

780 CMR 24.00

GLASS AND GLAZING

780 CMR 2401.0 GENERAL

2401.1 Scope. The provisions of 780 CMR 24.00 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.

Note: For Fire Fighter protection, additional skylight live load requirements or barrier protection are set forth in 527 CMR.

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

780 CMR 2402.0 DEFINITIONS

2402.1 Definitions. The following words and terms shall, for the purposes of 780 CMR 24.00 and as used elsewhere in 780 CMR, have the meanings shown in 780 CMR 2402.0.

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.

780 CMR 2403.0 GENERAL REQUIREMENTS FOR GLASS

2403.1 Identification. Each pane shall bear the manufacturer's label designating the type and thickness of the glass or glazing material. 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 780 CMR 24.00. Safety glazing shall be identified in accordance with 780 CMR 2406.2.

Each pane of tempered glass, except tempered spandrel glass, shall be permanently identified by the manufacturer. The identification label shall be acid etched, sand blasted, ceramic fired, embossed or shall be of a type that once applied cannot be removed without being destroyed.

Tempered 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 $\frac{1}{175}$ of the glass edge length or $\frac{3}{4}$ 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 780 CMR 1605.0.

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 $\frac{3}{16}$ 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.

780 CMR 2404.0 WIND, SNOW, SEISMIC 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 in 780 CMR 1609.0 for components and cladding. Glass in glazed curtain walls, glazed storefronts and glazed partitions shall meet the seismic requirements of ASCE 7, Section 9.6.2.10. Glazing firmly supported on all four edges is permitted to be designed by the following provisions. Where the glass is not firmly supported on all four edges, analysis or test data ensuring safe performance for the specific installation shall be prepared by a registered design professional.

THE MASSACHUSETTS STATE BUILDING CODE

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

EQUATION 24-1

$$F_{gw} - F_{ga}$$

where:

F_{gw} is the wind load on the glass computed in accordance with 780 CMR 1609 and F_{ga} is the maximum allowable load on the glass computed by the following Equation:

EQUATION 24-2

$$F_{ga} = c_1 F_{ge}$$

where:

F_{ge} = Maximum allowable equivalent load, pounds per square foot (psf) (kN/m²) determined from Figures 2404(1) through 2404(12) for the applicable glass dimensions and thickness.
 c_1 = Factor determined from Table 2404.1 based on glass type.

TABLE 2404.1 c_1 FACTORS FOR VERTICAL AND SLOPED GLASS

GLASS TYPE	FACTOR
Single Glass	
Regular (annealed)	1
Heat strengthened	2
Fully tempered	4
Wired	0.5
Patterned ^c	1
Sandblasted ^d	0.5
Laminated—regular plies ^e	0.7/0.90 ^f
Laminated—heat-strengthened plies ^e	1.5/1 .8 ^f
Laminated—fully tempered plies ^e	3.0/3.6 ^f
Insulating Glass^b	
Regular (annealed)	1.8
Heat strengthened	3.6
Fully tempered	7.2
Laminated—regular plies ^e	1.4/1 .6 ^f
Laminated—heat-strengthened plies ^e	2.7/3.2 ^f
Laminated—fully tempered plies ^e	5.4/6.5 ^f

- a. Either Table 2404.1 or 2404.2 shall be appropriate for sloped glass depending on whether the snow or wind load is dominant (see 780 CMR 2404.2). For glass types (vertical or sloped) not included in the tables, refer to ASTM E 1300 for guidance.
- b. Values apply for insulating glass with identical panes.
- c. The value for patterned glass is based on the thinnest part of the pattern; interpolation between graphs is permitted.
- d. The value for sandblasted glass is for moderate levels of sandblasting.
- e. Values for laminated glass are based on the total thickness of the glass and apply for glass with two equal glass ply thicknesses.
- f. The lower value applies if, for any laminated glass pane, either the ratio of the long to short dimension is greater than 2.0 or the lesser dimension divided by the thickness of the pane is 150 or less; the higher value applies in all other cases.

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.

EQUATION 24-3

$$F_g = W_o - D$$

EQUATION 24-4

$$F_g = W_i + D + 0.5 S$$

EQUATION 24-5

$$F_g = 0.5 W_i + D + S$$

where:

D = Glass dead load (psf) 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,
 $D = 13 t_g \cos q$ (For SI: 0.0245 $t_g \cos q$).
 F_g = Total load, psf (kN/m²) on glass.
 S = Snow load, psf (kN/m²) as determined in 780 CMR 1608.
 t_g = Total glass thickness, inches (mm) of glass panes and plies.
 W_i = Inward wind force, psf (kN/m²) as calculated in 780 CMR 1609.
 W_o = Outward wind force, psf (kN/m²) as calculated in 780 CMR 1609.
 q = Angle of slope from horizontal.

Exception. Unit skylights shall be designed in accordance with 780 CMR 2405.5.

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

EQUATION 24-6

$$F_g - F_{ga}$$

where F_g is the maximum load on the glass determined from Equations 24-3 through 24-5, and F_{ga} is the maximum allowable load on the glass.

If Fg is determined by Equation 24-3 or 24-4 above, Fga shall be computed as for vertical glazing in 780 CMR 2404.1. If Fg is determined by Equation 24-5 above, Fga shall be computed by the following equation:

EQUATION 24-7

$$F_{ga} = c_2 F_{ge}$$

where:

F_{ge} = Maximum allowable equivalent load (psf) determined from Figures 2404(1) through 2404(12) for the applicable glass dimensions and thickness.
 c_2 = Factor determined from Table 2404.2 based on glass type.

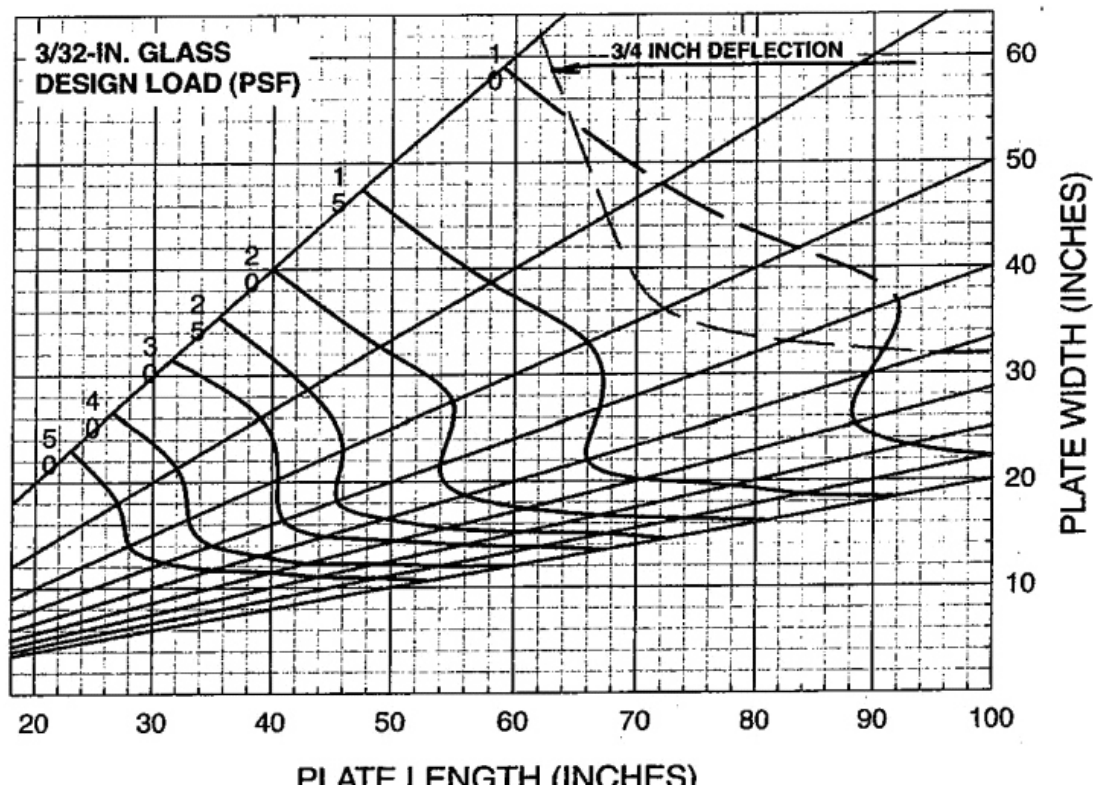
TABLE 2404.2 _{C2} FACTORS FOR SLOPED GLASS

