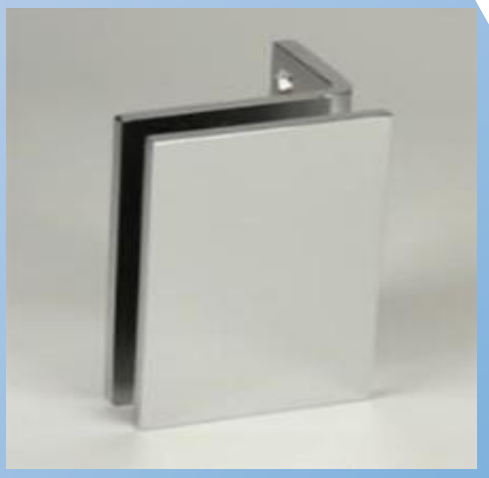
NATIONAL GLASS ASSOCIATION with GANA

Frameless Shower Enclosures



Design Guide

DG02-21

Introduction

Frameless glass shower enclosures can add a contemporary aesthetic to residential and commercial bathroom designs. Frameless shower enclosures are constructed of clear, translucent or opaque tempered glass, with optional colors, tints and textures. According to the International Building Code, shower enclosure glass must be safety glazing meeting the impact requirement of the federal standard, Cat II of CPSC 16 CFR 1201.

This document will discuss design considerations for frameless shower enclosures including doors and fixed panels, dimensional tolerances and limitations, hardware and structural support, visual quality expectations, and cleaning and maintenance guidelines. *Note: Semi-frameless and framed shower enclosures are not within the scope of this document.*

Frameless Enclosure Panels

Glass: This category of shower enclosure typically uses monolithic tempered glass minimum 3/8 inch (10 mm) or thicker. Frameless shower enclosures using glass less than 3/8 inch thick are not within the scope of this document.

- For applications using glass thinner than 3/8 inch, contact the hardware supplier for review and approval.
- Laminated glass may be used when glass retention after breakage is desirable. Consult the interlayer manufacturer for structural properties and durability in wet and humid environmental conditions.

Operating Panels: "Frameless" refers to the swinging, sliding, or moving panel(s) of the enclosure with no full-length metal attachments on the top, sides, or bottom.

Stationary or Sidelite Panels: "Frameless" may or may not apply to stationary or sidelite panels of the enclosures. The use of framing to support a stationary panel depends on the intended function of the stational panel, including:

- **Water Management:** a short, narrow stationary panel that is primarily intended to stop water from escaping the enclosure, for example, can be secured with few clips, channels on the bottom and one vertical edge or even a vertical silicone butt joint to another piece of glass.

***Figure 1**: Example of frameless shower enclosure with stationary and operating panels*

- **Structural Support:** some sidelites are intended to provide structural integrity to the unit in terms of:
  - Carrying the load of sliding or hinged doors where the sidelite may only have one exposed frameless edge because a header must be used for safety and functionality.
  - Supporting the size and weight of the sidelite panel itself; the taller and wider a panel, the more bracing or anchoring would be required.
  - Withstanding loads related to people leaning or falling into the panel. This may be necessary when a panel is installed in a high contact or high traffic area of an enclosure.

***Figure 2**: Example of frameless shower enclosure*

Specialty Glass Considerations

Patterned Glass

Install patterned glass with the smooth side facing inside the shower. Selecting a pattern glass with no smooth side is not recommended. Alternatives to using patterned glass for obscurity include acid-etched and sandblasted glass. Contact the supplier for detailed information regarding these specialty products.

Special considerations for hardware may be required when using high-relief or deep-Patterned glass types. Some deep patterns or cast glass will not fit standard channels and/or hardware with a pre-made flat area and these combinations of glass and hardware should be coordinated regarding size compatibility prior to final selection.

Glass Coatings

Glass coatings can be used in frameless shower enclosures. Glass manufacturers can provide float glass with glass coatings that can be tempered. Glass fabricators and installers can provide coatings that are applied after tempering.

