm) above the floor;
 - Exposed top edge greater than 36 inches (914 mm) above the floor; and
 - One or more walking surface(s) within 36 inches (914 mm) horizontally of the plane of the glazing.

Exception: Safety glazing for Item 7 is not required for the following installations:

- A protective bar 1½ inches (38 mm) or more in height, capable of withstanding a horizontal load of 50 plf (730 N/m) without contacting the glass, is installed on the accessible sides of the glazing 34

inches to 38 inches (864 mm to 965 mm) above the floor.

2. The outboard pane in insulating glass units or multiple glazing where the bottom exposed edge of the glass is 25 feet (7620 mm) or more above any grade, roof, walking surface or other horizontal or sloped [within 45 degrees (0.78 rad) of horizontal] surface adjacent to the glass exterior.
8. Glazing in *guards* and railings, including structural baluster panels and nonstructural in-fill panels, regardless of area or height above a walking surface.
9. Glazing in walls and fences enclosing indoor and outdoor swimming pools, hot tubs and spas where all of the following conditions are present:
 - 9.1. The bottom edge of the glazing on the pool or spa side is less than 60 inches (1524 mm) above a walking surface on the pool or spa side of the glazing; and
 - 9.2. The glazing is within 60 inches (1524 mm) horizontally of the water's edge of a swimming pool or spa.
10. Glazing adjacent to *stairways*, landings and ramps within 36 inches (914 mm) horizontally of a walking surface; when the exposed surface of the glass is less than 60 inches (1524 mm) above the plane of the adjacent walking surface.
11. Glazing adjacent to *stairways* within 60 inches (1524 mm) horizontally of the bottom tread of a *stairway* in any direction when the exposed surface of the glass is less than 60 inches (1524 mm) above the nose of the tread.

Exception: Safety glazing for Item 10 or 11 is not required for the following installations where:

1. The side of a *stairway*, landing or ramp which has a *guard* or handrail, including balusters or in-fill panels, complying with the provisions of Sections 1013 and 1607.7; and
2. The plane of the glass is greater than 18 inches (457 mm) from the railing.

2406.4.1 Exceptions. The following products, materials and uses shall not be considered specific hazardous locations:

1. Openings in doors through which a 3-inch (76 mm) sphere is unable to pass.
2. Decorative glass in Section 2406.4, Item 1, 6 or 7.
3. Glazing materials used as curved glazed panels in revolving doors.
4. Commercial refrigerated cabinet glazed doors.
5. Glass-block panels complying with Section 2101.2.5.
6. Louvered windows and jalousies complying with the requirements of Section 2403.5.

7. Mirrors and other glass panels mounted or hung on a surface that provides a continuous backing support.

2406.5 Fire department access panels. Fire department glass access panels shall be of tempered glass. For insulating glass units, all panes shall be tempered glass.

SECTION 2407 GLASS IN HANDRAILS AND GUARDS

2407.1 Materials. Glass used as a handrail assembly or a *guard* section shall be constructed of either single fully tempered glass, laminated fully tempered glass or laminated heat-strengthened glass. Glazing in railing in-fill panels shall be of an *approved* safety glazing material that conforms to the provisions of Section 2406.1.1. For all glazing types, the minimum nominal thickness shall be $\frac{1}{4}$ inch (6.4 mm). Fully tempered glass and laminated glass shall comply with Category II of CPSC 16 CFR 1201 or Class A of ANSI Z97.1, listed in Chapter 35.

2407.1.1 Loads. The panels and their support system shall be designed to withstand the loads specified in Section 1607.7. A safety factor of four shall be used.

2407.1.2 Support. Each handrail or *guard* section shall be supported by a minimum of three glass balusters or shall be otherwise supported to remain in place should one baluster panel fail. Glass balusters shall not be installed without an attached handrail or *guard*.

Exception: A top rail shall not be required where the glass balusters are laminated glass with two or more glass plies of equal thickness and the same glass type when *approved* by the *building official*. The panels shall be designed to withstand the loads specified in Section 1607.7.

2407.1.3 Parking garages. Glazing materials shall not be installed in handrails or *guards* in parking garages except for pedestrian areas not exposed to impact from vehicles.

2407.1.4 Glazing in wind-borne debris regions. Glazing installed in in-fill panels or balusters in *wind-borne debris regions* shall comply with the following:

2407.1.4.1 Ballusters and in-fill panels. Glass installed in exterior railing in-fill panels or balusters shall be laminated glass complying with Category II of CPSC 16 CFR 1201 or Class A of ANSI Z97.1.

2407.1.4.2 Glass supporting top rail. When the top rail is supported by glass, the assembly shall be tested according to the impact requirements of Section 1609.1.2. The top rail shall remain in place after impact.

SECTION 2408 GLAZING IN ATHLETIC FACILITIES

2408.1 General. Glazing in athletic facilities and similar uses subject to impact loads, which forms whole or partial wall sections or which is used as a door or part of a door, shall comply with this section.

2408.2 Racquetball and squash courts.

2408.2.1 Testing. Test methods and loads for individual glazed areas in racquetball and squash courts subject to impact loads shall conform to those of CPSC 16 CFR 1201 or ANSI Z97.1, listed in Chapter 35, with impacts being applied at a height of 59 inches (1499 mm) above the playing surface to an actual or simulated glass wall installation with fixtures, fittings and methods of assembly identical to those used in practice.

