Definition of Safety Glazing

- Glazing material so constructed, treated, or combined with other materials that, if broken by human contact, the likelihood of cutting or piercing injuries that might result from such contact is reduced.
- NOT fire, fall-out, or an assessment of strength
- CAN/CGSB 12.1 (and ANSI Z97.1) are the inspiration of “Safety Glazing” standards for the world.
Background

- Injuries from glass doors
- ANSI Z97.1 – 1966 (voluntary)
- 1970’s (Canada and USA)
  - safety glazing regulations
  - mandating use
  - primarily doors

https://www.youtube.com/watch?v=1zHZDf9DI0

Previous CGSB 12.1 Updates

- Original publication CAN-2-M2-12.1-76
  - Published 10.01.1975
- Several revisions yield CAN/CGSB – 12.1-M90
  - Reasonably harmonized with ANSI Z97.1-1984
    - Glass Types (laminated & tempered)
    - Categories (457 mm & 1219 mm impact)
    - Boil test for laminated
    - Centre punch test for tempered
- Updates halted 1990 - 2014
PROMPTING CHANGE

- Several law suits involving monolithic wired glass
- Interests felt standards updates were needed (Canadian Code Center @ NRC)
- Notice sent by Standards Council of Canada (SCC) to Canadian Glass Committee indicating need to review standards periodically
- Canadian Glass Committee re-established

Glass Committee Objectives

- Clearly define safety glass and its product categories
- Update to address technology and new products
- Harmonize as much as possible with ANSI Z97.1
- Develop under SCC rules
- Ensure applicable to Canadian building practices and codes

- First meeting Spring of 2014
- Publication in Feb 2017
- Acknowledged assistance from ASC Z97
CGSB Committee on Glass

- **Chair**
  - Webb, M., Insulating Glass Manufacturers Alliance (Producer)

- **General interest category**
  - Flack, J., Consultant
  - Steel, K., Steel Consulting Services
  - Zaremba, T., Roetzel & Andress, LPA

- **Producer category**
  - Botman, R., Glassopolis Specialty Glass
  - Fraser, E., PPG Flat Glass Canada Inc.
  - Harder, B., Ferguson Corporation
  - Liversidge, M., Precision Glass Services Inc.
  - Schimmelpenningh, J., Eastman Chemical Company
  - Wakefield, R., Trulite Canada

- **Regulator category**
  - Chowhan, P., Health Canada
  - Fortin, M., National Research Council of Canada

- **User category**
  - Brook, M., BVDA Facade Engineering Inc.
  - Panzier, S., Thinkform Architecture & Interiors
  - Redmond, T., Ontario Building Official Association
  - Sharp, G., Canadian Home Builders' Association
  - Shelbourn, K., Canadian Building Envelope Science & Technology

- **Secretary (non-voting)**
  - Jimenez, J., Canadian General Standards Board

Standard Adoption Process

- **CGSB (Canadian General Standards Board) establishes the standard**

- **CGSB follows SCC (Standards Council of Canada) requirements for standards development.**

- After the building code development process, NRC (National Research Council of Canada) publishes NBC (National Building Code of Canada)

- Provinces then consider adoption
Title

CAN/CGSB12.1-2017
- Safety Glazing

CAN/CGSB12.1-M90
- Tempered or Laminated Safety Glass
General

- Format and order of sections
- Section titles
- Limits and tolerances - small differences (1-3mm)
- Not published as dual language (English/French)
- References predominately CGSB Glass & ASTM International Standards
- Product definitions enhanced
- Specifications removed
- Test methodologies detailed
- Nominal thickness difference requires test
- Number of specimens stays the same (4)
- Weathering requirements (Laminated, OCG, Plastics, Mirror)

Scope

CGSB 12.1-2017

- Broadens to glazing materials
- Defines injury (cutting and piercing)
- Results from breaking by human impact
- Defines products not considered safety-glazing materials (monolithic)
  - annealed glass
  - heat-strengthened glass
  - chemically-strengthened glass
  - glass-ceramic
  - wired glass
- Harmonization with ANSI Z97.1-2015

CGSB 12.1 M-90

- Applicable to tempered glass or glass combined with materials to reduce the likelihood of injury
- By objects projected from an exterior source or by glass fragments when the glass is cracked or broken.
- Intended primarily for use in doors and adjacent glazed panels
Terms & Definitions

- Asymmetrical material
- Bent glass
- Bubble
- Cracking
- Crack-free particle
- Crazing
- Delamination
- Discoloration
- Fully tempered glass
- Laminated glazing
  - 2-ply glass laminates
  - Multi-ply glass laminates
- Glass/Plastic laminates
- Mirror glazing
- Organic Coated glass
- Plastic Glazing material
- Safety Glazing Materials