For use with Figures 2404(1) through 2404(12)

GLASS TYPE	FACTOR
Single Glass	
Regular (annealed)	0.6
Heat strengthened	1.6
Fully tempered	3.6
Wired	0.3
Patterned ^c	0.6
Laminated — regular plies ^d	0.3/0.45 ^e
Laminated — heat-strengthened plies ^d	0.8/1.2 ^e
Laminated — fully tempered plies ^d	1.8/2.7 ^e
Insulating Glass^b	
Regular (annealed)	1.1
Heat strengthened	2.9
Fully tempered	6.5
Laminated — regular plies ^d	0.54/0.81 ^e
Laminated — heat-strengthened plies ^d	1.4/2.2 ^e
Laminated — fully tempered plies ^d	3.3/4.9 ^e

- Either Table 2404.1 or 2404.2 shall be appropriate for sloped glass depending on whether the snow or wind load is dominant (see 780 CMR 2404.2). For glass types (vertical or sloped) not included in the tables, refer to ASTM E 1300 for guidance.
- Values apply for insulating glass with identical panes.
- The value for patterned glass is based on the thinnest part of the pattern; interpolation between graphs is permitted.
- Values for laminated glass are based on the total thickness of the glass and apply for glass with two equal glass ply thicknesses.
- The lower value applies where, for any laminated glass pane, either the ratio of the long to short dimension is greater than 2.0 or the lesser dimension divided by the thickness of the pane is 150 or less. The higher value applies in all other cases.

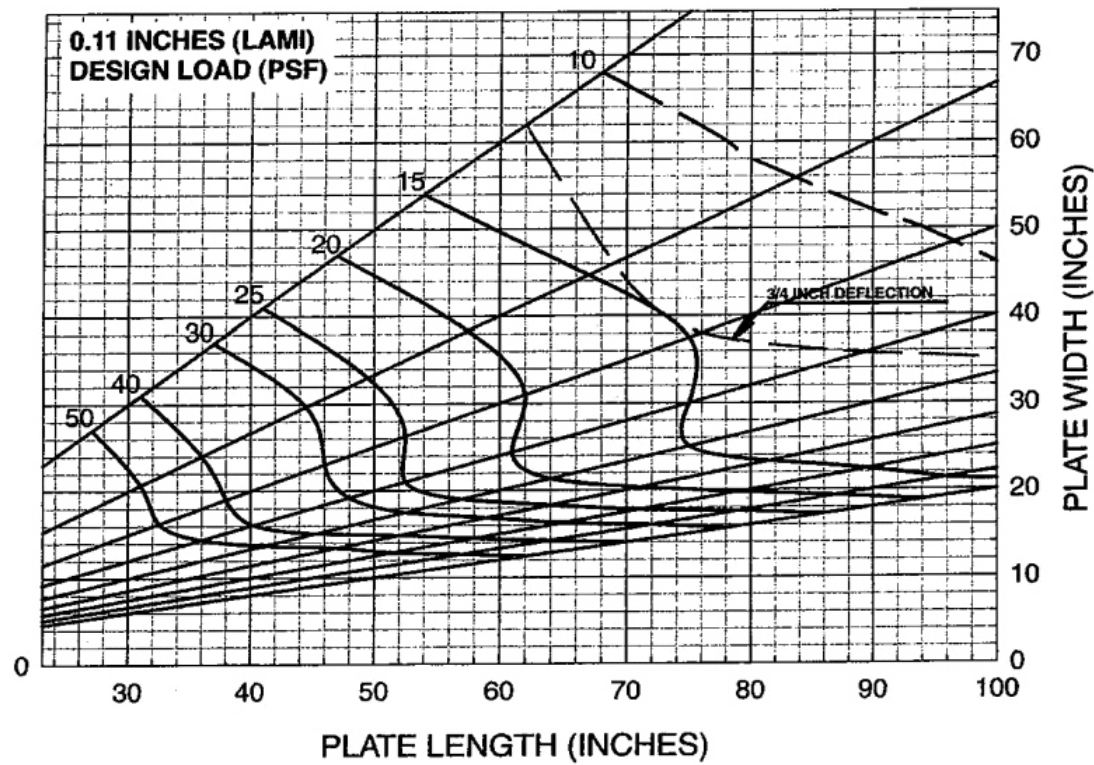
FIGURE 2404(1)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.