Glass walls shall comply with the following conditions:

1. A glass wall in a racquetball or squash court, or similar use subject to impact loads, shall remain intact following a test impact.
2. The deflection of such walls shall not be greater than 1½ inches (38 mm) at the point of impact for a drop height of 48 inches (1219 mm).

Glass doors shall comply with the following conditions:

1. Glass doors shall remain intact following a test impact at the prescribed height in the center of the door.
2. The relative deflection between the edge of a glass door and the adjacent wall shall not exceed the thickness of the wall plus ½ inch (12.7 mm) for a drop height of 48 inches (1219 mm).

2408.3 Gymnasiums and basketball courts. Glazing in multipurpose gymnasiums, basketball courts and similar athletic facilities subject to human impact loads shall comply with Category II of CPSC 16 CFR 1201 or Class A of ANSI Z97.1, listed in Chapter 35.

SECTION 2409 GLASS IN ELEVATOR HOISTWAYS AND ELEVATOR CARS

2409.1 Glass in elevator hoistway enclosures. Glass in elevator hoistway enclosures and hoistway doors shall be laminated glass conforming to ANSI Z97.1 or CPSC 16 CFR.

2409.1.1 Fire-resistance-rated hoistways. Glass installed in hoistways and hoistway doors where the hoistway is required to have a fire-resistance rating shall also comply with Section 715.

2409.1.2 Glass hoistway doors. The glass in glass hoistway doors shall be not less than 60 percent of the total visible door panel surface area as seen from the landing side.

2409.2 Glass vision panels. Glass in vision panels in elevator hoistway doors shall be permitted to be any transparent glazing material not less than ¼ inches (6.4 mm) in thickness conforming to Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR. The area of any single vision panel shall not be less than 24 square inches (15 484 mm²) and the total area of one or more vision panels in any hoistway door shall be not more than 85 square inches (54 839 mm²).

2409.3 Glass in elevator cars.

2409.3.1 Glass types. Glass in elevator car enclosures, glass elevator car doors and glass used for lining walls and ceilings of elevator cars shall be laminated glass conforming

to Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR.

Exception: Tempered glass shall be permitted to be used for lining walls and ceilings of elevator cars provided:

1. The glass is bonded to a nonpolymeric coating, sheeting or film backing having a physical integrity to hold the fragments when the glass breaks.
2. The glass is not subjected to further treatment such as sandblasting; etching; heat treatment or painting that could alter the original properties of the glass.
3. The glass is tested to the acceptance criteria for laminated glass as specified for Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR.

2409.3.2 Surface area. The glass in glass elevator car doors shall be not less than 60 percent of the total visible door panel surface area as seen from the car side of the doors.

SECTION 2410 HIGH-VELOCITY HURRICANE ZONES— GENERAL

2410.1 Exterior wall cladding, surfacing and glazing, where provided, shall be as set forth in Sections 2410 through 2415.

2410.2 Exterior wall cladding, surfacing and glazing shall be designed and constructed to sufficiently resist the full pressurization from the wind loads prescribed in Chapter 16 (High-Velocity Hurricane Zones) and the concentrated loads that result from hurricane-generated wind-borne debris.

1. Exterior wall cladding, surfacing and glazing, within the lowest 30 feet (9.1 m) of the exterior building walls shall be of sufficient strength to resist large missile impacts as outlined in Chapter 16 (High-Velocity Hurricane Zones).
2. Exterior wall cladding, surfacing and glazing located above the lowest 30 feet (9.1 mm) of the exterior building walls shall be of sufficient strength to resist small missile impacts as outlined in Chapter 16 (High-Velocity Hurricane Zones).

Exception: Exterior wall cladding, surfacing and glazing when protected by fixed, operable or portable shutters or screens which have product approval to resist full pressurization from wind loads as well as large and small missile impacts as outlined in the high-velocity hurricane provisions of Chapter 16, without deforming to the point where the substrate being protected is compromised.

2410.3 Workmanship. Cladding and glazing shall be in conformance with the tolerances, quality and methods of construction as set forth in the standard referenced in Chapter 35.

2410.4 All exterior wall cladding, surfacing, garage doors, skylights, operative and inoperative windows shall have Product Approval.

**SECTION 2411
HIGH-VELOCITY HURRICANE ZONES—
WINDOWS, DOORS, GLASS AND GLAZING**

2411.1 General.

2411.1.1 Windows, doors, glass and glazing shall be as set forth in this section.

2411.1.2 Glass shall comply with ASTM C 1036 requirements for flat glass Type I and II and GSA DD-G-451c *Standard for Glass, Flat and Corrugated, for Glazing Mirrors and Other Uses*.

2411.1.3 Tempered glass shall comply with 16 CFR 1201.

2411.1.4 Transparent and obscure safety glazing shall conform to the *Performance Specifications and Methods of Test for Transparent Safety Glazing Materials Used in Buildings*, ANSI Z 97.1.