When using coatings applied by the glass fabricator or installer, the installer should verify with the coating manufacturer whether the coating may cause slippage if applied at the location(s) of the hardware attachment. The installer should determine what locations, if any, should be free of coatings. Contact the coating manufacturer for appropriate cleaning instructions. Cleaning products approved by coating manufacturers may vary from manufacturer to manufacturer but will typically be non-abrasive. Coatings can be damaged by using unapproved cleaning products or cleaning process.

Height and Weight Considerations

Operable Door Limitations

- The width and weight limitations for operable doors – sliding and swinging – are determined by the manufacturer of the selected hardware.
- Hardware manufacturer width and weight limitations should be followed and maintained. No implied performance should be assumed based on any similarities in hardware from different manufacturers. Strict adherence to manufacturer's specifications is required.
- Structural wall construction is normally required to support the weight of a side-mounted hinged door.
- Regarding a single door with three wall mounted hinges (see Figure 3), if three hinges are to be used, the pivot points of the hinges should align with one another. If there is a misalignment, the door may slip over time. To check for pivot alignment, view the pivot points in the hinges from two directions: left to right and front to back.
  - Left to Right: To confirm the pivot points are in alignment on the left to right plane, place a straight edge on the face of the door glass and slide it to the hinge side of the glass until it touches the hinges. All three hinges should make contact with the straight edge simultaneously and should be plumb against the straight edge. If the straight edge touches the top and bottom hinge and the center is away from the straight edge, the pivot points are out of alignment and the door may slip.
  - Front to Back: To confirm the hinges are aligned on the front to back plane, place the same straight edge flat against the wall adjacent to the mounting plates of the hinges. Slide the straight edge to all three mounting plates until they make contact. Again, all the plates should be touching the straight edge simultaneously and evenly. If there is contact on the top and bottom hinges and the center one is away from the straight edge, the door may slip due to pivot misalignment.

***Figure 3**: Examples of 3-hinge installation of frameless shower door enclosures*

Fixed Panel Size Limitations

The vast majority of frameless shower enclosures are assembled using 3/8 inch (10 mm) and ½ inch (12 mm) thick glass. Glass thickness is typically determined based on three factors: total height, total width and total square area. See Table 1 for industry-standard panel size and thickness limitations based on the panel support configuration.

Generally,

- Maximum Height (see Table 2)
  - The maximum height for 3/8 inch (10 mm) glass is 84 inches (2133.6 mm), regardless of the width, when supported on two vertical edges and the base, or on two horizontal edges.
  - The maximum height for ½ inch (12 mm) glass is 120 inches (3048 mm), regardless of the width, when supported on two vertical edges and the base, or on two horizontal edges.
- Maximum Width (see Table 2)
  - The maximum width for 3/8 inch (10 mm) thick glass with an unsupported corner is 30 inches (762 mm) if full heigh and/or adjacent to a door.
  - The maximum width for ½ inch (12 mm) thick glass with an unsupported corner is 36 inches (914.4 mm) if full height and/or adjacent to a door.

Table 1: Fixed Panel Height Limitations for Frameless Glass Panels

Fixed Panel Size:	*Under 7 feet (84 inches) (2133.6 mm)*	*Up to 10 feet (120 inches) (3048 mm)*
Two-Sided Support (L-shape)	3/8 inch (10 mm) glass thickness	1/2 inch (12 mm) glass thickness
Three-Sided Support	3/8 inch (10 mm) glass thickness	1/2 inch (12 mm) glass thickness

Contact a design professional for the following design considerations:

- 3/8 inch (10 mm) thick glass over 84 inches (2133.6 mm) and ½ inch thick (12 mm) glass over 120 inches (3028 mm) in height.
- Hardware weight limitations based on substrate material or support capability. Examples of substrates requiring further considerations include:
  - Walls with the tile applied directly on drywall without stud framing behind the fastening location
  - Directly on drywall (no cladding or cover material)

Fixed Panel Weight Limitations

Maximum panel weight considerations vary significantly depending upon whether the fixed panels are floor supported or suspended.

