

CHAPTER 24

GLASS AND GLAZING

780 CMR 2401.0 GENERAL

2401.1 Scope: The provisions of 780 CMR 24 shall govern the materials, design, construction and quality of glass and glazing in vertical and sloped applications. For the definition of approved light-transmitting plastic, see 780 CMR 2604.1. *Safety glazing materials shall conform to the requirements of M.G.L. c. 143, §§ 3T, 3U, and 3V, as amended and CPSC 16 CFR; 1201, as applicable.*

780 CMR 2402.0 GENERAL REQUIREMENTS FOR GLASS

2402.1 Marking: Each *lite* shall bear the manufacturer's mark designating the type and thickness of glass. The mark shall not be omitted unless approved and an affidavit is furnished by the glazing contractor certifying that each *lite* is glazed in accordance with approved plans and specifications in accordance with the provisions of 780 CMR 24. Safety glazing shall be marked in accordance with 780 CMR 2405.1.1 *and shall conform to the requirements of M.G.L. c. 143, §§ 3T, 3U, and 3V, as amended.* The mark shall not be omitted from tempered glass. Each unit of tempered glass shall be permanently identified by the manufacturer's mark. The identifying mark shall be etched or ceramic fired on the glass and shall be visible when the unit is glazed. Tempered spandrel glass is exempted from permanent marking, but shall be provided with a removable paper marking by the manufacturer.

2402.2 Glass supports: Where one or more sides of any *lite* of glass is not firmly supported, or is 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* and approved. Analysis shall be based on the *wind loads* required by 780 CMR 1611.6. The elevation of the glazed openings shall be computed by adding the distances from grade to the head and sill, respectively, and dividing the sum by two.

2402.3 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 (730 N/m) is applied horizontally to one panel at any

point up to 42 inches (1067 mm) above the walking surface.

2402.4 Glass dimensional tolerance: Glass thickness tolerances shall comply with those established in Table 2402.4. Where the thickness is to be controlled, nominal values are stated subject to the tolerances shown in Table 2402.4.

**Table 2402.4
MINIMUM GLASS THICKNESS**

Nominal thickness (inches)
Single strength
Double strength
—
3/16
13/64
7/32
1/4
5/16
—
1/2
—
3/4
—
1
1 1/4

Note a. One inch = 25.4 mm.

2402.5 Louvered windows or жалousies: Regular float, wired and patterned glass in louvered windows and жалousies shall not be thinner than nominal 3/16 inch and not longer than 48 inches (1219 mm). Where other glass types are used, design shall be submitted to the code official for approval. Exposed glass edges shall be smooth. Wired glass with wire exposed on longitudinal edges shall not be used in жалousies or louvered windows.

780 CMR 2403.0 WIND, SNOW AND DEAD LOADS ON GLASS

2403.1 Vertical glass: All glass within 15 degrees (0.26 rad) of vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the *wind loads* in 780 CMR 1611.6 for components and cladding. Maximum allowable sizes shall be based on Figure 2403.1. The equivalent *load* for use in the figure shall be determined by dividing the design *wind load* by the applicable factor from Table 2403.1. Figure

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2403.1 is for rectangular glass firmly supported on all four edges.

2403.2 Sloped glass: All 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 combination of *wind loads* in 780 CMR 1611.6 for components and cladding, the *snow loads* in 780 CMR 1610.0, and the *glass dead load*. Maximum allowable sizes shall be based on Figure 2403.1. Figure 2403.1 is for rectangular glass firmly supported on all four edges.

The combined *load* shall be calculated as follows. The largest of 1, 2 or 3 shall be used:

1. Negative *wind load*; - $F \times \text{dead load}$
2. Positive *wind load*; + $F \times (\text{dead load} + \frac{1}{2} \text{wind load})$
3. $F \times (\text{snow load} + \text{dead load}) + \frac{1}{2}$ positive *wind load*

where:

- $F = 2.0$ where any pane or ply is regular glass.
- $F = 1.5$ where any pane or ply is heat-strengthened glass and the remainder are fully tempered glass.
- $F = 1.2$ where all panes and plies are fully tempered glass.

The *glass dead load* is equal to the cosine of the slope from horizontal x the total glass thickness in inches x 13.

The equivalent *load* for use in Figure 2403.1 shall be determined by dividing the combined load by the applicable factor from Table 2403.2.

Note b. For laminated glass, values are based on two panes of identical thickness and type.

Note c. For insulated glass, values are based on two panes of identical thickness and type. Utilize thickness for one pane. For example, the maximum allowable area for an insulating glass unit consisting of two plies of fully tempered 1/4-inch glass is determined using the line for 1/2-inch glass.

