History of safety glazing

- Building codes did not address safety glazing until the 1960s.
- Lawsuits against manufacturers
- The National Safety Council formed National Glazing Association
- Reported up to 320,000 injuries per year from people impacting glass in doors and windows
History of safety glazing

• ANSI Z97.1 standard formed in 1966 for impact resistance of glass
• 1968-73: Greatest number of injuries in residential applications
  – patio doors and shower enclosures

History of safety glazing

• Developed a two-tiered standard
• Greater hazard in impact with large area of glass
• Category I glass rated at 150 pounds
• Category II rated at 400 pounds
• CPSC 16 CFR 1201 became law on July 6, 1977

Impact Test

• CPSC 16 CFR 1201
  – Glazing shall comply with the test criteria for Category II unless otherwise indicated in the Table
• Exception:
  – ANSI Z97.1
  – Glazing not in doors or enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers
  – Glazing shall comply with the test criteria for Class A unless indicated in Table
### CPSC 16 CFR 1201 - Impact Test

<table>
<thead>
<tr>
<th>Exposed surface area</th>
<th>Doors</th>
<th>Sliding patio doors</th>
<th>Glazing near floor</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 9 sq ft</td>
<td>I</td>
<td>II</td>
<td>NR</td>
</tr>
<tr>
<td>&gt; 9 sq ft</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
</tbody>
</table>

### CPSC 16 CFR 1201 - Impact Test

<table>
<thead>
<tr>
<th>Exposed surface area</th>
<th>Adjacent to Doors</th>
<th>Tub/shower enclosures &amp; doors</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 9 sq ft</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>&gt; 9 sq ft</td>
<td>II</td>
<td>II</td>
</tr>
</tbody>
</table>

### ANSI Z97.1 - Impact Test

<table>
<thead>
<tr>
<th>Exposed surface area</th>
<th>Glazing near floor</th>
<th>Adjacent to Doors</th>
<th>Exception to wet surfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 9 sq ft</td>
<td>NR</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>&gt; 9 sq ft</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>
Types of glazing

- Annealed glass (float glass)
  - Ordinary glass
  - Can be cut
  - Breaks into shards.
- Plate glass
  - Heavier
  - Stronger
- Heat strengthened glass
  - Double strength
  - Cannot be cut after manufacture

Wired glass

- Not safety glazing
- ANSI Z97.1 Category class C
- Used for fire resistance
- Some history of use as safety glazing in fire doors

Louvered Windows or Jalousies

- Regular, float, wired or patterned glass in jalousies and louvered windows:
  - ≥ 3/16 in. thick nominal and
  - ≤ 48 in. in length
- Exposed glass edges shall be smooth.
- Wired glass with wire exposed on longitudinal edges prohibited
Types of safety glazing

- Tempered glass
  - Heating and rapid cooling process
  - Four times more resistant to impact than annealed glass
  - Fractures perpendicular to the plane of the surface
  - Small pebbles less likely to cause significant injury
  - Cannot be cut after manufacture

Types of Glazing

- Laminated glass
  - Two layers of annealed, heat-strengthened or tempered glass
  - Clear polyvinyl butyral (PVB) center membrane
  - Used in car windshields
  - Often used for frameless glass railings
  - Annealed laminated can be cut to size after manufacture

- Proprietary
Identification of safety glazing

Manufacturer’s designation for each pane of glazing in hazardous location:

- Who applied the designation
- Type of glass
- Safety glazing standard
- Visible in the final installation
- Label permitted

Identification of safety glazing

Exceptions:

- Certificate, affidavit or other evidence (not tempered)
- Tempered spandrel glass - removable paper

Identification of safety glazing

Multiple assemblies

- Individual panes ≤1 sq. ft.
- ≥ one pane identified
- Other panes labeled
  - CPSC 16 CFR 1201 or
  - ANSI Z97.1
Human Impact Loads

- Glazed areas in hazardous locations shall pass the test requirements
- Exceptions:
  - Mirrors and other glass panels mounted or hung on a surface that provides a continuous backing support
  - Glass unit masonry
  - IRC: Louvered windows and jalousies
  - IBC: Plastic glazing shall meet the weathering requirements of ANSI Z97.1.