Product Types

CGSB 12.1-2017
- Laminated
- Fully Tempered
- Organic-coated
- Plastic
- Mirror

CGSB 12.1-M-90
- Laminated
- Fully Tempered
Sizes

- **CGSB 12.1-2017**
  - Unlimited
    - 863mm x 1930mm
    - Designated: “U”
  - Limited
    - min 406mm x 762mm up to “U”
    - Designed: “L”
    - Dimensional limits as tested

- **CGSB 12.1-M-90**
  - ≤0.8m (Cat I)
  - >0.8m (Cat II)

Note:
M-90 Sizes linked to categories I and II

Classes & Categories

**CGSB 12.1-2017**

- **Impact Classification**
  - A = Drop height of 1219mm – 1232mm
  - B = Drop height of 452mm - 470mm

**CGSB 12.1 M-90**

- **Product Classification**
  - A = Sheet Glass
  - B = Float Glass

- **Impact Category**
  - Category I
  - Category II
Marking

CGSB 12.1-2017
- Supplier name, designation or mark (Logo)
- Standard: CAN/CGSB-12.1-2017
- Size: L or U
- Class: A or B
- Place of Fabrication (if more than 1 location)
- Other info permitted
- Sample Label:

ABC Lam – Kelowna
CAN/CGSB-12.1-2017 UA

CGSB 12.1 M-90
- Manufacturer's name/ Trademark
- CAN|CGSB-12.1-M
- CAN|CGSB-12.1-M-1 for Cat 1 only

NOTES
- Shall be legibly and permanently marked
- Same nominal thickness
- Same production manner
- No mark = No compliance

NOTES

Application of the mark (2017)

- Laminated glass stock sheets
  - Marked by the manufacturer of the stock sheet
- Cut size laminates, FT, OCG
  - Marked by company producing the finished cut size panel
- Fabricator to mark plastic glazing
- Indoor only application = “Indoor Use Only”
- Installer shall mark field applied OCG (films) also mark: “Glaze this side in”

©Eastman Chemical Company
No Re-Use/Reproduction without written authorization from author.
jcschi@eastman.com
Test Methods

Test Overview

- **Impact Test** is essentially the same but with added clarification
- **Fragmentation test** – Tempered glass
- **Mirrors** – impact on “non-reinforced” side
- **Bent Glass** – direction how to test
- **Indoor (only) Applications** – aging, weathering and testing
  - Exterior qualifies interior
- **Thermal test** – Laminated and Organic Coated
- **Weathering** – exposure and testing
## Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Laminated glazings</th>
<th>Fully tempered glass</th>
<th>Organic coated glazings</th>
<th>Plastic glazing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact (see 10.1)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Centre punch fragmentation (see 10.2)</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Thermal (see 10.3)</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Weathering (see 10.4)</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Indoor aging (see 10.4.3)</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hardness (see 6.5 and 10.1.4 c)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Modulus (see 6.5 and 10.1.4 c)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

* Bent and mirror glazing shall be tested in accordance with requirements of the base-glazing product (see 6.2).
* Centre Punch Fragmentation test is used to evaluate the fracture pattern of fully tempered glass specimens that do not break during impact test of 10.1.
* Thermal test only applies to organic coated glazings when organic coated glazings are used in the building envelope.
* Weathering tests on laminated and organic coated glasses shall be performed on the thinnest construction of all components with clear glass, clear plastics and clear interlayers.
* Mirror glazing shall be tested in accordance with 10.4.3.
* Only required if breakage occurs under impact.

## Specimen Requirements

- Impact – 4 (same)
- Mirror with backing – 4
  - Impact non-reinforced side only
- Bent Glass – 4
  - Simple arc bend 1016 mm
- Thermal – 3 (same)
- Weathering – Various per product
- Indoor - various
- Flexural Modulus – ASTM D790
- Rockwell Hardness – 25 mm²; 6 mm thick

![Figure 11 – Bent glass impact test frame (Exploded view)](image-url)
**Impact**

- Specimen conditioning
  - Temperature 18°C – 29°C
  - Spaced for free air circulation
  - Minimum 4 hours
- Bag rotated around axis for each impact
- Pummel bag to original shape
- Free hanging impactor no more than 51mm from glazing surface (M-90: 10 mm)
- Torque bolts 20Nm
- Sphere – vertical, 18N or less force
- Protective cloak suspended from frame no more than 10 mm from surface (M-90: bag drape)
- Curved glass impacted on convex surface