Note d. Values for patterned glass are based on the thinnest part of the pattern. Interpolation between lines in the figure is permitted.

Note e. Value for sandblasting glass is minimum and depends on severity and depth of sandblast.

Figure 2403.1
MAXIMUM ALLOWABLE AREA FOR VERTICAL AND SLOPED GLASS

Maximum allowable area - sq. Ft.

Table 2403.1
FACTORS FOR VERTICAL GLASS

Glass type	Factor for use with figure 2403.1
Single Glass	
Regular (annealed)	1.0
Heat strengthened	2.0
Fully tempered	4.0
Wired	0.5
Patterned ^d	1.0
Sandblasted ^e	0.5
Laminated, regular plies ^{a,b}	0.75
Laminated, heat strengthened plies ^{a,b}	1.5
Laminated, fully tempered plies ^{a,b}	3.0
Insulating Glass ^c	
Regular, (annealed)	1.8
Heat strengthened	3.6
Fully tempered	7.2
Laminated, regular plies ^{a,b}	1.4
Laminated, heat strengthened plies ^{a,b}	2.7
Laminated, fully tempered plies ^{a,b}	5.4

Note a. For laminated glass, use the line in Figure 2403.1 for total glass thickness (after adjusting wind load by the factor in Table 2403.1).

Equivalent Load Determined from 780 CMR 2403.1 and Table 2403.0 or 780 CMR 2403.2 and 2403.2 on psf

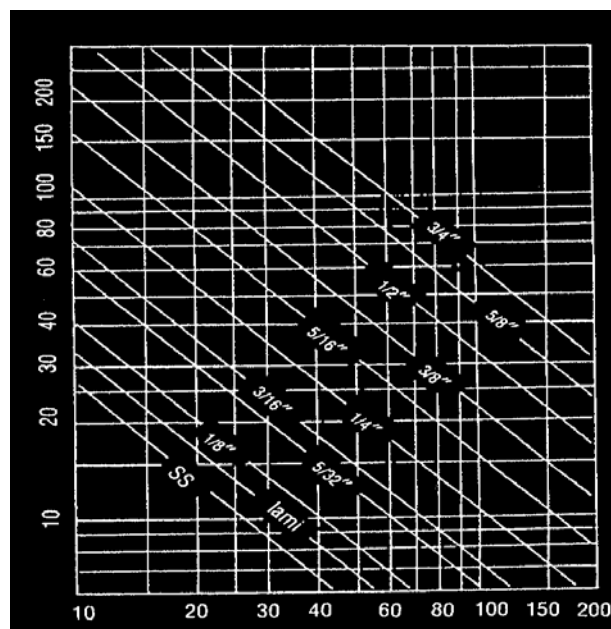


Table 2403.2
FACTORS FOR SLOPED GLASS

Glass type	Factor for use with figure 2403.1
Single Glass	
Regular (annealed)	0.72

Heat strengthened	1.7
fully tempered	3.6
Wired	0.36
Laminated, regular plies ^{a,b}	0.54
Laminated, heat strengthened plies ^{a, b}	1.3
Laminated, tempered plies ^{a,b}	2.7
Insulating Glass ^c	
Regular, (annealed)	1.3
Heat strengthened	3.1
Fully tempered	6.6
Laminated, regular plies ^{a,b}	1.0
Laminated, heat strengthened plies ^{a, b}	2.3
Laminated, fully tempered plies ^{a,b}	4.9

780 CMR 2404.0 SLOPED GLAZING AND SKYLIGHTS

2404.1 Sloped glazing: Any installation of glass or other transparent, translucent or opaque glazing material which is installed at a slope of 15 degrees (0.26 rad) or more from the vertical plane — including skylights, roofs and sloped walls—shall comply with 780 CMR2404.0.

2404.2 Allowable glazing materials: Sloped glazing shall be any of the following materials, subject to the limitations specified in 780 CMR 2404.3 and the exceptions specified in 780 CMR 2404.4:

1. For monolithic glazing systems, the glazing material of the single light or layer shall be laminated glass with a minimum 30-mil (762 µm) polyvinyl butyral interlayer, wired glass, approved *plastic* materials, 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 780 CMR 2404.2 item 1.

For additional requirements for *plastic* skylights, see 780 CMR 2608.0. Glass-block construction shall conform to the requirements of 780 CMR 2115.0.