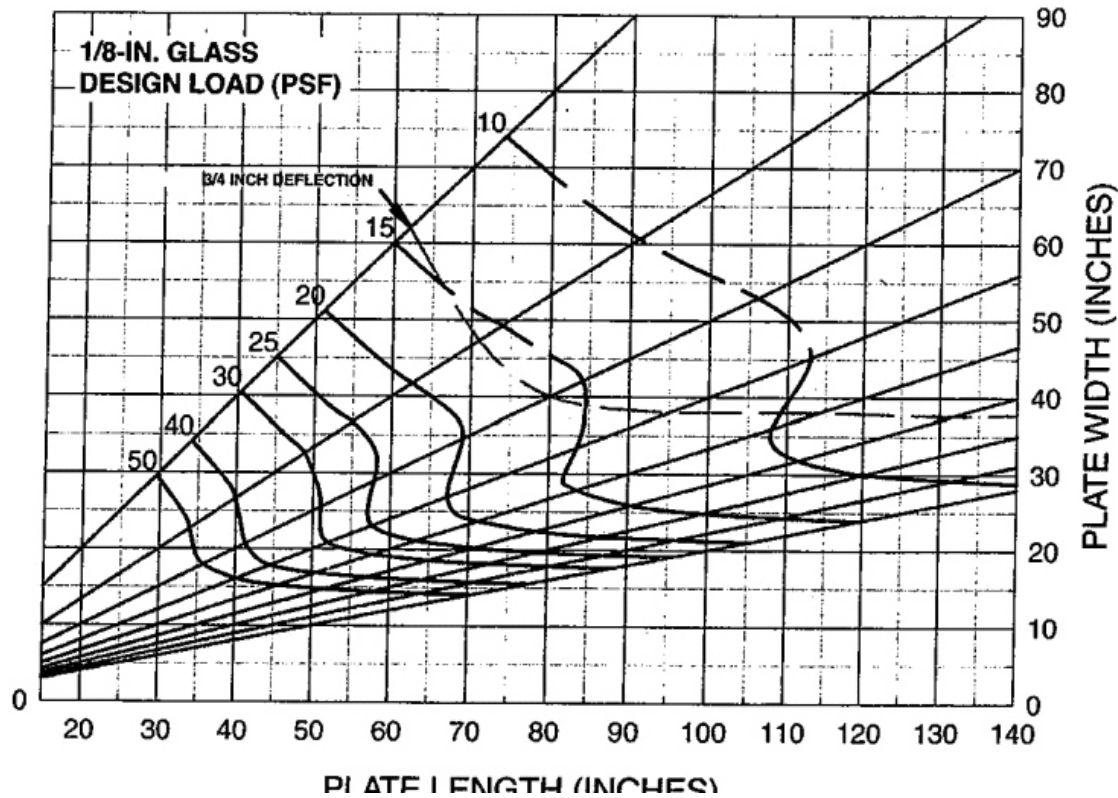
- In each graph, the vertical axis is the lesser dimension
- The diagonal number on each graph shows the equivalent design load in psf/
- The dashed lines indicate glass that has deflection in excess of ¾ inch.
- Interpolation between lines is permitted, Extrapolation Is not allowed.
- For laminated glass, the applicable glass thickness is the total glass thickness.
- For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(2)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



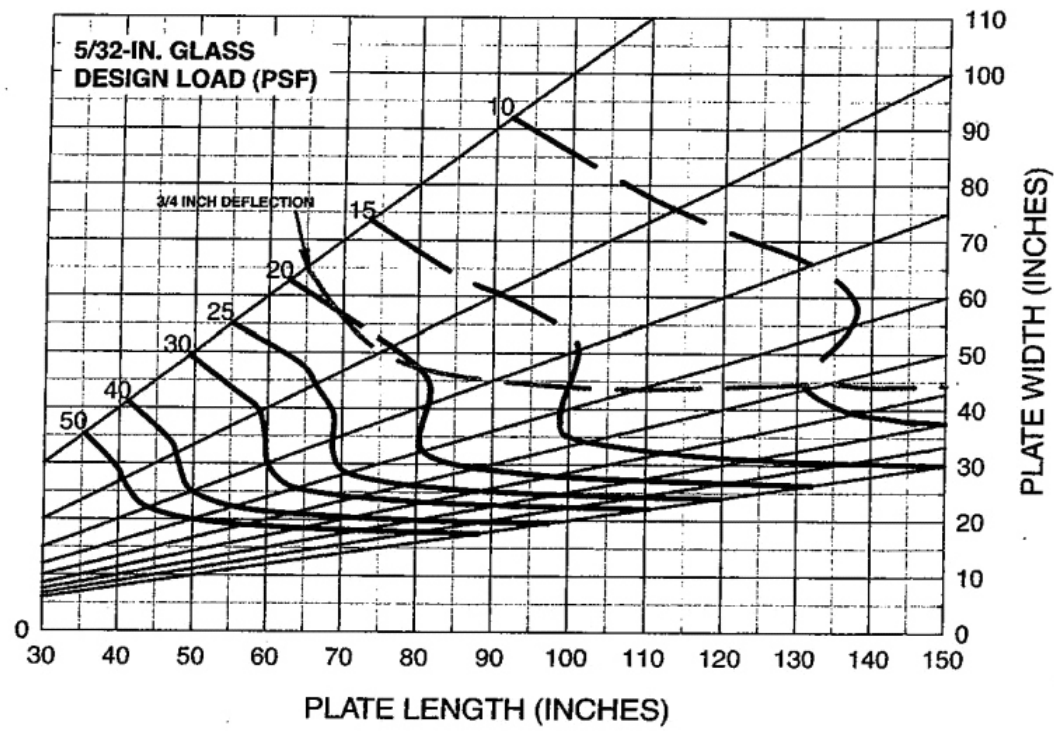
- For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.
- a. In each graph, the vertical axis is the lesser dimension
 - b. The diagonal number on each graph shows the equivalent design load in psf/
 - c. The dashed lines indicate glass that has deflection in excess of 3/4 inch.
 - d. Interpolation between lines is permitted, Extrapolation Is not allowed.
 - e. For laminated glass, the applicable glass thickness is the total glass thickness.
 - f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(3)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



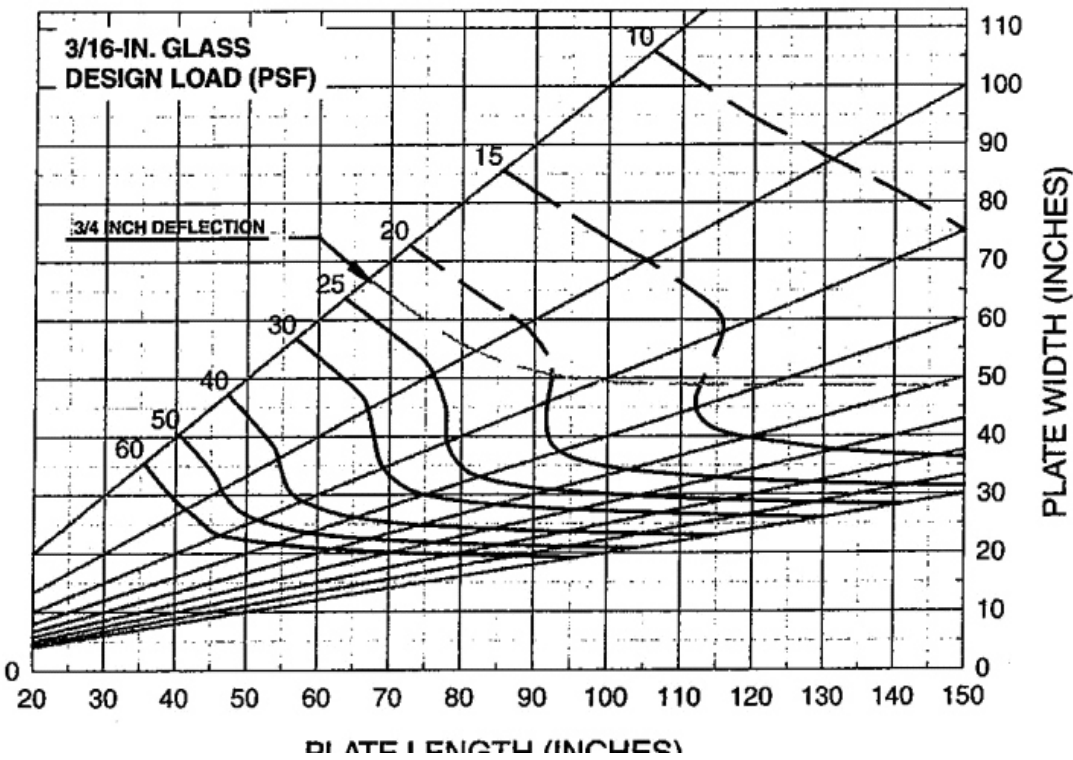
- For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.
- a. In each graph, the vertical axis is the lesser dimension
 - b. The diagonal number on each graph shows the equivalent design load in psf/
 - c. The dashed lines indicate glass that has deflection in excess of 3/4 inch.
 - d. Interpolation between lines is permitted, Extrapolation Is not allowed.
 - e. For laminated glass, the applicable glass thickness is the total glass thickness.
 - f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(4)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