2411.1.5 Heat-strengthened and ceramic-coated spandrel glass shall comply with ASTM C 1048.

2411.1.6 Wired glass shall comply with ANSI Z 97.1 and shall only be used in fire doors and in glazed panels where safety glazing is not required.

2411.1.7 Installed glass shall not be less than Single-Strength B quality unless otherwise approved by the building official, and where edges are exposed they shall be seamed or ground.

2411.1.8 Where a lite of glass is of such height above grade that the top 50 percent or more is in a zone of greater wind load, the area of the entire lite shall be limited as for the greater height above grade.

2411.1.9 Replacement of any glazing or part thereof shall be designed and constructed in accordance with Chapter 34, Existing Buildings Provisions for High-Velocity Hurricane Zones.

2411.1.10 Fixed glazing used as an exterior component shall require product approval. Comparative analysis in compliance with Section 2411.3.2.6 by a Florida-registered engineer or architect may be accepted when the actual pressure and geometry conditions differ from the conditions shown in the approval.

2411.1.11 Exterior lite of glass in an insulated glass unit shall be safety glazed.

Exceptions:

1. Large missile impact-resistant glazed assemblies.
2. Nonmissile impact units protected with shutters.

2411.2 Fixed glass in exterior walls.

2411.2.1 Limits of size of glass.

2411.2.1.1 The minimum thickness of annealed float glazing materials used in exterior walls shall be determined and shall not be less than as set forth in ASTM E 1300.

2411.2.1.2 For glazing materials other than annealed float use the glazing material resistance factors used in ASTM E 1300.

2411.2.1.3 Corrugated glass and other special glass shall be limited to spans determined by analysis and test to resist the loads set forth in Chapter 16 (High Wind Zones) based on fiber stresses not exceeding 4000 psi (27.58 MPa).

2411.2.1.4 Glass block shall have product approval.

2411.3 Doors and operative windows in exterior walls.**2411.3.1 Design and approval.**

2411.3.1.1 The design and approval of sliding doors, swinging doors and operative windows in exterior walls, including the supporting members shall be based on the proposed use-height above grade in accordance with Chapter 16 (High-Velocity Hurricane Zones).

2411.3.1.2 Maximum glass sizes shall comply with ASTM E 1300.

2411.3.1.3 Glazing in sliding and in swinging doors shall be safety-glazing complying with 16 CFR 1201, *Safety Standard for Architectural Glazing Materials, Consumer Product Safety Commission*, and as described in Sections 2411.3.1.3.1 through 2411.3.1.3.5.

2411.3.1.3.1 Doors containing glazing material not greater than 9 square feet (0.84 m²) in surface area shall be classified as Category I glazing products.

2411.3.1.3.2 Doors, bath and shower enclosures, and sliding glass doors containing glazing material greater than 9 square feet (0.84 m²) in surface area shall be classified as Category II glazing products.

2411.3.1.3.3 Category I glazing products shall be capable of withstanding a 150 foot-pound (102 N-m) impact test.

2411.3.1.3.4 Category II glazing products shall be capable of withstanding a 400 foot-pound (542 N-m) impact test.

2411.3.1.3.5 Doors shall be designed to be readily operative without contact with the glass.

2411.3.1.4 The architect or professional engineer of record shall be required to specify the design wind pressure, determined in accordance with Chapter 16 (High-Velocity Hurricane Zones), for all garage doors, skylights operative windows and fixed glazing. The design wind pressure for each component of the exterior building surface shall be incorporated into the building design drawing so as to allow the respective manufacturer to size the prefabricated assembly for the proper wind pressures.

2411.3.1.5 Exterior garage doors shall be designed and constructed to actively or passively lock in the closed position when subjected to a uniform lateral pressure in excess of 50 percent of the design wind pressure as prescribed in Chapter 16 (High-Velocity Hurricane Zones).

2411.3.1.6 The architect or professional engineer of record shall be required to detail on the drawings submitted for permit, rough opening dimensions, supporting framework, method of attachment and waterproofing

procedures for all garage doors, passage doors, skylights, operative and inoperative windows in exterior walls. Said framework and method of attachment shall be designed and constructed so as to sufficiently resist the design wind pressures as outlined in Chapter 16 (High-Velocity Hurricane Zones).

Exception: When detailed engineered shop drawings along with the notices of product approval, produced by the manufacturer's specialty engineer and approved by the architect or professional engineer of record, are admitted at the time of permit application, which completely identifies rough openings, supporting framework, method of attachment and waterproofing procedures are prepared and bear the signature and seal of a professional engineer.

2411.3.2 Tests.

2411.3.2.1 Operative window and door assemblies shall be tested in accordance with the requirements of this section, TAS 202 and provisions from ANSI/AAMA/MWWDA 101/IS 2, and the forced entry prevention requirements of the American Architectural Manufacturers Association (AAMA) Sections 1302.5 and 1303.5.

Exceptions:

1. Door assemblies installed in nonhabitable areas where the door assembly and area are designed to accept water infiltration need not be tested for water infiltration.
2. Door assemblies installed where the overhang (OH) ratio is equal to or more than 1 need not be tested for water infiltration. The overhang ratio shall be calculated by the following equation:

$$\text{OH ratio} = \text{OH Length} / \text{OH Height}$$

where:

OH length = The horizontal measure of how far an overhang over a door projects out from the door's surface.