2404.3 Limitations: Where used in monolithic glazing systems, heat-strengthened glass and fully tempered glass shall have screens installed below the glazing material, subject to the exceptions in 780 CMR 2404.4, 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 four 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 a mesh not larger than one inch by one inch (25 mm by 25 mm). In a corrosive atmosphere, structurally equivalent noncorrosive atmosphere, structurally equivalent noncorrosive screening materials shall be used. Where used in multiple-layer glazing systems as the bottom glass layer over the walking surface, heat-

Note a. For laminated glass, use the line in Figure 2403.1 for total glass thickness (after adjusting wind load by the factor in Table 2403.2).

Note b. For laminated glass, values are based on two panes of identical thickness and type.

Note c. For insulated glass, values are based on two panes of identical thickness and type. Utilize thickness for one pane. For example, the maximum allowable area for an insulating glass unit consisting of two plies of fully tempered ¼-inch glass is determined using the line for ¼-inch glass.

strengthened glass, fully tempered glass and wired glass shall be equipped with screening that conforms to the requirements specified for monolithic glazing systems.

2404.4 Exceptions: In monolithic and multiple-layer sloped glazing systems, the following exceptions apply:

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 ten 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 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 20 feet (6096 mm) above grade. Greenhouse frames shall be noncombustible if the height of the sloped glazing exceeds 20 feet (6096 mm) above grade.
4. Screens shall not be required within dwelling units of occupancies in Use Groups R-2 and R-3 where fully tempered glass **or laminated glass with a 15 mil polyvinyl butyral interlayer** is used as single glazing or as both panes in an insulating glass unit, and all of the following conditions are met:
 - 4.1. Each pane of 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 area having access thereto; and
 - 4.3. The glass thickness is 3/16 inch (5 mm) or less.

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2404.5 Framing: In Types I and 2 construction, all sloped glazing and skylight frames shall be constructed of noncombustible materials. In buildings where acid fumes deleterious to metal are incidental to the occupancy of the buildings, approved pressure-treated woods or other approved noncorrosive materials shall be permitted for sash and frames. All sloped glazing and skylights shall be designed to meet all structural requirements for roofs specified in 780 CMR 16. All skylights set at an angle of less than 45 degrees (0.79 rad) from the horizontal plane shall be mounted at least four inches (102 mm) above the plane of the roof on a

2405.1 Human impact loads: Individual glazed areas, including glass mirrors, in hazardous locations such as those indicated in 780 CMR 2405.2 shall pass the test requirements of CPSC 16 CFR; 1201 and shall conform to the requirements of *M.G.L. c. 143, §§ 3T, 3U and 3V, as applicable*, listed in *Appendix A*. The requirements of 780 CMR 2405.1 and 780 CMR 2405.2 and 2407.0 shall apply equally to replacement glass and new glass installation. Additional requirements as specified in 780 CMR 2407.2 are to be satisfied for glass used in locations where the hazard is of a continuous nature, such as glass enclosures for sporting activities as identified in 780 CMR 2407.1.

Exceptions:

1. Polished wired glass used in required fire resistance rated assemblies *or polished wire glass used in hazardous locations such as those indicated in 780 CMR 2405.2, items 6, 7, 8 and 9* shall comply with ANSI Z97.1 listed in *Appendix A*.
2. Plastic glazing shall meet the weathering requirements of ANSI Z97.1 listed in *Appendix A*.
3. Glass-block walls shall comply with 780 CMR 2115.0.

2405.1.1 Marking: Each light of safety glazing material installed in hazardous locations as defined in 780 CMR 2405.2 shall bear a permanent identifying mark issued by an *approved agency* which specifies the marking agency, whether manufacturer or installer, and the test standard.

Exceptions

1. *Polished wire glass is exempt from a permanent identifying mark provided that the distributor or the installer provides an affidavit certifying that the polished wire glass complies with ANSI Z97.1 listed in Appendix A.*
2. *Laminated glass is exempt from a permanent identifying mark provided that the distributor or installer provides an affidavit certifying that the laminated glass*

curb construction 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: Curbs for skylights are not required on roofs with a minimum slope of three units vertical in 12 units horizontal (3:12) in occupancies in Use Group R-3.

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complies with CPSC 16 CFR 1201, listed in Appendix A.