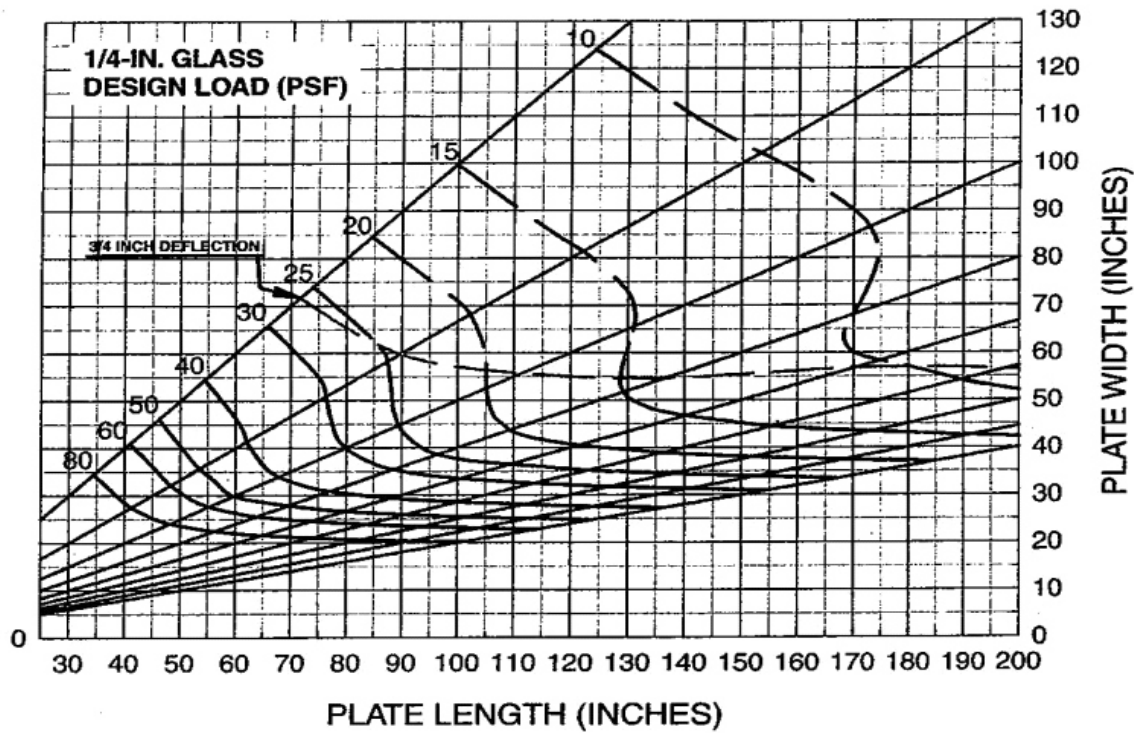
- For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.
- a. In each graph, the vertical axis is the lesser dimension
 - b. The diagonal number on each graph shows the equivalent design load in psf/
 - c. The dashed lines indicate glass that has deflection in excess of 3/4 inch.
 - d. Interpolation between lines is permitted, Extrapolation Is not allowed.
 - e. For laminated glass, the applicable glass thickness is the total glass thickness.
 - f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(5)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



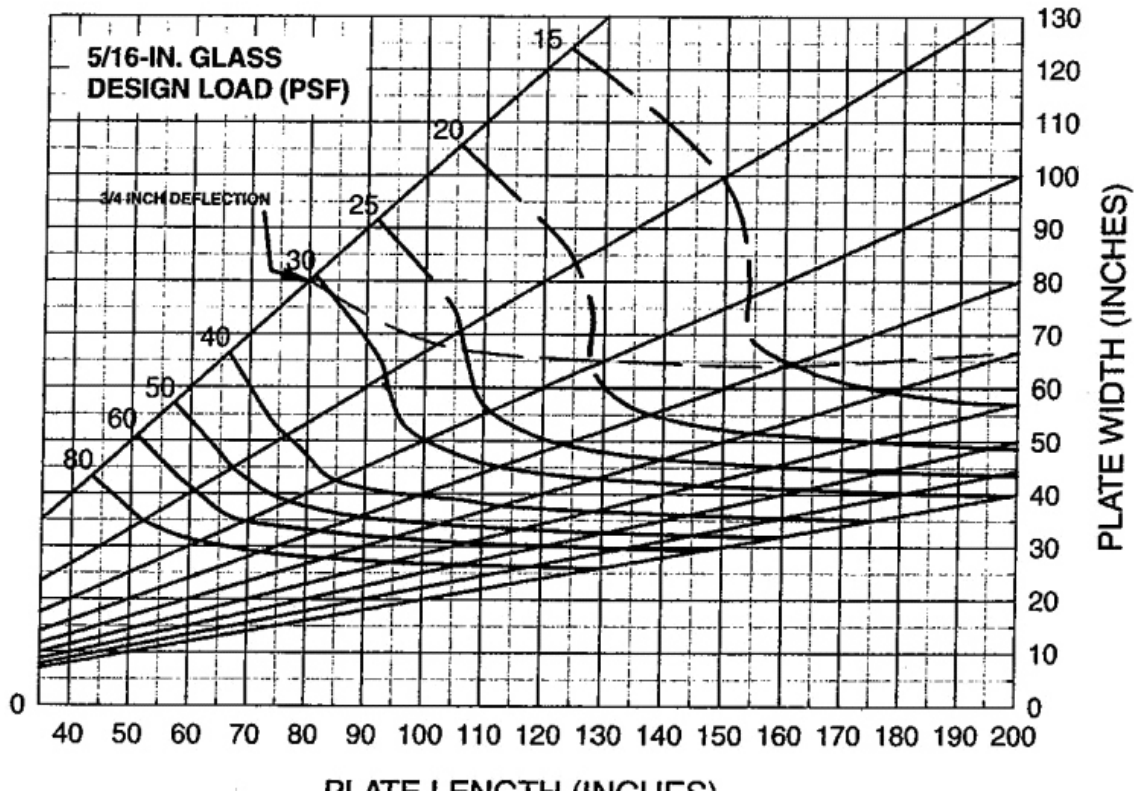
- For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.
- a. In each graph, the vertical axis is the lesser dimension
 - b. The diagonal number on each graph shows the equivalent design load in psf/
 - c. The dashed lines indicate glass that has deflection in excess of 3/4 inch.
 - d. Interpolation between lines is permitted, Extrapolation Is not allowed.
 - e. For laminated glass, the applicable glass thickness is the total glass thickness.
 - f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(6)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