OH height = The vertical measure of the distance from the door's sill to the bottom of the overhang over a door.

3. Pass-through windows for serving from a single-family kitchen, where protected by a roof overhang of 5 feet (1.5 m) or more shall be exempted from the requirements of the water infiltration test.

2411.3.2.1.1 Glazed curtain wall, window wall and storefront systems shall be tested in accordance with the requirements of this section and the laboratory test requirements of the American Architectural Manufacturers Association (AAMA) Standard 501, following test load sequence and test load duration in TAS 202.

2411.3.2.2 Such assemblies with permanent muntin bars shall be tested with muntin bars in place.

2411.3.2.3 Such assemblies shall be installed in accordance with the conditions of test and approval.

2411.3.2.4 Test loads for inward and outward pressures shall be equal to the velocity pressures for the appropriate height in accordance with Chapter 16 (High-Velocity Hurricane Zones) as further modified by a factor of 1.5.

2411.3.2.5 Comparative analysis of operative windows and glazed doors may be made provided the proposed unit complies with the following:

1. Shall always be compared with a tested and currently approved unit.
2. Varies only in width, height and/or load requirements.
3. Shall not exceed 100 percent of the proportional deflection for fiber stress of the intermediate members of the approved unit.
4. Shall conform as to extruded members, reinforcement and in all other ways with the tested approved unit.
5. Shall not exceed 100 percent of the concentrated load at the juncture of the intermediate members and the frame of the approved unit.
6. Shall not permit more air and water infiltration than the approved unit based on the height above grade.
7. Compared unit shall not exceed the maximum cyclic pressure when tested per TAS 203.

2411.3.2.6 Comparative analysis of fixed glass windows may be made provided the proposed unit complies with the following:

1. Shall always be compared with a tested and currently approved unit.
2. Varies only in width, height and/or load requirements.
3. The design is identical in all respects. e.g., extrusions, glazing system, joinery, fasteners, etc.
4. Shall not permit more air and water infiltration than the approved unit based on height above grade.
5. The maximum uniform load distribution (ULD) of any side is equal to the uniform load carried by the side divided by the length of the side.
6. The ULD of any member must not exceed the ULD of the corresponding member of the tested window.
7. The uniform load distribution on each member shall be calculated in accordance to Section 2, Engineering Design Rules, of the AAMA 103.3 *Procedural Guide*.
8. Compared unit shall not exceed the maximum cyclic pressure when tested per TAS 203.

2411.3.3 Construction details. Construction details for fixed glass shall comply with the requirements of this para-

graph except that structural glazing as defined in Section 202 need not comply with this section, but shall comply with Section 2415.

2411.3.3.1 Each lite of fixed glass more than 3 feet (914 mm) in width shall have two approved setting blocks or approved suspension clamps. Setting blocks shall be Neoprene 70-90 Shore A durometer hardness or approved equal.

2411.3.3.2 Fixed glass lites shall be set in corrosion-resistant metal frames and shall comply with applicable requirements of Chapter 16 (High-Velocity Hurricane Zones) for wind loads, allowable stresses and load tests. Fixed glass lights may be set in wood, metal or concrete frames as permitted for the types of construction by Chapter 3 through Chapter 6.

2411.3.3.3 Wood shall have been preservative treated or shall be of a durable species as defined in Section 2326.2.

2411.3.3.4 Attachment shall be as set forth in Chapter 16 (High-Velocity Hurricane Zones) and shall be corrosion-resistant.

2411.3.3.5 Glass in fixed lights shall be securely and continuously supported at the perimeter of each sheet unless the design is based on one or more unsupported edges. Supporting members such as division bars and mullions shall be designed by rational analysis to support the wind pressures set forth in Chapter 16 (High-Velocity Hurricane Zones). Supporting bars shall be attached at the ends to resist the loads set forth in Chapter 16 (High-Velocity Hurricane Zones).

2411.3.3.6 The depth of the glazing rabbet and depth of engagement in the rabbet for fixed glass shall be based on consideration of the dimensional reduction from deflection and the dimensional changes caused by temperature.

2411.3.3.7 Exterior lite of glass in an insulated glass unit shall be safety glazed.

Exceptions:

1. Large missile impact-resistant glazed assemblies.
2. Nonmissile impact units protected with shutters.

2411.3.4 Gaskets used in glazing systems shall comply with the following standards as applicable:

1. ASTM C 864, Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
2. ASTM C 509, Elastomeric Cellular Preformed Gaskets and Sealing Material.
3. ASTM C 1115, Dense Elastomeric Silicone Rubber Gaskets and Accessories.
4. ASTM E 2203, Dense Thermoplastic Elastomers Used for Compression Seals, Gaskets, Setting Blocks, Spacers and Accessories.

2411.4 Glazed panel safeguards. Glazed panels shall be protected in accordance with this section.

2411.4.1 Where there is a drop of 4 feet (1219 mm) or more on the far side of a fixed glazed panel 24 inches (610 mm) or more in width, the bottom of which is less than 36 inches (914 mm) above the near side walking surface, safeguards as set forth in Section 1618.4 shall be provided.

