



Standards for Laminated Glass



Julia Schimmelpenningh Eastman | Saflex[®] NGA Laminating Technical Liaison MARK YOUR CALENDAR FOR THESE OTHER UPCOMING EVENTS

NGA Glass Conference: Long Beach Jan 24-26, 2022 | Long Beach, CA

BEC Conference Mar 27-29, 2022 | Nashville, TN

GPAD|Glass Processing Automation Days Mar 29-30, 2022 | Nashville, TN



glass.org

NGA Glass Conference™ Long Beach

Renaissance Long Beach Jan. 24-26, 2022 California





glass.org/nga-glass-conference-long-beach

Golf Scramble | Aquarium of the Pacific

Volunteer Celebration Dinner | 7th annual Fun Run



Frameless Shower Enclosures





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Design Guide

Join the effort for the new Frameless Shower Enclosures Installation Guide

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DG02-21

Bridging the Supply Chain -

Forging stronger bonds among glazing contractors, fabricators & suppliers with special programming on March 29



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ASTM Standards for Laminated Glass



Outline

- Objectives of standards
- "New" ASTM standards for laminated glass
- Summary
- Questions



Objectives of Standards

- Create needed documents for guidance
- Enable fair product comparisons/classifications
- Refine with market pace
- Update for clarification
- Facilitate Equality
 - Methods of test
 - Design methodology and calculations
 - Consumer/End user comparisons





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Why were they needed?

Where did they come from?

How will they be used?



DURABILITY & PROCESS





WEATHERING

ASTM¹ C1900 (2020)

Standard Practice for Weathering and Evaluation of Laminated Glass

- Scope: This practice is intended to cover procedures for the exposure of laminated glass materials to natural and accelerated weather.
- Testing Types
 - Accelerated (Xenon)
 - Method A: Outdoor No Spray
 - Method B: Outdoor Spray
 - Method C: Indoor
 - Natural Exposure (Sub-tropical)
- Time Duration: specified by AHJ

- Evaluation
 - Bubbles
 - Crazing
 - Delamination
 - Visible Light Transmittance Decrease
 - Yellowness increase
 - Haze increase
 - Color Change (Delta E)
- Typical Extended Testing (not in standard)
 - Adhesion
 - Moisture

¹ <u>www.ASTM.org</u> – 100 Barr Harbor Road, West Conshohocken, PA



ASTM C1900 - Natural

Outdoor/Indoor Applications

- Natural weathering in accordance with Practice D1435.
- All materials are exposed in an unbacked condition.
 - Specific conditions of use may require the glass material to also be evaluated with a suitable backing material
- External use products use a 26° North latitude, 45° angle of exposure, direct, facing South
 - Façade | storefront | window | door etc.
- Same exposure as External under 3 mm clear glass
 - Partitions | shower doors | fins | balustrades | furniture etc.
- Natural weathering for outdoor use qualifies products for indoor use without additional exposure or testing.





ASTM C1900 - Accelerated

Outdoor Applications

TABLE 1 Accelerated Weathering Exposure Conditions Method A—Outdoor Applications No Spray

Parameter	Description
Practice D2565 Cycle	Cycle 1
Black Panel Temperature	64 ± 2 °C (145 ± 4 °F)
Relative Humidity	50 ± 5 %
Spray Water	None
Irradiance ^A	0.35 ± 0.02 W/m² at 340 nm, or
	41.5 ± 2.5 W/m ² from 300 to 400 nm
Exposure Duration ^A	3000 h

^A Minimum acceptable levels of irradiance and duration are indicated and shall be recorded in the report section.

TABLE 2 Accelerated Weathering Exposure Conditions Method B—Outdoor Applications With Water Spray

Parameter	Description
Practice D2565 Cycle	Cycle 1
Black Panel Temperature	64 ± 2 °C (145 ± 4 °F)
Relative Humidity	50 ± 5 %
Spray Water	De-ionized
Irradiance ^A	0.35 ± 0.02 W/m ² at 340 nm, or
	41.5 ± 2.5 W/m ² from 300 to 400 nm
Exposure Duration ^A	3000 hours

^A Minimum acceptable levels of irradiance and duration are indicated and shall be recorded in the report section.