For the case of fixed panels that are floor supported, when the panel is installed plumb, there is no real weight for the clamps to support. A plumb fixed panel, conceptually, has no reason to "fall" one way or another. If the glass is reliably resting on setting blocks at the bottom, and is installed plumb, there would not normally be a need to put weight limitations on a fixed panel assuming the substrate upon which the panel is resting is sufficient to support the weight.

Suspended Panels are not recommended in a frameless shower enclosure.

Table 2: Fixed Panel Size Limitations for Frameless Glass Panels with Unsupported Top Corner

Glass Thickness	*Maximum Height*	*Maximum Width with Unsupported Top Corner*
3/8" (10 mm)	Up to 84" (2133.6 mm)	30" (762 mm)
1/2" (12 mm)	Up to 120" (3028 mm)	36" (914.4 mm)

Glass Fabrication Tolerances

ASTM C1048 *Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass* provides fabrication guidelines for tempered glass including, but not limited to, holes, notches, cutouts, minimum dimensions and tolerances (see Figure 4 for examples of hardware attached through holes through the glass).

Some hardware may require fabrication to more stringent tolerances than ASTM C1048 guidelines. If values required are more stringent than those outlined in Table 3, the purchaser should consult with the glass fabricator.

***Figure 4**: Examples of hardware (handle and horizontal towel bar) on a frameless shower enclosure attached with holes through the glass.*

Table 3: Glass Fabrication Requirements for Frameless Shower Enclosures
(Note t = thickness of the glass panel)

Hole dimensions:	6 mm or 1*t minimum
Distance between edges of holes:	10 mm or 2*t, whichever is greater
Distance from edge of hole to edge of glass:	6 mm or 2*t, whichever is greater
Distance from edge of hole to corner of glass:	6.5*t
Length and width tolerances:	+/- 3/32 inch (for 10 mm thick glass) to +/- 1/8 inch (for 12 mm thick glass)
Bow:	Refer to ASTM C1048 *Overall Bow, Maximum* table

End User Visual Quality Expectations

If quality expectations exceed those indicated below, the purchaser should consult with the glass fabricator.

Table 4: Allowable Point Blemish Size and Distribution for Cut Size Quality 3[A] (based on ASTM C1036 *Standard Specification for Flat Glass*[B])

Glass Thickness (nominal)	Allowed[C,D]	Allowed with a Minimum Separation Distance of 600 mm (24")[E]	Not Allowed
¼" (6mm) *for reference only	Smaller than 1.5 mm	1.5 mm up to 2.0 mm	2.0 mm and larger
5/16" (8mm) *for reference only	Smaller than 1.875 mm	1.875 mm up to 2.5 mm	2.5 mm and larger
⅜" (10mm)	Smaller than 2.25 mm	2.25 mm up to 3.0 mm	3.0 mm and larger
½" (12mm)	Smaller than 3.0 mm	3.0 mm up to 4.0 mm	4.0 mm and larger

[A]Quality 3 is defined by ASTM C1036 as "Production of architectural glass products including coated, heat treated, laminated, and other select glass products." Note: For laminated glass, refer to ASTM C1172.
[B]Values quoted directly in the corresponding ASTM C1036 table (*ASTM C1036 Table 5*) are for 6.0 mm (1⁄4 in.) and less. Values in Table 4 above are calculated as instructed by ASTM C1036 as follows: for glass thicker than 6.0 mm (1⁄4 in.) and less than or equal to 12.0 mm (1⁄2 in.), they may contain proportionally larger blemishes for the same minimum separation distances. ASTM C1036 Table 5 does not apply to glass thicker than 12.0 mm (1⁄2 in.). Allowable blemishes for glass thicker than 12.0 mm (1⁄2 in.) shall be determined by agreement between the buyer and the seller.
[C,D] See ASTM C1036 section 6.1.1.1 for detection of point blemishes **and** 6.1.1.2 for measurement of point blemishes.
[E] See ASTM C1036 section 6.1.1.4 for minimum blemish separation.