2411.4.2 Where there is a drop of less than 4 feet (1219 mm) on opposite sides of an operable or nonoperable glazed panel 24 inches (610 mm) or more in width and 9 square feet (0.84 m²) or more in area, one of the following safeguards shall be provided where persons might walk into or through such glazing:

1. Safety glazing conforming to federal standard 16 CFR 1201.
2. An opaque bulkhead not less than 18 inches (457 mm) higher than the upper level.
3. A single horizontal bar of handrail strength requirements not less than 1½ inches (38 mm) in width measured parallel to the plane of the glazing and located between 24 inches and 36 inches (610 and 914 mm) above the upper level.
4. A planter with plantings not less than 18 inches (457 mm) higher than the upper level.

2411.4.3 Glazed panels located adjacent to, or in doors, shall be of safety glazing, in accordance with the following:

1. All glazed panels through which a 3-inch-diameter (76 mm) sphere is able to pass.
2. In all occupancies, any glazing material adjacent to a door within 48 inches (1219 mm) of the door in the closed position and below the top of the door.

Exceptions:

1. Wired glass in fire doors.
2. Leaded glass of 30 square inches (.02 m²) or less.
3. Curved glass in revolving doors.
4. Commercial refrigerated cabinet doors.
5. A solar screen may serve as a safeguard where such screen complies with strength requirements of railings.

2411.5 Operable window safeguards. Operable windows shall be protected in accordance with this section.

2411.5.1 Where there is a drop of more than 4 feet (1219 mm) on the far side of such windows and the sill is less than 36 inches (914 mm) above the near side walking surface, safeguards shall be provided to prevent the fall of persons when such windows are open as set forth in Section 1618.4.

Exceptions:

1. Where the vent openings are 12 inches (305 mm) or less in least dimension and are restricted in operation to reject objects as required for safeguard in Section 1618.4.
2. Slats or grillwork constructed to comply with Standard OSHA-1910, set forth in Section 1618.4 or other construction approved by the building

official, may be provided in lieu of other safeguards.

3. Where the near side of such windows is less than 4 inches (102 mm) above the floor and falling objects could present a hazard, toeboards shall be provided as required by 29 CFR 1910.
4. Alternate approved designs.

2411.5.2 Where the drop from such windows is less than 4 feet (1219 mm) or where such windows are adjacent to a door, the glazing shall comply with Sections 2411.4.2 and 2411.4.3.

2411.6 Interior locations.

2411.6.1 Swinging or sliding doors of glass without a continuous frame shall be of only fully tempered glass not less than $\frac{3}{8}$ -inch (9.5 mm) in thickness.

2411.6.2 Safeguards. The glazing in sliding and swinging doors and in shower to tub enclosures, including any glazing within 60 inches (1.5 m) of the finished floor surface in walls surrounding any tub or shower enclosure, shall be safety glazing as set forth in Section 2411.3.1.3 for Category II glazing products.

2411.6.3 Glass or mirrors immediately surrounding a bathtub or shower enclosure shall be safety glazing where the glass or mirrors are less than 60 inches (1.5 m) above the floor of the tub or the shower.

2411.6.4 The glazing in fixed panels adjacent to paths of egress shall comply with Section 2411.4.3.

2411.6.5 Glass shall not be solid painted or otherwise concealed where such painted glass may be mistaken for other construction materials.

2411.6.6 Glass mirrors of more than 9 square feet (0.84 m²) in area that are used as surface finish material on walls in public spaces shall be directly secured to supports and shall not be hung.

2411.7 Safety glazing.

2411.7.1 Safety glazing, where required, shall be as set forth in this section.

2411.7.2 Safety glazing shall comply with the standard set forth in Section 2411.1.4 for transparent and obscure safety-glazing materials, and plastic glazing shall in addition comply with the specifications of Section 2411.7.3.

2411.7.3 Plastics, with or without reinforcing or acrylic modifiers shall comply with Section 2612, and consideration of dimension reduction caused by deflection and/or dimensional instability of the materials shall be given in the determination of the depth of the glazing rabbet and engagement of the plastic in the rabbet. Plastics shall be limited to spans determined by analysis and test to resist the loads set forth in Chapter 16 (High-Velocity Hurricane Zones).

2411.7.4 Glass louvered doors need not be safety glazed.

2411.8 Sloped glazing.

2411.8.1 Sloped glazing includes any installation of glass or other transparent, translucent or opaque glazing material installed at a slope of 15 degrees (0.26 rad) or more from the

vertical plane. Glazing materials in skylights, roofs and sloped walls are included with this definition.

2411.8.2 Allowable glazing materials. Sloped glazing shall be any of the following materials subject to the limitations specified in Section 2411.8.3.

2411.8.2.1 For monolithic glazing systems, the glazing material of the single light or layer shall be laminated with a minimum 30 mil polyvinyl butyryl (or equivalent) interlayer, wire glass, approved plastic material meeting the requirements of this chapter, heat strengthened glass or fully tempered glass.

2411.8.2.2 For multiple glazing systems, each light or layer shall consist of any glazing materials specified in Section 2411.8.2.1.