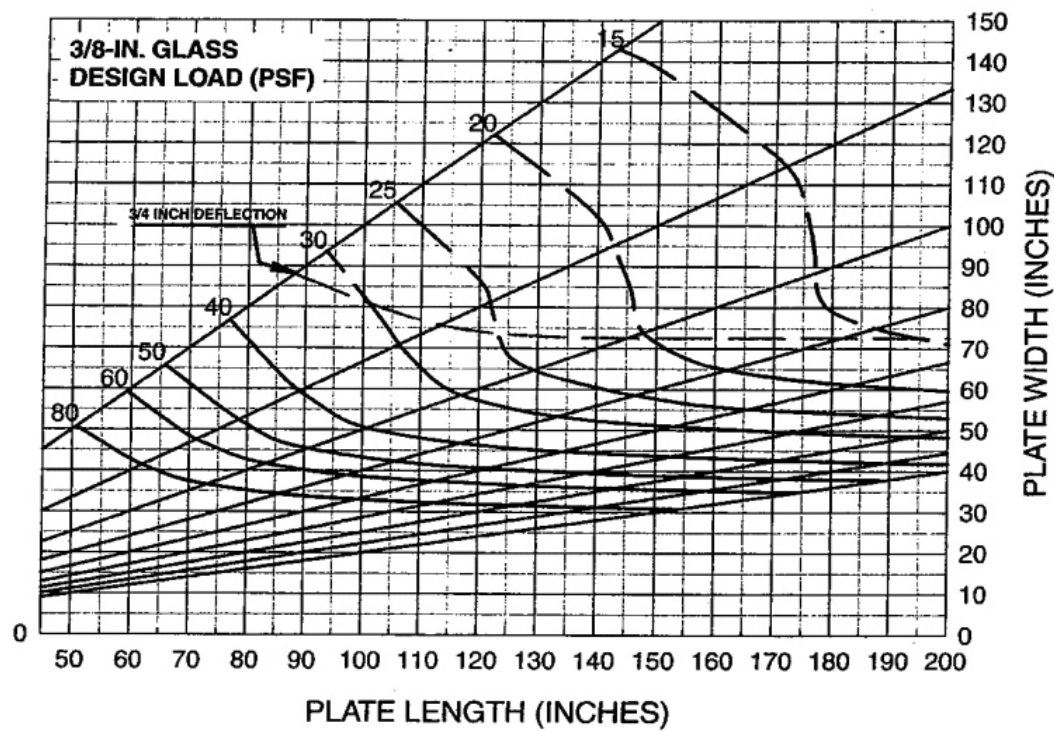
- For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.
- a. In each graph, the vertical axis is the lesser dimension
 - b. The diagonal number on each graph shows the equivalent design load in psf/
 - c. The dashed lines indicate glass that has deflection in excess of 3/4 inch.
 - d. Interpolation between lines is permitted, Extrapolation Is not allowed.
 - e. For laminated glass, the applicable glass thickness is the total glass thickness.
 - f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(7)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



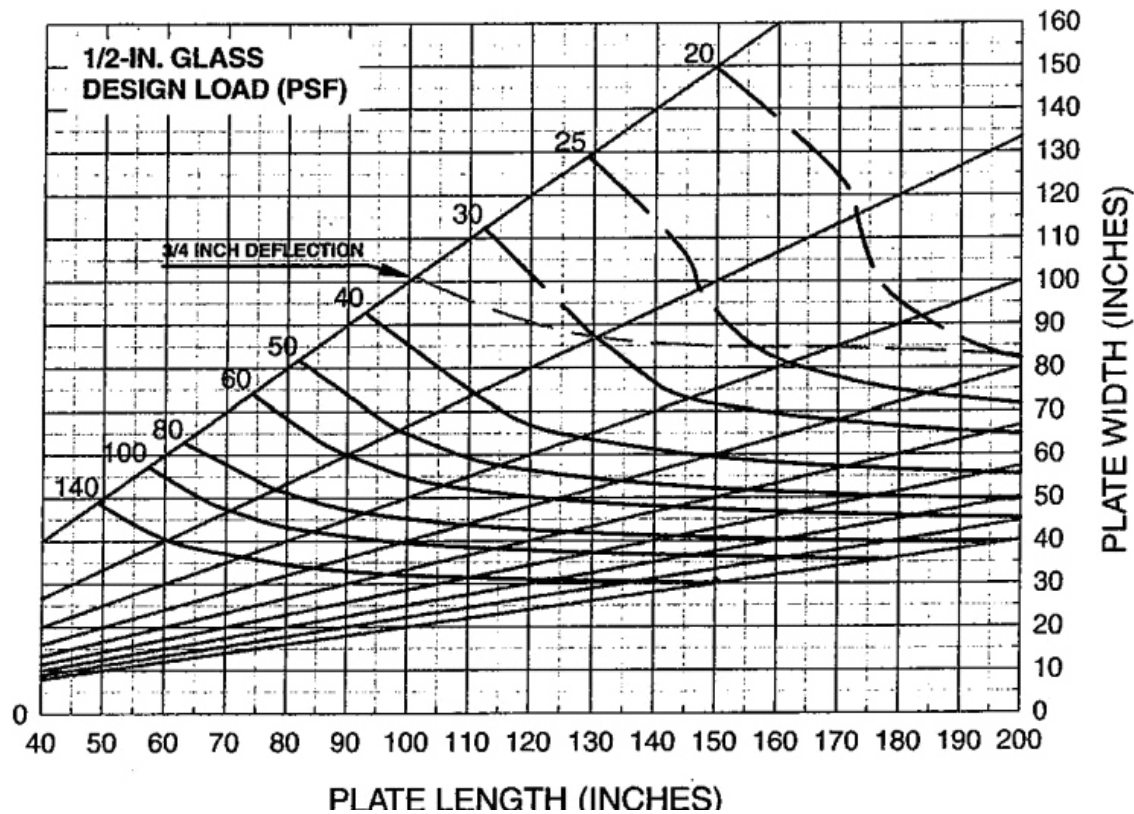
- For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.
- a. In each graph, the vertical axis is the lesser dimension
 - b. The diagonal number on each graph shows the equivalent design load in psf/
 - c. The dashed lines indicate glass that has deflection in excess of 3/4 inch.
 - d. Interpolation between lines is permitted, Extrapolation Is not allowed.
 - e. For laminated glass, the applicable glass thickness is the total glass thickness.
 - f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(8)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