**Centre Punch Fragmentation**

**CGSB 12.1-2017**

- Required for tempered if no break after impact
- Flat and bent specimens
- Centre punch break 25mm in at midpoint of longest edge
- Temperature
  - 18.3°C - 29.4°C
- Exclusion area
- Within 5 min from fracture
- 10 largest particles, no more than mass of 6452mm² of unbroken specimen

**CGSB 12.1 M-90**

- Centre punch break 15 mm in at midpoint of longest edge
- 10 largest particles, no more than mass of 6500mm² of unbroken specimen
Thermal

CGSB 12.1-2017
- Boil (Wet)
  - 2 hours @ 100°C
- Bake (Dry)
  - 16 hours @ 100°C
- Re-conditioned prior to rating
  - 4 hrs. at 18°C – 29°C
  - separated with free flowing air;
- Evaluation
  - 12mm from edge
- Select either based on product
- OCG used in exterior glazing

CGSB 12.1 M-90
- Boil test only
- Remove & cool, no timing
- Evaluation
  - 10mm from edge


Laminated & OCG
- Exposure
  - South Florida – 1 year (Natural)
  - Xenon Arc – 3000 hrs. (Accelerated)
- Assessment
  - Visible light stability
  - Yellowness
  - Haze
  - Color (Delta E)
  - Bubbles
  - Gaging
  - Decomposition
- OCG only
  - Peel adhesion & tensile
- Qualifications
  - Thin qualifies thicker
  - Clear qualifies colored

Plastics
- Natural Exposure
  - South Florida – 1 year
  - Xenon Arc – 3000 hrs.
- Assessment
  - Charpy impact
  - Bubbles
  - Degradation
Weathering – Indoor Applications (2017)

- Filtered Xenon Arc
  - Lower irradiance
  - 3000 hrs..
- Assessment
  - Same as exterior
- Qualifications
  - Passing exterior qualifies indoor
  - Thin qualifies thicker
  - Clear qualifies colored

Mirror
- Full size panels
- Cyclic heat and humidity
- Impact after exposure

Weathering – Inserts

- Thinnest construction desired for qualification
- Inserts
  - Weathering
    - Encapsulated insert
    - Interlayer complies with weathering
    - Minimum thickness per ply as tested
  - Impact test required
Interpretation of Results

- Performance broken into Types
  - Type 1 – Fragments contained
  - Type 2 – Break safe
  - Type 3 – “Plastic” type break
  - Type 4 – No Break

Interpretation of Results

- Type 1
  - No passage of 76mm diameter sphere with horizontally applied force of 18 N
  - Detached particles up to 3 min after impact
    - In total weigh no more than a mass equivalent to 10,000 mm² of the original test specimen
    - Single largest particle shall weigh less than a mass equivalent to 4,400 mm² of the original test specimen.
    - Detached individual particles less than the mass equivalent of 650 mm² shall be excluded from the fragment analysis.
Interpretation of Results

- **Type 2**
  - The 10 largest crack-free particles
  - Selected within 5 minutes after impact
  - Weigh no more than the equivalent weight of 6,452mm² of the original specimen.

- **Type 3**
  - The stiffness and hardness of the specimen shall be determined.
  - A modulus of elasticity (see ASTM D790) less than 3.9 GPa
  - Rockwell hardness (see ASTM D785) less than M or R 140 shall indicate satisfactory compliance.
Interpretation of Results

- **Type 4**
  - Performed on tempered glass specimens
  - Specimens for testing shall previously have been tested via impact and, when impacted, no breakage has occurred.
  - Specimens temperature shall be between 18.3°C and 29.4°C prior to testing.

Removed content from M-90

- Discussion of dimensional tolerances except for impact and weathering specimen sizes.
- Glass thickness table
- No designation of clear or translucent (ASTM C1036, ASTM C1172)
- No flatness requirements (ASTM C1048)
- Wired Glass
- Preparation for Delivery
- Inspection
- Localized Warp and Overall Bow and Warpage
- Notes
- Dimensions and glass quality
- Sampling
- Tempered glass - description
- Strain Pattern - description
Summary

- Broader applicability or glazing types
- Impact test virtually unchanged
- Option in thermal tests based on product
- Glazing types for glass retention specification
- Impact classes changed from Cat to Class
- Weathering requirements included
- Specification details removed
- Reference standards and terminology added
- Harmonization with ANSI Z97.1-2015 achieved
- Safety Glazing standard significantly upgraded

Questions?

Thank you!

Julia Schimmelpenningh, 730 Worcester Street, Springfield, MA 01151
e-mail: jcschi@eastman.com