Indoor Applications

TABLE 3 Accelerated Weathering Exposure Conditions Method C—Indoor Product Use

Parameter	Description
Light Mode	Continuous
Black Panel Temperature	55 ± 2 °C (131 ± 4 °F)
Relative Humidity	55 ± 5 %
Spray Water	None
Irradiance ^A	0.3 ± 0.02 w/(m ² · nm) at 340 nm, or
	0.8 ± 0.05 w/(m ² · nm) at 420 nm, or
	$36.5 \pm 2.5 \text{ w/m}^2$ between 300 and 400 nm
Exposure Duration	3000 h

^A Minimum acceptable levels of irradiance indicated. Higher irradiance levels and longer duration are permitted. Levels and duration shall be recorded in the report section.

Accelerated instrument – ATLAS





- No change in irradiation for accelerated weathering from ANSI Z97.1
 - Method A Dry | Method B Spray
- Standardizes weathering and reporting
- New products have target performance criteria
- Compliant with SGCC requirements
- Increase requests for exposure data compliance
- Update reference to the standard in references and literature



PROCESS QUALITY – POST WEATHERING

ASTM¹ C1914 (2021)

Standard Test Method for Bake and Boil Testing of Laminated Glass

- SCOPE: The purpose of this test method is to measure quantitatively the laminate stability under controlled conditions, specifically in relation to the formation of bubbles in a laminate with heat exposure
- Performed on laminates exposed to weathering or as manufactured samples

¹ www.ASTM.org – 100 Barr Harbor Road, West Conshohocken, PA



ASTM C1914 – Test specifics

- Visual rating of tested specimens which have been engulfed in heat
- Predetermined amount of time Temperature 100 °C (212 °F)
 - Boil 2 hr.
 - Bake 16 hr.
- Determines the stability of laminated glass when subjected to high heat environments.
 - Determine the amount of excess air dissolved in the interlayer
 - Indicates high moisture content
 - Indicates volatiles formation with exposure
- Does not provide an indication of laminated glass capability for impact resistance, glass shard retention on breakage or edge stability



ASTM C1914 – Test specifics

- Typical specimen size is 300 × 300 mm (12 × 12 inch)
- Specimen minimum size is 152 × 152 mm (6 × 6 inch)
- 3 specimens (min) per sample set
- Defects measured from edge or cracks
 - Disregard outer edge/around cracks
 - Record Number and location of any bubbles







- No change in requirements vs. ANSI Z97.1
- Standardizes processing check for QC
- New products have target performance criteria
- ISO 12543 Part 4 Deviates!
- Compliant with SGCC requirements
- Increase requests for production certifications
- Update reference to standard in references and literature



PROCESS QUALITY - ADHESION

ASTM1 C1908 (2021)

Standard Test Method for Pummel Adhesion Testing of Two-ply Laminated Architectural Glass

- Scope: This test method determines the relative strength of the adhesive bond between interlayer and glass, inks, coatings, frit or other materials adhered to the glass surface to which interlayers may bond (hereinafter, glass substrate).
- To be used on laminated architectural glass with two layers of glass substrate bonded by an interlayer.
 - Decorated | undecorated
 - Coated |uncoated
 - Annealed | strengthened
 - Flat | patterned
- One or more of the surfaces of glass may have a surface with ink, coatings, frit, patterns, a low-e type coating etc.
- Qualitative test which covers manual and semi-automatic mechanical pummel testing and
- Visual rating of tested specimens

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Procedure

- Rapid systematic and progressive striking
- Expose the interlayer
- Energy is necessary to separate laminates at interface
- Strike face of hammer impact flat
- Determine a ratio of exposed interlayer.
 - The less interlayer visible after pummeling, the higher the adhesion of the interlayer to the surface it was in contact with



Significance and Use of Pummel

- Pummel adhesion used to measure the relative adhesive bond strength
- Adhesion has a great effect on the impact resistance of laminates as well as long term stability
- Three levels of grading
- Bond strength in most applications must be controlled to avoid potential problems of delamination at low adhesion and impact failures of undesirable post breakage characteristics at high adhesion