2411.8.2.3 See Section 2612 for additional requirements for plastic skylights.

2411.8.3 Limitations. Heat strengthened and fully tempered glass when used in monolithic glazing systems shall have screens installed below the glazing material to protect building occupants from falling glass should breakage occur. The screens shall be capable of supporting the weight of the glass and shall be substantially supported below and installed within 4 inches (102 mm) of the glass. They shall be constructed of a noncombustible material not thinner than 0.0808 inch (2 mm) (12 B and S gauge) diameter with a mesh not larger than 1 inch by 1 inch (25 mm by 25 mm). In a corrosive atmosphere structurally equivalent corrosion-resistant screening materials shall be used. Heat-strengthened glass, fully tempered glass and wire glass, when used in multiple glazing systems as the bottom layer over the walking surface, shall be equipped with screening meeting the requirements for monolithic glazing systems.

Exceptions:

1. In monolithic and multiple-layer sloped glazing systems, any glazing material, including annealed glass, may be installed without required screens if the walking surface below the glazing material is permanently protected from the risk of falling glass or if the area below the glazing material is not a walking surface.
2. In monolithic and multiple layer sloped glazing systems, any glazing material, including annealed glass, may be installed in the sloped glazing systems of greenhouses (structures used primarily for growing plants) without screens provided the height of the penthouse at the ridge does not exceed 20 feet (6.1 m) above grade. Frames may be of wood construction in greenhouses located outside the fire district if the height of the sloped glazing does not exceed 20 feet (6.1 m) above grade. In other cases, noncombustible frames shall be used.

2411.8.4 Sloped glazed framing. In other than Types IV II-B and III-B construction, all sloped glazing skylight frames shall be constructed of noncombustible materials. In foundries or buildings where acid fumes deleterious to metal are incidental to the use of the building, approved

pressure treated woods or other approved noncombustible material shall be permitted for sash and frames. All sloped glazing and skylights shall be designed for the roof and wind loads in Chapter 16 (High-Velocity Hurricane Zones). All skylights set at an angle of less than 45 degrees (0.79 rad) from the horizontal shall be mounted at least 4 inches (102 mm) above the planer of the roof on a curb construction as required for the frame. Sloped glazing may be installed in the plane of the roof where the roof pitch is greater than 45 degrees (0.79 rad) from the horizontal.

SECTION 2412 HIGH-VELOCITY HURRICANE ZONES— GLASS VENEER

2412.1 Glass veneer shall be as set forth in this section.

2412.2 Dimension. Glass veneer units shall be not less than $1\frac{1}{32}$ inch (8.7 mm) in thickness. No unit shall be larger in area than 10 square feet (0.93 m²) where 15 feet (4.6 m) or less above the grade directly below, nor larger than 6 square feet (0.56 m²) where more than 15 feet (4.6 m) above the grade directly below.

2412.3 Attachment. Every glass veneer unit shall be attached to the backing with approved mastic cement and corrosion-resistant ties and shall be supported on shelf angles.

2412.3.1 Where more than 6 feet (1829 mm) above grade, veneer shall be supported by shelf angles, and ties shall be used in both horizontal and vertical joints.

2412.3.2 Below a point 6 feet (1829 mm) above grade, glass veneer shall rest on shelf angles. Veneering shall not be supported on construction which is not an integral part of the wall, and over sidewalks shall be supported on a shelf angle not less than $\frac{1}{4}$ inch (6.4 mm) above grade.

2412.3.3 All edges of glass veneer shall be ground.

2412.4 Mastic.

2412.4.1 The mastic shall cover not less than one-half of the area of the unit after the unit has been set in place and shall be neither less than $\frac{1}{4}$ inch (6.4 mm) nor more than $\frac{1}{2}$ inch (12.7 mm) in thickness.

2412.4.2 The mastic shall be insoluble in water and shall not lose its adhesive qualities when dry.

2412.4.3 Absorbent surfaces shall be sealed by a bonding coat before mastic is applied. The bonding coat shall be cohesive with the mastic.

2412.4.4 Glass veneer surfaces to which mastic is applied shall be clean and uncoated.

2412.4.5 Space between edges of glass veneer shall be filled uniformly with an approved type pointing compound.

2412.5 Shelf angles and ties.

2412.5.1 Shelf angles shall be of corrosion-resistant material capable of supporting four times the width of the supported veneer. The shelf angles shall be spaced vertically in alternate horizontal joints, but not more than 3 feet (914 mm) apart. Shelf angles shall be secured to the wall at intervals not exceeding 2 feet (610 mm) with corrosion-resistant

bolts not less than $\frac{1}{4}$ inch (6.4 mm) diameter. Bolts shall be set in masonry and secured by lead shields.

2412.5.2 Ties shall be of corrosion resistant metal as manufactured, especially for holding glass-veneer sheets to masonry surfaces. There shall be not less than one such approved tie for each 2 square feet (0.19 m²) of veneer surface.

2412.6 Backing. Exterior glass veneer shall be applied only upon masonry, concrete or stucco.

2412.7 Expansion joints. Glass veneer units shall be separated from each other and from adjoining materials by an expansion joint at least $\frac{1}{16}$ inch (1.6 mm) in thickness. There shall be at least $\frac{1}{64}$ inch (0.4 mm) clearance between bolts and the adjacent glass.