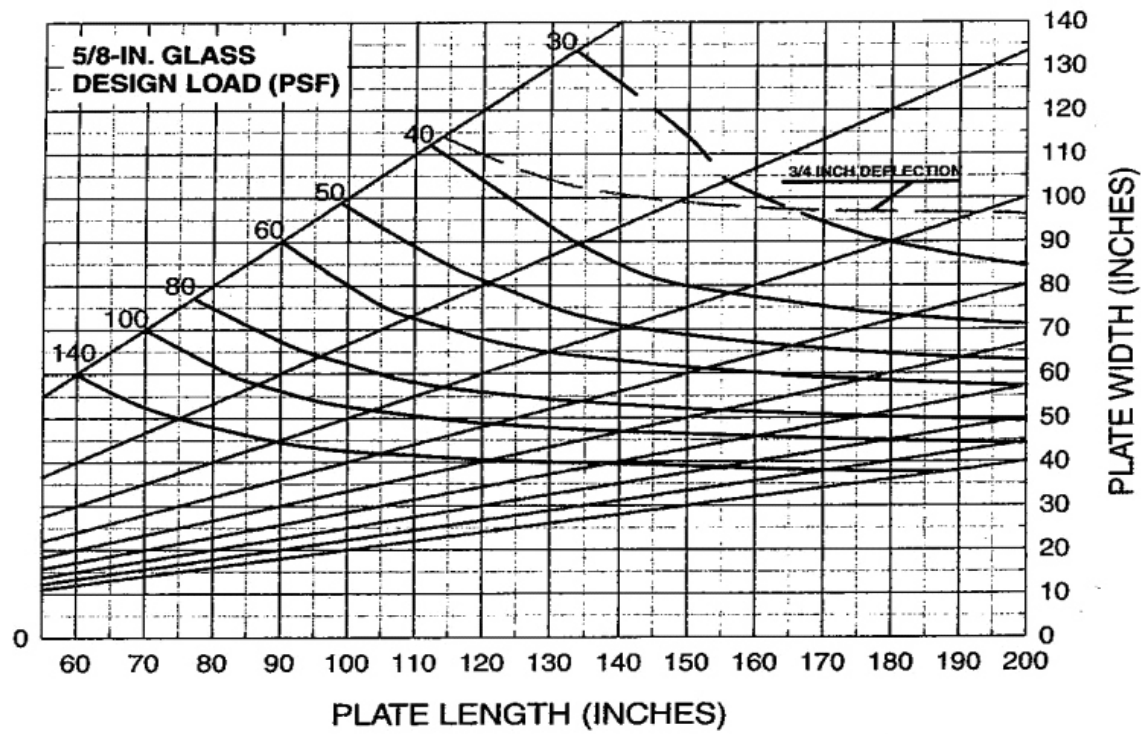
- For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.
- a. In each graph, the vertical axis is the lesser dimension
 - b. The diagonal number on each graph shows the equivalent design load in psf/
 - c. The dashed lines indicate glass that has deflection in excess of 3/4 inch.
 - d. Interpolation between lines is permitted, Extrapolation Is not allowed.
 - e. For laminated glass, the applicable glass thickness is the total glass thickness.
 - f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(9)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



- For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.
- a. In each graph, the vertical axis is the lesser dimension
 - b. The diagonal number on each graph shows the equivalent design load in psf/
 - c. The dashed lines indicate glass that has deflection in excess of 3/4 inch.
 - d. Interpolation between lines is permitted, Extrapolation Is not allowed.
 - e. For laminated glass, the applicable glass thickness is the total glass thickness.
 - f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

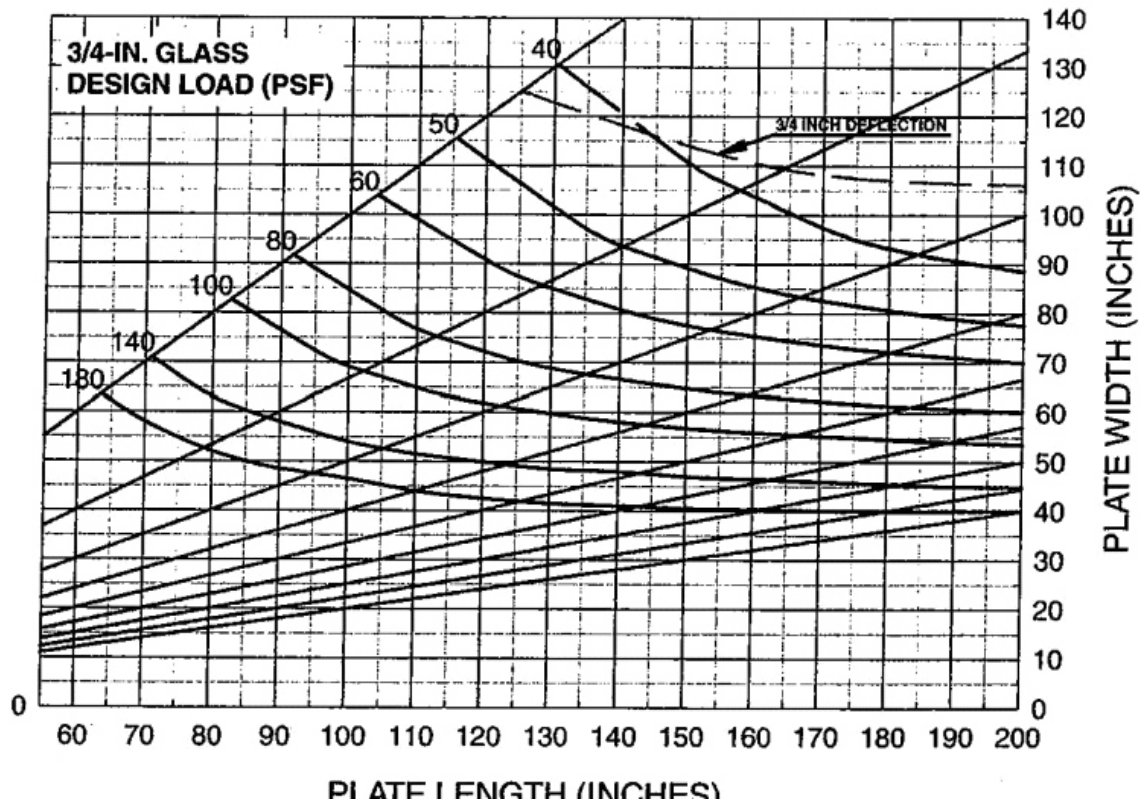
FIGURE 2404(10)^{a, b, c, u, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



For SI: 1 inch = 25.4 mm, 1 pound per square foot - 0.0479 kPa.