Table 5: Excerpt from ASTM C1036 *Allowable Linear Blemish Size and Distribution for Cut Size and Stock Sheet Qualities*

Linear Blemish Size Intensity Length[A]	Q3 Quality 3 Distribution
Faint ≤ 75 mm (3 in.)	Allowed
Faint > 75 mm (3 in.)	Allowed
Light ≤ 75 mm (3 in.)	Allowed
Light > 75 mm (3 in.)	Allowed
Medium ≤ 75 mm (3 in.)	Allowed with a minimum separation of 600 mm (24 in.)
Medium > 75 mm (3 in.)	None allowed
Heavy ≤ 150 mm (6 in.)	None allowed
Heavy > 150 mm (6 in.)	None allowed

[A]See ASTM C1036 Table 12 ("Blemish Intensity Chart") for definition of Faint, Light, Medium and Heavy blemish intensity and viewing detection distances for each blemish intensity.

Table 6: Excerpt from ASTM C1036 *Allowable Shell Chip Size and Distribution for Cut Size and Stock Sheet Qualities for Type 1 – Transparent Flat Glass*

Description	Q3
Chip depth	Chip depth ≤ 50 % of glass thickness
Chip width[A]	Chip width ≤ glass thickness or 6 mm (1⁄4 in.) whichever is greater
Chip length[A]	Chip length ≤ 2 times the chip width

[A] For stock sheets, there is no limit for chip width and length.

Note from ASTM C1036: Glass edges are typically supplied as factory cut. Optional edge work can be specified as seamed, ground, polished, beveled, mitered, or other, as arranged with the manufacturer. See manufacturer's literature for more information.

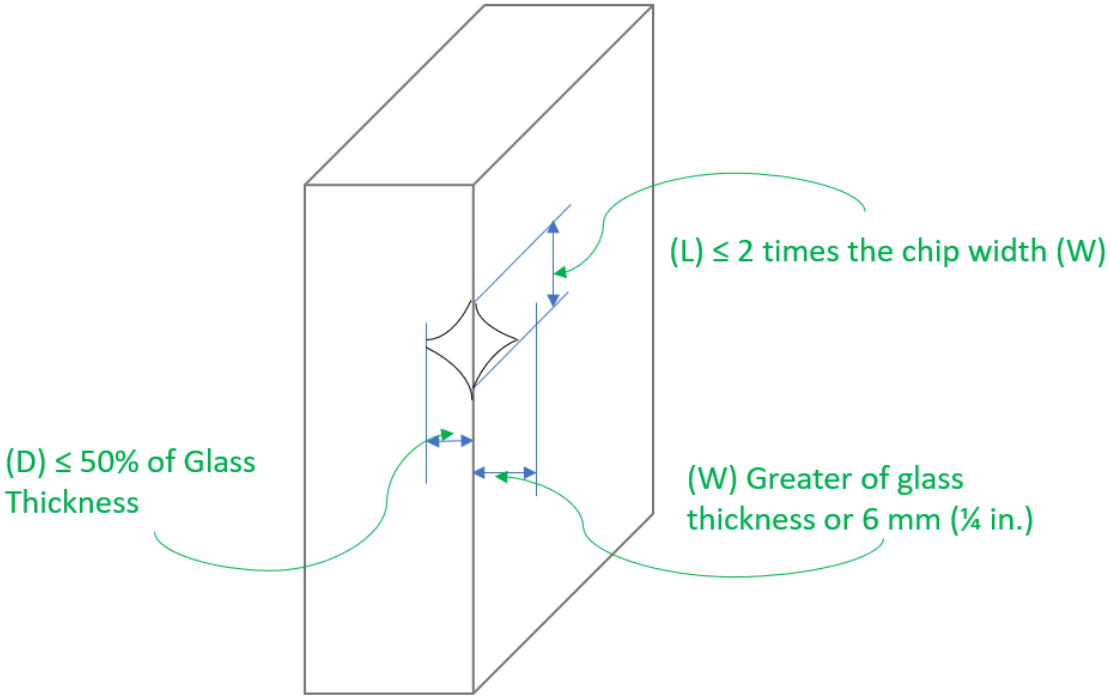


Figure 5: *Allowable shell chip for cut edges. Note: Shell chip width (W) shall be ≤ glass thickness or 6 mm (1/4 in.), whichever is greater, length (L) shall be ≤ 2 times the chip width, and depth (D) ≤ 50 percent of the glass thickness, per ASTM C1036.*
Source: NGA Engineering Standards Manual

Structural support: headers, u-channel vs. clamps; building materials

All frameless showers must be installed with the first priority being the safety of the end user. Cutting corners to appease an end user may be a short-term solution, but one that should not be considered.