SECTION 2413 HIGH-VELOCITY HURRICANE ZONES— STORM SHUTTERS/EXTERNAL PROTECTIVE DEVICES

2413.1 General. Unless exterior wall components including but not limited to structural glazing, doors and windows of enclosed buildings have specific Product Approval to preserve the enclosed building envelope against impact loads as set forth in Chapter 16 (High-Velocity Hurricane Zones), all such components shall be protected by product approved storm shutters.

2413.2 The storm shutters shall be designed and constructed to insure a minimum of 1 inch (25 mm) separation at maximum deflection with components and frames of components they are to protect unless the components and frame are specifically designed to receive the load of storm shutters, and shall be designed to resist the wind pressures as set forth in Chapter 16 (High-Velocity Hurricane Zones) by methods admitting of rational analysis based on established principles of design. Storm shutter shall also be designed to comply with the impact load requirements included within Chapter 16 (High-Velocity Hurricane Zones).

2413.3 The storm shutter design calculations and detailed drawings, including attachment to the main structure, shall be prepared by and bear the seal of a qualified Florida-registered delegated engineer, or if qualified to prepare such design, by the engineer or architect of record, which architect or engineer shall be proficient in structural design. The architect or engineer of record shall, in all instances, review and approve documents prepared by the delegated engineer.

2413.4 Storm shutters shall be approved by the certification agency and shall bear the name of the company engraved in every section of the system.

2413.5 Deflection shall not exceed the limits set forth in Chapter 16 (High-Velocity Hurricane Zones).

2413.6 Unless storm shutters are permanently attached to the main structure, all such storm shutters shall, where practicable, be neatly stored at all times in a designated and accessible area within the building.

2413.6.1 Shutters used to protect openings above the first story of any building or structure must be permanently

installed and closable from the inside of the building or structure unless such openings are accessible without the use of a ladder or lift, or shutters can be installed from the interior of the building or structure.

Exception: Group R3 detached single-family residences not exceeding two stories.

2413.7 Storm shutters must completely cover an opening in all directions.

2413.7.1 On any side of an opening, the maximum side clearance between the shutter and a wall or inset surface shall be $\frac{1}{4}$ inch (6.4 mm). Any distance in excess of $\frac{1}{4}$ inch (6.4 mm) shall require end closure or shutter overlap, where applicable.

2413.7.2 Shutter overlap shall be a minimum of 1.5 times the side clearance between the shutter and wall.

2413.7.3 End closures shall be designed to resist wind loads specified in Chapter 16 (High-Velocity Hurricane Zones), based on rational analysis.

SECTION 2414 HIGH-VELOCITY HURRICANE ZONES— CURTAIN WALLS

2414.1 Scope. This section prescribes requirements for curtain walls of buildings or structures regulated by this code.

2414.2 Definition. A curtain wall is any prefabricated assembly of various components to enclose a building usually attached to and/or supported by the building frame other than a single door or window, masonry units, poured in place concrete and siding of single membrane metal, wood or plastic.

2414.3 Curtain walls, as defined in Section 2414.2, shall be designed and constructed in accordance with the requirements of this section.

2414.4 Structural glazing in curtain walls shall also comply with the requirements of Section 2415.

2414.5 General.

2414.5.1 All structural elements of curtain wall systems and their attachments (including embeddings) to the main structural frame shall be designed by and bear the seal of a qualified Florida-registered delegated engineer, or if qualified to prepare such design, by the engineer or architect of record, which architect or engineer shall be proficient in structural design. The engineer of record shall, in all instances, review and approve documents prepared by the delegated engineer.

2414.5.2 Curtain wall systems supported from more than two adjacent floors shall be designed to withstand all imposed loads without exceeding allowable stresses in the event of destruction or failure of any single span within the system. Documents for the main building permit shall include sufficient details describing the curtain wall system attachment to the main structure. This portion of the contract documents, if not prepared by the qualified engineer or architect of record, shall bear the signature and seal of the qualified Florida-registered delegated engineer charged

with the responsibility for the design of the curtain wall system.

2414.5.3 Individual mullions acting as a continuous member shall transfer loads through supports from no more than three adjacent floors.

2414.5.4 Materials. The materials used in any curtain wall shall comply with the applicable provisions of this code.

2414.6 Fire protection.

2414.6.1 Curtain wall supports, spandrel panels, anchors and the connections at the intersection of the floor and wall shall be fire protected based on building distance separation as required in this code.

2414.6.2 Irrespective of distance separation, anchors, embedded hardware, connections at the intersection of the wall and floor and other connectors used to attach the curtain wall framing system to the building frame shall be provided with fire protection from the floor below with fire-resistant materials having a fire rating equivalent to that of the floor.

2414.6.3 Reserved.

2414.6.4 Openings between curtain wall systems and fire resistive floors shall be protected against the passage of fire and smoke in accordance with Section 2414.6.2

2414.6.5 Where fire safing is used to achieve such protection, it shall be installed in such a manner that it will remain in place for at least a duration equivalent to the fire-resistive rating of the floor system,

2414.7 Inspection. Curtain wall systems and their attachments to the main structure shall be inspected by a special inspector at both the point of assembly and the point of installation.