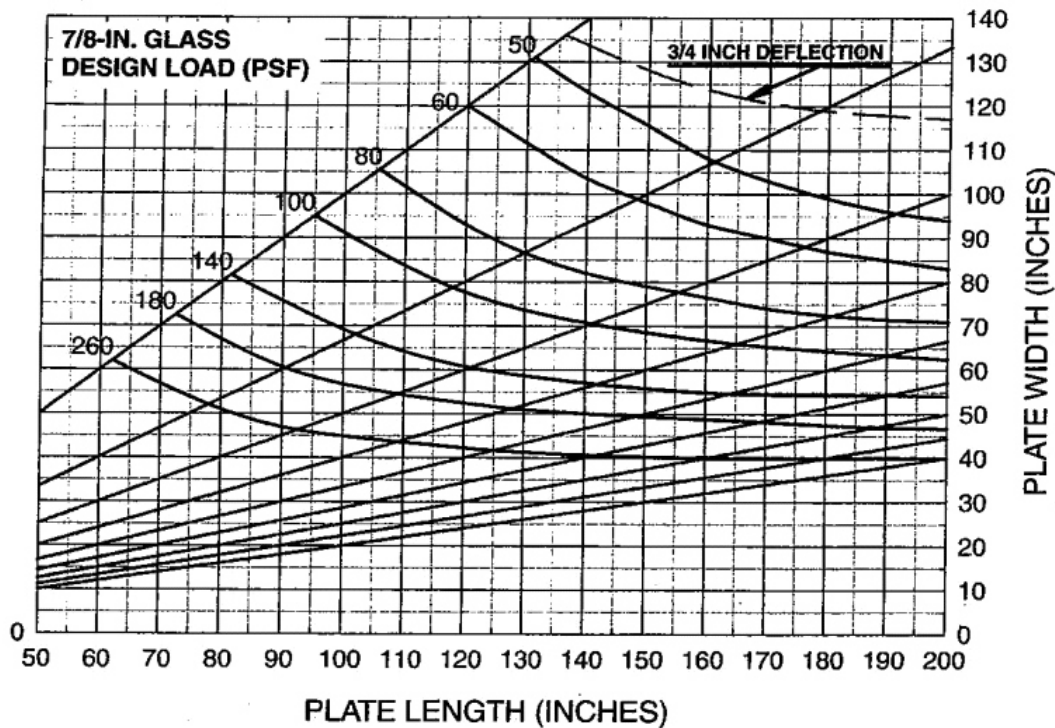
- In each graph, the vertical axis is the lesser dimension
- The diagonal number on each graph shows the equivalent design load in psf/
- The dashed lines indicate glass that has deflection in excess of $\frac{3}{4}$ inch.
- Interpolation between lines is permitted, Extrapolation Is not allowed.
- For laminated glass, the applicable glass thickness is the total glass thickness.
- For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(11)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES



For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

- In each graph, the vertical axis is the lesser dimension
- The diagonal number on each graph shows the equivalent design load in psf/
- The dashed lines indicate glass that has deflection in excess of $\frac{3}{4}$ inch.
- Interpolation between lines is permitted, Extrapolation Is not allowed.
- For laminated glass, the applicable glass thickness is the total glass thickness.
- For insulating glass panes, the applicable glass thickness is the thickness of one pane.

FIGURE 2404(12)^{a, b, c, d, e, f} MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED RECTANGULAR GLASS SUPPORTED ON ALL EDGES

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

- In each graph, the vertical axis is the lesser dimension
- The diagonal number on each graph shows the equivalent design load in psf/
- The dashed lines indicate glass that has deflection in excess of $\frac{3}{4}$ inch.
- Interpolation between lines is permitted, Extrapolation Is not allowed.
- For laminated glass, the applicable glass thickness is the total glass thickness.
- For insulating glass panes, the applicable glass thickness is the thickness of one pane.

780 CMR 2405.0 SLOPED GLAZING AND SKYLIGHTS

2405.1 Scope. 780 CMR 2405.0 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.

- 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 780 CMR 2607, heat-strengthened glass or fully tempered glass.
- For multiple-layer glazing systems, each light or layer shall consist of any of the glazing materials specified in 780 CMR 2405.2, Item 1.

Annealed glass is permitted to be used as specified within 780 CMR 2405.3, Exceptions 2. and 3.

For additional requirements for plastic skylights, see 780 CMR 2610.0. Glass-block construction shall conform to the requirements of 780 CMR 2101.2.2.

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:

- be capable of supporting twice the weight of the glazing;
- be firmly and substantially fastened to the framing members and
- be 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 mesh not larger than one inch by one 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:

- 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.

THE MASSACHUSETTS STATE BUILDING CODE

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 as applicable in 780 CMR 101.2 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 $\frac{3}{16}$ 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 as applicable in 780 CMR 101.2 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 1 and 2 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 non-corrosive 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 four 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 as applicable in 780 CMR 101.2. All unit skylights

installed in a roof with a pitch flatter than 14 degrees (0.25 rad) shall be mounted at least four 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 *101/I.S.2/NAFS Voluntary Performance Specification for Windows, Skylights and Glass*. The label shall state the name of the manufacturer, the approved labeling agency, the product designation and the performance grade rating as specified in 101/I.S.2/NAFS. 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 101/I.S.2/NAFS and the skylight shall comply with 780 CMR 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 101/I.S.2/NAFS for both positive and negative design pressure, and the skylight shall conform to 780 CMR 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:

EQUATION 24-8

$$F_g \leq PG$$

where:

F_g is the maximum load on the skylight determined from Equations 24-3 through 24-5 in 780 CMR 2404.2.

PG is the 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:

EQUATION 24-9

$$F_{gi} \leq PG_{Pos}$$

EQUATION 24-10

$$F_{go} \leq PG_{Neg}$$

where:

PG_{Pos} is the performance grade rating of the skylight under positive design pressure,

PG_{Neg} is the performance grade rating of the skylight under negative design pressure, and

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

If $W_o \leq D$, where W_o is the outward wind force, psf (kN/m²) as calculated in 780 CMR 1609 and D is the dead weight of the glazing, psf

(kN/m²) as determined in 780 CMR 2404.2 for glass, or by the weight of the plastic, psf (kN/m²) for plastic glazing.

F_{gi} is the maximum load on the skylight determined from Equations 24-4 and 24-5 in 780 CMR 2404.2,

F_{go} is the maximum load on the skylight determined from Equation 24-3.

If $W_o \ll D$, where W_o is the outward wind force, psf (kN/m²) as calculated in 780 CMR 1609 and D is the dead weight of the glazing, psf (kN/m²) as determined in 780 CMR 2404.2 for glass, or by the weight of the plastic for plastic glazing.

F_{gi} is the maximum load on the skylight determined from Equations 24-3 through 24-5 in 780 CMR 2404.2,

$F_{go} = 0$.

780 CMR 2406.0 SAFETY GLAZING

2406.1 Human Impact Loads. Individual glazed areas, including glass mirrors, in hazardous locations as defined in 780 CMR 2406.3 shall comply with 780 CMR 2406.1.1 through 2406.1.5.

2406.1.1 CPSC 16 CFR 1201. Except as provided in 780 CMR 2406.1.2 through 2406.1.5, all glazing shall pass the test requirements of CPSC 16 CFR 1201, listed in 780 CMR 35.00. Glazing shall comply with the CPSC 16 CFR, Part 1201 criteria, for Category I or II as indicated in Table 2406.1.

2406.1.2 Wired Glass. In other than Group E, wired glass installed in fire doors, fire windows and view panels in fire-resistant walls shall be permitted to comply with ANSI Z97.1.