The structural integrity of a glass shower enclosure is paramount. It is the duty of the glazing professional to provide a safe shower environment. Installing an unsafe enclosure, proclaiming "the customer signed a waiver, so they know it's not installed right" is not an acceptable or viable excuse for doing the wrong thing. If anything happens down the line, the waiver with that language may be used against the glazier. The waiver, under those circumstances, may be construed as an admission of guilt as the glazier holds himself or herself out as a professional and arguably knowingly did the wrong thing.

Fixed Panels

All fixed panels that contact a vertical wall should be fastened mechanically on two edges: (1) horizontal and vertical (bottom and side) or (2) horizontal (top and bottom). The substrate to which the fixed panels are fastened must be adequate to support the fixed panels.

Fixed panels can be attached using U-channel extrusions or clamps.

All U-channels (see Figure 6) should be mechanically fastened to substrates using stainless steel screws. Any screws that penetrate the tile/stone should have silicone sealant filling the hole before the screw is fastened, and after the U-channel is permanently fastened to the base/wall, the heads of all screws should be fully covered using silicone sealant to prevent water infiltration.

Figure 6: *Example of channels used below the frameless shower enclosure to secure and seal the glass.*

Doors Wall Mounted

All frameless shower doors with hinges fastened to vertical walls should be attached to an adequate substrate that can support the weight and motion of the door. It is normally up to the glazier to ensure there is adequate support in the wall for the hinges to be safely fastened. Examples of adequate support include wood studs to lag into, or at least 1-inch of cement-like material, including tile or stone itself, or cement float or cement board. Correct anchors are required. The only application

in which "tile on drywall" application should be used is when a stud is directly behind the connection point. Tile on drywall without a stud immediately behind the connection point normally is not an adequate anchoring substrate. Clamps can also be used to capture fixed panels (see Figure 7). All clamps should be mechanically fastened to adequate substrates using stainless steel screws. When screws penetrate stone or tile, the pre-drilled hole should be filled with silicone sealant before the screw is installed to prevent water leakage. At least one clamp should be used at the bottom for fixed panels up to 12 inches in width. Panels wider than 12 inches should use at least two clamps, see manufacturer for recommended clamp spacing/placement.

Figure 7: *Examples of glass clamps (brackets) used to support glass panels in a frameless shower enclosure.*

Doors Non-Wall Mounted

Doors Hinged to Fixed Panels

Any door hinged directly to a fixed panel of glass imposes a load on the fixed panel. For the door to operate safely, the fixed panel must be held firmly in place. There are several ways to safely secure the fixed panel from which the door will hinge. One way is to attach the fixed panel to a ceiling/soffit, capturing the top and bottom edges of the glass. Another method is to use a Header extrusion across the top of all fixed panels or a Support Bar. In reference to Support Bars, see the manufacturer for the specific application and limitations.

Doors may also hinge from a fixed panel of glass that has no top support, creating a Header-Free application. This Header-Free application has very specific criteria that should be strictly adhered to in order to create a safe application. The Header-Free criteria are:

1. Fixed panel should be ½ inch glass and attached to a vertical wall.
2. The fixed panel may not exceed 22 inches in width, or 84 inches in height.

3. The fixed panel should have valid bottom support (mechanically fastened to the curb/floor).
4. The fixed panel should use large, heavy-duty wall mount brackets (3-1/2 inches in height and with a 90° "L" shape that fastens to the wall) and use the same number of wall brackets as there are hinges.
5. The door should not exceed 30 inches in width and can be either 3/8 inch or ½ inch glass.
6. These criteria should work for doors hinging from a panel that is at 180° and 135° to the door. It is not recommended for 90°return panels.