Safety

- General safety when conducting tests on laminated glass:
 - Heavy cut resistant gloves
 - Safety glasses, goggles or face shield
 - Ear plugs or ear protection during the pummel test





Specimens & Calibration

- Pummel hammer: 0.45 kg (1 lb.) ball peen hammer
- Specimens: min 76 mm (3 in.) wide; 2/set
- Calibration:
 - Deform split shot
 - Manual & Semi-auto
 - Min delta 3 mm (0.125 in.)
 - 3 split shots
 - 0.10 mm (0.004 in.) deviation in set





Conditioning Specimens

- Duration not specified (Guidance provided 4 6 h)
- Air movement in cabinet suggested
- Sufficient space between samples
- Temperature Options
 - Frozen (-18 °C | 0 °F)
 - Room Temp (22 °C | 72 °F)
 - Alternate (X °C | X °F)





Pummel Test

After conditioning pummel samples

- Remove from freezer and begin immediate pummeling
- Hold laminate at about a 5° angle to the plane of the pummel plate
- Turn the laminate over and pummel the opposite side only enough to ensure all smooth glass is pulverized
- Entire procedure < 1 min; begin pummel within seconds of removing from conditioning environment





Pummeling

- Systematic
- Strike not intentionally angled
- Strike progressively along the bottom
- Systematically progress into the body of the specimen until at least 7-10 cm (3 – 4 inches)has been pummeled
- Adjust strike index per adhesion
- Ensure all smooth glass is pulverized.
- If length allows pummel opposite face on opposite end
- Strengthened and glass thicker than 6 mm increased force noted





Rating

- Recondition samples to room temperature (~ 2- 6 hrs.)
- Use ASTM pictures or physical standards
- Pummeled sample on cardboard backing
- Tilt sample to see reflection of exposed interlayer
- Rate both sides
- If adhesion is between two ratings lower rating is assigned
- Note non-uniform adhesion (not assoc. with pre-existing crack)
- 3 levels only: Low, Medium and High with 2 references



ASTM C1908 Rating: ZERO (reference)

Nearly 100% glass-free interlayer showing







Rating: LOW

Greater than 80% glass-free interlayer showing Designated: L-PU





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Rating: MEDIUM

20% - 80% glass-free interlayer showing Evenly dispersed glass and interlayer throughout pummeled area Designated: M-PU





Rating: HIGH

- Less than 20% glass-free interlayer showing
- Designated: H-PU





Rating: NONE (reference)

Over-pummeled Specimen dismissed





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Pummel Video(s)

• Manual



• Semi-Automatic





Interpretation of Results

- Minimum 2 specimens 4 ratings/sample set
- If greater than 50% of sample set are classified the same assign higher level
- If even split assign lower level
- Sets with 3 or more abnormal areas (not associated with a crack) specify in report
- Over-pummeled samples are not rated
- Skilled pummelers and raters typically will deviate ± 1 PU





- Industry and downstream specification of levels
 - Application needs | un-informed specification
- Compliance documentation & testing
 - Coupon | batch | frequency
- Requests for pummel standards (physical | pictures)
- Evolution of systems & digital rating (not currently available)
- Reference to ASTM levels in laboratory evaluations
 - Training and capability



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- Objectives of standards
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- Laminated glass base standards
- "New" ASTM standards for laminated glass
 - Why were they needed?
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Existing ASTM Standards for LAG

Structural

Strength | Redundancy | Post breakage



Comfort | Well-being | Conduciveness



Protection | Deterrence



Comfort | Protection | Performance

Impact | Penetration resistance



Sustainability

Circularity | Recycle | Carbon



Summary

- Laminated glass specifications increase standards keep pace
- Requirements for quality information on laminated glass increase
- Processes developing to providing compliance documentation
- Basic ASTM C1172 Specification Blemish | Bow | Tolerances etc.
- Boil (& Bake) ASTM C1914 Deairing quality durability indicator
- Weathering ASTM C1900 Durability polymer degradation indicator
- Pummel Adhesion ASTM C1908
 - Glass shard containment | Durability | Product Specification
- Several additional documents are "incubating" in NGA and ASTM International!



What else is needed?





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Standards for Laminated Glass QUESTIONS?

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