Doors

- Glazing in fixed and operable panels of swinging, sliding and bi-fold doors
- Exceptions:
  - Glazed openings where a 3-in.-diameter sphere cannot pass through
  - Decorative glazing
- IBC Exceptions
  - Curved glazed panels in revolving doors
  - Commercial refrigerated cabinet glazed doors

Adjacent to Doors

- Within 24 in. horizontally of door in closed position
- < 60 in. above floor
Adjacent to Doors

- Bottom exposed edge < 60 inches above floor and
- 1. Glazing is within 24 inches of either side of door in the plane of the door in a closed position.
### Adjacent to Doors

- Bottom exposed edge < 60 inches above floor and
- 2. Where the glazing is on a wall perpendicular to the plane of the door in a closed position and within 24 inches of the hinge side of an in-swinging door.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glazing installed perpendicular to a door</td>
<td>Yes</td>
</tr>
<tr>
<td>&lt; 24 inches from door</td>
<td>Yes</td>
</tr>
<tr>
<td>Safety glazing if on hinge side of an in-swinging door</td>
<td>Yes</td>
</tr>
<tr>
<td>IRC</td>
<td>Yes</td>
</tr>
<tr>
<td>IBC Limited Exception</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Adjacent to Doors

- IBC Exception:
  - Glazing in walls on the latch side of and perpendicular to the plane of the door in a closed position in one- and two-family dwellings or within dwelling units in Group R-2.
Adjacent to Doors

- Exceptions:
  - Decorative glazing
  - Intervening wall or other permanent barrier between door and glazing
  - Access through door is to closet or storage area ≤ 3 ft. in depth
  - Glazing that is adjacent to the fixed panel of patio doors (IRC)

R308.4.2 – Glazing adjacent doors

Windows

- Exposed area of an individual pane > 9 sq. ft.
- Bottom edge of glazing < 18 in. above floor
- Top edge of glazing > 36 in. above floor
- Walking surface within 36 in.
Windows

Exceptions
- Decorative glazing
- Horizontal rail on accessible side 34 to 38 in. above walking surface.
  - Withstand horizontal load of 50 lb. per lin. ft. without contacting glass
  - ≥ 1 1/8 in. in height.
- Outboard panes ≥ 25 feet above any grade, roof, walking surface or other surface adjacent to the glass exterior

R308.4.4 Glazing in guards and railings
- Always require safety glazing
- Table R301.5 requires a safety factor of 4
  - h. The safety factor is applied to concentrated loads at top of rail and to load on in-fill components.

<table>
<thead>
<tr>
<th>USE</th>
<th>LIVE LOAD (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guardrails and handrails</td>
<td>200</td>
</tr>
<tr>
<td>Guardrail in-fill components</td>
<td>50</td>
</tr>
</tbody>
</table>

Glazing in guards and railings
- Glazing used in guards require a safety factor of 4
  - 4 x 50 psf (minimum design load for in-fill components) = 200 psf

IRC Table R301.5
Minimum Uniformly Distributed Live Loads
Footnote h
Glazing in guards and railings

• **IBC Section 2407 Glass in Handrails and Guards**
  - Loads: A design factor of four
  - Each rail supported by ≥ 3 glass balusters or equivalent
  - Glass balusters shall not be installed without an attached handrail or guard
Glazing in guards and railings

- **IBC Section 2407**
  - Glass in Handrails and Guards
    - **Exception:** A top rail not required where laminated glass balusters:
      - ≥ 2 glass plies of equal thickness
      - When approved by the building official

Glazing and Wet Surfaces

- Where the bottom exposed edge of the glazing is less than 60 inches above standing or walking surface, and
- Glazing in walls, enclosures or fences containing …
- Glazing in walls, enclosures or fences … facing
  - Bathtubs, showers, hot tubs, spas, whirlpools, saunas, steam rooms, and swimming pools

**Exception:** Glazing that is more than 60 inches, measured horizontally and in a straight line, from the water’s edge of a bathtub, hot tub, spa, whirlpool or swimming pool or from the edge of a shower, sauna or steam room.
• Glazing in walls or fences near swimming pools
  – ≤ 60 in. of water’s edge
  – < 60 in. above walking surface
Adjacent Stairs and Ramps

IRC

• Exception if rail installed:
  – Withstand horizontal load of 50 plf without contacting glass
  – Cross-sectional height ≥ 1½ in.

  • Glazing 36 in. horizontally from walking surface.

IBC

• < 60 inches above the plane of the adjacent walking surface of stairways, landings between flights of stairs and ramps

• Exceptions:
  – A guard and the plane of the glass >18 inches (457 mm) from the railing
  – Glazing ≥ 36 inches horizontally from the walking surface (IBC and IRC)
Adjacent Bottom Stair Landing
IRC

• Applies to the area in front of the plane of the bottom tread.

Exception: Glazing that is protected by a guard where the plane of the glass is >18 inches from the guard.
Adjacent Bottom Stair Landing

IBC

• Glazing < 60 inches above the landing and within a 60-inch horizontal arc from the bottom tread nosing

• Exception:
  – Glazing that is protected by a guard where the plane of the glass is >18 inches from the guard

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