2406.1.3 Plastic Glazing. Plastic glazing shall meet the weathering requirements of ANSI Z97.1.

2406.1.4 Glass Block. Glass-block walls shall comply with 780 CMR 2101.2.2.

2406.1.5 Louvered Windows and Jalousies. Louvered windows and jalousies shall comply with 780 CMR 2403.5.

2406.2 Identification of Safety Glazing. Except as indicated in 780 CMR 2406.1.2, each pane of safety glazing installed in hazardous locations shall be identified by a label specifying the labeler, whether the manufacturer or installer, and the safety glazing standard with which it complies, as well as the information specified in 780 CMR 2403.1. The label shall be acid etched, sand blasted, ceramic fired or an embossed mark, or shall be of a type that once applied cannot be removed without being destroyed.

Exceptions:

- 1. For other than tempered glass, labels are not required, provided the building official approves the use of a certificate, affidavit or other evidence confirming compliance with 780 CMR.
- 2. Tempered spandrel glass is permitted to be identified by the manufacturer with a removable paper label.

2406.2.1 Multilight Assemblies. Multilight glazed assemblies having individual lights not exceeding one square foot (0.09 square meter) in exposed area shall have at least one light in the assembly marked as indicated in 780 CMR 2406.2. Other lights in the assembly shall be marked “CPSC 16 CFR 1201” or “ANSI Z97.1,” as appropriate.

TABLE 2406.1 MINIMUM CATEGORY CLASSIFICATION OF GLAZING

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZING IN STORM OR COMBINATI ON DOORS (Category class)	GLAZING IN DOORS (Category class)	GLAZED PANELS REGULATED BY 780 CMR 2406.3, ITEM 7. (Category class)	GLAZED PANELS REGULATED BY 780 CMR 2406.3, ITEM 6. (Category class)	DOORS AND ENCLOSURES REGULATED BY 780 CMR 2406.3, ITEM 5. (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 - 0.0929m²

THE MASSACHUSETTS STATE BUILDING CODE

2406.3 Hazardous Locations. The following shall be considered specific hazardous locations requiring safety glazing materials:

1. Glazing in swinging doors except jalousies.
2. Glazing in fixed and sliding panels of sliding door assemblies and panels in sliding and bifold closet door assemblies.
3. Glazing in storm doors.
4. Glazing in 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 (1524 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 (1524 mm) above the walking surface.

Exceptions:

1. Panels where there is an intervening wall or other permanent barrier between the door and glazing.
2. Where access through the door is to a closet or storage area three feet (914 mm) or less in depth. Glazing in this application shall comply with 780 CMR 2406.3, Item 7.
3. 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 dwellings or within dwelling units in Group R-2.
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 (457 mm) above the floor;
 - 7.3. Exposed top edge greater than 36 inches (914 mm) above the floor; and
 - 7.4. One or more walking surface(s) within 36 inches (914 mm) horizontally of the plane of the glazing.

Exception. Safety glazing for 780 CMR 2406.3, Item 7 is not required for the following installations:

1. A protective bar 1½ inches (38 mm) or more in height, capable of withstanding a horizontal load of 50 pounds 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 of horizontal) (0.78 rad) 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 780 CMR 2406.3, Item 10. or 11. is not required for the following installations where:

1. The side of a stairway, landing or ramp which has a guardrail or handrail, including balusters or in-fill panels, complying with the provisions of 780 CMR 1012 and 1607.7; and
2. The plane of the glass is greater than 18 inches (457 mm) from the railing.

2406.3.1 Exceptions. The following products, materials and uses shall not be considered specific hazardous locations:

1. Openings in doors through which a three-inch (76 mm) sphere is unable to pass.
2. Decorative glass in 780 CMR 2406.3, 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 780 CMR 2101.2.2.
6. Louvered windows and jalousies complying with the requirements of 780 CMR 2403.5.
7. Mirrors and other glass panels mounted or hung on a surface that provides a continuous backing support.

2406.4 Fire Department Access Panels. Fire department glass access panels shall be of tempered glass. For insulating glass units, all panes shall be tempered glass.

780 CMR 2407.0 GLASS IN HANDRAILS AND GUARDS

2407.1 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 be of an approved safety glazing material that conforms to the provisions of 780 CMR 2406.1.1. For all glazing types, the minimum nominal thickness shall be ¼ inch (6.4 mm). Fully tempered glass and laminated glass shall comply with Category II of CPSC 16 CFR 1201, listed in 780 CMR 35.00.

2407.1.1 Loads. The panels and their support system shall be designed to withstand the loads specified in 780 CMR 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.

2407.1.3 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 2408.0 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 780 CMR 2408.0.

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, Part 1201, listed in 780 CMR 35.00, 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, listed in 780 CMR 35.00.

780 CMR 2409.0 GLASS IN FLOORS AND SIDEWALKS

2409.1 General. Glass installed in the walking surface of floors, landings, stairwells and similar locations shall comply with 780 CMR 2409.2 through 2409.4.

2409.2 Design Load. The design for glass used in floors, landings, stair treads and similar locations shall be determined as indicated in 780 CMR 2409.4 based on the load that produces the greater stresses from the following:

1. The uniformly distributed unit load (F_u) from 780 CMR 1605.0;
2. The concentrated load (F_c) from Table 1607.1; or
3. The actual load (F_a) produced by the intended use.

The dead load (D) for glass in psf (kN/m²) shall be taken as the total thickness of the glass plies in inches by 13 (For SI: glass plies in mm by 0.0245). Load reductions allowed by 780 CMR 1607.9 are not permitted.

2409.3 Laminated Glass. Laminated glass having a minimum of two plies shall be used. The glass shall be capable of supporting the total design load, as indicated in 780 CMR 2409.4, with any one ply broken

2409.4 Design Formula. Glass in floors and sidewalks shall be designed to resist the most critical of the following combinations of loads:

EQUATION 24-11

$$F_g = 2 F_u + D$$

EQUATION 24-12

$$F_g = (8F_c / A) + D$$

EQUATION 24-13

$$F_g = F_a + D$$

THE MASSACHUSETTS STATE BUILDING CODE

where:

A = Area of rectangular glass, ft² (m²).

D = Glass dead load (psf) = 13 t_g (for SI: 0.0245

t_g , kN/m²).

t_g = Total glass thickness, inches (mm).

F_a = Actual intended use load, psf (kN/m²).

F_c = Concentrated load, pounds (kN).

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

F_u = Uniformly distributed load, psf (kN/m²).

The design of the glazing shall be based on

EQUATION 24-14

$$F_g - F_{ga}$$

where F_g is the maximum load on the glass determined from the load combinations above, and F_{ga} is the maximum allowable load on the

glass, computed by the following formula:

EQUATION 24-15

$$F_{ga} = 0.67 c_2 F_{ge}$$

where:

F_{ge} = Maximum allowable equivalent load, psf (kN/m²), determined from Figures 2404(1) through 2404(12) for the applicable glass dimensions and thickness; and

c_2 = Factor determined from Table 2404.2 based on glass type.

The factor, c_2 , for laminated glass found in Table 2404.2 shall apply to two-ply laminates only. The value of F_a shall be doubled for dynamic applications.