SECTION 2415 HIGH-VELOCITY HURRICANE ZONES— STRUCTURAL GLAZING SYSTEMS

2415.1 Scope. This section prescribes requirements for structural glazing systems of buildings or structures regulated by this code.

2415.2 Application.

2415.2.1 Structural glazing, as defined in Section 2414.2, shall be designed and constructed in accordance with the requirements of this section.

2415.2.2 Structural glazing systems used in curtain walls shall also comply with the requirements of Section 2414.

2415.3 Definition. The terms used in this section shall be defined as set forth in Section 202.

2415.4 Standards. Adhesives and sealants used in structural glazing systems shall comply with following standards:

ASTM C 794, *Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants.*

ASTM C 920, *Specification for Elastomeric Joint Sealants.*

ASTM D 412, *Test Methods for Rubber Properties in Tension.*

ASTM D 624, *Test Method for Rubber Property-Tear Resistance*.

ASTM D 2240, *Test Method for Rubber Property-Durometer Hardness*.

Federal Specifications TT-S-001543A and TT-S-00230C.

ASTM E 331, *Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors*.

ASTM E 330, *Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors*.

2415.5 Design.

2415.5.1 General. Structural glazing systems shall be designed by and bear the seal of a Florida-registered professional engineer.

2415.5.2 Materials.

2415.5.2.1 Identification. All materials shall be clearly identified as to manufacturer and manufacturer's product number.

2415.5.2.2 Adhesives and sealants.

2415.5.2.2.1 Only approved silicone elastomer adhesives and sealants shall be used for fastening glass lights and other panels to curtain wall framing.

2415.5.2.2.2 Such adhesives and sealants shall be of a polymer that is 100-percent silicone.

2415.5.2.2.3 Adhesives and sealants shall have been tested in accordance with the standards set forth in Section 2415.4.

2415.5.3 Manufacturer's testing, recommendation and approval.

2415.5.3.1 Compatibility of all components and fabrication procedures of structural glazing systems shall be tested, approved and recommended in writing by the manufacturer of the adhesive; the manufacturer of the coating; whether it is anodized, baked or otherwise applied and the manufacturer of the glass panel.

2415.5.3.2 Manufacturer's testing, recommendation and approval shall address, but shall not be limited in scope by the following sections.

2415.5.3.2.1 The compatibility of the sealant with metal, glazing materials, shims, spacers, setting blocks, backer rods, gaskets and other materials.

2415.5.3.2.2 Adhesion to the designated substrates and adhesion of the substrates to the base metal.

2415.5.3.2.3 The design and structural capability of silicone joints and cross sections.

2415.5.4 Structural requirements.

2415.5.4.1 Design of structural seals.

2415.5.4.1.1 The design stress of the structural silicone shall not exceed 20 psi (138 kPa) for materials having a minimum strength of 100 psi (690 kPa) at the weakest element in the line of stress.

2415.5.4.1.2 Such design stress shall also provide for a safety factor of not less than 5.0.

2415.5.4.1.3 Safety factors greater than 5.0 shall be specified by the engineer when required or recommended by the manufacturer.

2415.5.4.1.4 The silicone structural seal shall have a maximum modulus of elasticity to allow no more than 25 percent movement of the joint width at 20 psi (138 kPa) stress.

2415.5.4.1.5 In insulating glass units, the secondary silicone seal shall be designed to withstand a minimum of one-half the design negative wind load applicable to the outboard lights.

2415.5.4.2 Bonding limits. Structural glazing shall be limited to adhesive bonding on one side or on two opposing sides of an infill glass lite or panel.

Exception: Three- or four-side bonding shall be permitted only when structural glazing units are shop fabricated and shop glazed.

2415.5.4.3 Job-site reglazing.

2415.5.4.3.1 Job-site replacement reglazing shall be permitted only when performed following a procedure approved in writing by the applicable structural silicone manufacturer.

2415.5.4.3.2 Replacement shall be performed only by individuals or firms approved or certified by the silicone manufacturer.

2415.6 Fire protection. Structural glazing in curtain walls shall be fire protected as required by Section 2414.6.

2415.7 Inspections, testing and recertification.

2415.7.1 A minimum of 1 percent of the structurally glazed panels shall be tested for load carrying capacity and sealant adhesion in accordance with Chapter 16 (High-Velocity Hurricane Zones) and ASTM E 330.

2415.7.2 Structural glazed panels shall be inspected by a Florida-registered architect or professional engineer for conformance with the approved design and installation procedures determined by the authority having jurisdiction prior to the erection of such panels and after the seal curing period established by the silicone manufacturer.

2415.7.3 It shall be the responsibility of the contractor to verify the adhesion of the cured sealant periodically throughout the application to assure compliance with the manufacturer's specifications and quality of application.

2415.7.4 Structural glazing systems on threshold buildings shall be recertified by the owner as specified by the authority having jurisdiction at six month intervals for the first year after installation. Subsequently, such systems shall be recertified every five years at regular intervals.

2415.7.5 Such recertifications shall determine the structural condition and adhesion capacity of the silicone sealant.