Figure 8: *Example of hinges used to support glass door panels and allow them to swing in or out of glass shower enclosures.*

Managing End-User Expectations

The following statements, as well as others, may be used to explain to an end-user what can be expected from frameless shower enclosures:

- A frameless shower enclosure is not the same as its framed or semi-frameless counterpart.
- There is minimal use of hardware, leaving an all-glass look. This all-glass look does not allow for a kit that is assembled and has aluminum extrusions that interlock into one another, preventing water from leaking. An end-user should be prepared for these differences and have expectations that align with this knowledge. A frameless shower is not an aquarium, meaning it will not hold water without any leakage.
- The amount a frameless shower will leak is dependent on various factors.
- The primary factor in whether a frameless shower will leak or not is the configuration of the shower itself and the type of enclosure being installed. There are some showers that, by virtue of their design, will not have water escape. For example, a very large shower with the door far away from the water source will be unlikely to leak water outside of the enclosure.
- A shower type on the other side of this spectrum may be, for example, a corner-installed enclosure of small proportions, which would be almost guaranteed to leak (see Figure 9). Most showers fit somewhere between these two extreme examples.

Figure 9: *(Left) Example of a smaller corner shower enclosure. (Right) Example of a large shower enclosure with the door far away from the water source.*

Clear plastic seals do assist in minimizing water escape (see Figure 10), however they do not ensure a leak-proof shower.

The end-user must be made to realize that there may be some water escape, depending on the shower configuration. The installer can best prepare the end-user by explaining the appropriate expectations based on the different variables.

Figure 10: *Examples of optional seals (gaskets) used in frameless shower enclosures.*

Retrofitting/Custom Installation

When removing an old shower and prepping a new one, generally the following steps should be pursued:

1. Assess how the original shower enclosure is secured.
2. Remove all enclosure doors.
3. Unscrew all visible features.
4. Tap the vertical frame pieces to loosen them.
5. Remove the glued and caulked frame pieces.
6. Align new enclosure such that it will utilize and/or cover existing holes left by previous enclosure. If this is not possible, consideration may need to be given to covering holes with new tile or cover material being used.

Maintenance/Cleaning

Hardware

Properly cared and maintained hardware normally will maintain its original appearance. Neglecting or ignoring the maintenance needs and procedures is likely to result in reducing the hardware's quality appearance and/or service life.

- The best way to maintain the original finish on the hardware normally is to wipe it down after every use. After showering, a dry towel may be used to thoroughly dry the hardware. If the hardware is kept clean after every use, it is less likely to collect mineral deposits that require the use of a soap solution (noted below).
- If unable to dry the hardware after every use, a weekly cleaning is suggested. Cleaning the hardware with a mild soap and warm water mixture and using a soft, non-abrasive cloth is suggested. Rinse thoroughly with clean warm water, then dry.
- **Warning:** As a general rule, never use an abrasive cleanser of any kind on the hardware. Many of the components are coated with a clear lacquer that may be irreparably damaged if subjected to harsh abrasive chemicals or scrubbing devices.

Glass

Squeeqeeing the glass frequently with a non-metallic squeegee is recommended, then drying with a soft cloth. Using a squeegee after each shower helps keep spots and scaling from forming and accumulating on glass components. Also recommended is cleaning the glass regularly with a glass cleaner and reading labels on cleaning products thoroughly before using. If the glass is coated or treated with surface protectants, instructions on the labels provided by the manufacturer should be followed.

A short list of some of the cleaning agents that should be avoided because they either damage the metal or scratch the glass surface includes:

- Abrasive or soft abrasive powders and liquid
- Acidic or vinegar-based cleaners
- Bleach or bleach-based cleaners
- Steel or Teflon pads

References

- ASTM C1048 *Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass*
- ASTM C1036 *Standard Specification for Flat Glass*
- ASTM C1172 *Standard Specification for Laminated Architectural Flat Glass*
- NGA Glass Technical Paper FB01-00 *Proper Procedures for Cleaning Architectural Glass*
- NGA Glass Technical Paper FB28-11 *Assessing the Compatibility of Glazing Materials and Components*
- NGA Engineering Standards Manual