2405.2 Specific hazardous locations: The following shall be considered specific hazardous locations for the purposes of glazing:

1. Glazing in ingress and *means of egress* doors except jalousies (see 780 CMR 2402.5).
2. Glazing in fixed and sliding panels of sliding (patio) door assemblies and panels in swinging doors.
3. Glazing in storm doors.
4. Glazing in all unframed swinging doors.
5. 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 (1525 mm) above a standing surface.
6. 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 (1525 mm) above the walking surface.
7. 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:
 - 7.1. Exposed area of an individual pane greater than nine square feet (0.84 m²);
 - 7.2. Exposed bottom edge less than 18 inches (460 mm) above the floor;
 - 7.3. Exposed top edge greater than 36 inches (915 mm) above the floor; and
 - 7.4. One or more walking surface(s) within 36 inches (915 mm) horizontally of the plane of the glazing.
8. All glazing in guards and railings regardless of area or height above a walking surface. Included are structural baluster panels and nonstructural in-fill panels.
9. Glazing in walls and fences enclosing indoor and outdoor swimming pools where the bottom edge of the glazing on the pool side is less than 60 inches (1525 mm) above a walking surface and within 36 inches (914 mm) horizontally of a

walking surface. This shall apply to single glazing and all panes in multiple glazing.

Exception: 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. Assemblies of leaded glass or faceted glass and items of carved glass used for decorative purposes in locations described in 780 CMR 2405.2, items 1, 6 or 7.
3. Glazing materials used as curved glazed panels in revolving doors.
4. Commercial refrigerated cabinet glazed doors.
7. Outboard panes in insulating glass units and other multiple-glazed panels as described in 780 CMR 2405.2, item 7, 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 of horizontal) surface adjacent to the glass exterior.
8. Louvered windows and jalousies complying with the requirements of 780 CMR 2402.5.
9. Glazing which is mounted or hung on a surface that provides a continuous backing support.

2405.3 Glass in fire-fighter access panels: In cases where tempered glass is required in fire-fighter access panels, both panes in double glazing shall be tempered glass.

780 CMR 2406.0 GLASS IN HANDRAILS AND GUARDRAILS

2406.1 Materials: Glass used as structural balustrade panels in railings 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 conform to ANSI Z97.1 listed in *Appendix A* or shall be of an approved safety glazing material that conforms to the provisions of 780 CMR 2405.1. For all glazing types, the minimum nominal thickness shall be ¼ inch. Fully tempered glass and laminated glass shall comply with Category II of CPSC 16 CFR; 1201, listed in *Appendix A*. Wired glass shall comply with ANSI Z97.1 listed in *Appendix A*.

2406.1.1 Loads: The panels and their support system shall be designed to withstand the *loads* specified in 780 CMR 1606.4. A safety factor of 4 shall be used.

5. Glazing as described in 780 CMR 2405.2, item 6, where there is an intervening wall or some other permanent barrier that will prevent a person approaching the door from accidentally striking the glazing.

6. Glazing as described in 780 CMR 2405.2, item 7, where a protective bar is installed 34 inches to 38 inches (864 mm to 965 mm) above the floor on the side of the glazing having access thereto. The bar shall be capable of withstanding a horizontal load of 50 pounds per linear foot (730 N/m) without contacting the glass and be a minimum of 1½ inches (38 mm) in height. ***The protective bar may be an applied bar or an integral part of the glazed framing dividing an upper lite from a lower lite.***

2406.1.2 Support: Each handrail or guardrail 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 guardrail.

2406.1.3 Parking garages: Glazing materials shall not be installed in railings in parking garages except for pedestrian areas not exposed to impact from vehicles.

780 CMR 2407.0 GLAZING IN RACQUETBALL AND SQUASH COURTS

2407.1 Continuously hazardous locations: The following shall be considered continuously hazardous locations for the purposes of glazing:

1. Glazing in squash and racquetball courts which forms whole or partial wall sections.
2. Glazing in squash and racquetball courts which is used as a door or part of a door.

2407.2 Testing: Test methods and loads for individually glazed areas such as those described in 780 CMR 2407.1 shall conform to those of CPSC 16 CFR; 1201, listed in *Appendix A*, with impacts being applied at a height from ground level of 59 inches (1499 mm) to an actual or simulated glass wall installation with fixtures, fittings and methods of assembly identical to those used in practice.

In order to be deemed acceptable, the following conditions shall be achieved for glass walls:

1. Any glass wall in a squash or racquetball court 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.

In order to be deemed acceptable, the following conditions shall be achieved for glass doors:

1. Glass doors shall remain intact following a test impact at the prescribed height in the center of the door.

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2. The relative deflection between the edge of a glass door and the adjacent wall shall not exceed the following values for the impact test bag-drop heights:

2.1. The thickness of the wall plus $\frac{1}{4}$ inch (3 mm) for a drop height of 24 inches (610 mm).

2.2. The thickness of the wall plus $\frac{1}{4}$ inch (6 mm) for a drop height of 36 inches (914 mm).

2.3. The thickness of the wall plus $\frac{1}{2}$ inch (13 mm) for a drop height of 48 inches (1219 mm).

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