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NHTSA

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Status of NHTSA's Glazing Evaluation Tests

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Presentation Outline

1. Background and Objectives
2. Test Development
    - Test equipment
    - Test methods
3. Current Status and Updates
    - Results
        - Rear quarter (RQ) 10 ft ball drop
        - Rear quarter 8 ft shot bag drops
4. Next Steps

Background

- Federal Motor Vehicle Safety Standard (FMVSS) No. 205, “Glazing Materials,” uses impact test methods specified in the American National Standard for Safety Glazing Materials, ANSI/SAE Z26.1-1996
  - Section 5.6: Impact Test 6 (227 gram Ball), 3.05 m [10 ft])
  - Section 5.7: Fracture, Test 7
  - Section 5.8: Impact, Test 8 (5 kg Shot Bag)
  - Section 5.9: Impact, Test 9 (198 gram Dart Drop, 9.14 m [30 ft])
  - Section 5.12: Impact, Test 12 (227 gram Ball Drop, 9.14 m [30 ft])

- United Nations (UN) Economic Commission for Europe (ECE) Regulation (R) 43 “Uniform provisions concerning the approval of safety glazing materials and their installation on vehicles”
  - Fragmentation test (Annex 5, S2)
  - Laminated (windshield) hot/cold tests
  - Other related sections referenced, but not primarily used for tests

Objectives

- Evaluate various test situations including situations for comparison with GTR
  - Evaluate shot bag with stiffer sidewalls
  - Examine altered fracture test for tempered glazing with one impact point vs two
  - Compare results from laminated glazing impacted by 227 gram ball drop (30 ft) and 198 gram dart (30 ft and 34.393 ft)
  - Evaluate and compare different impact heights
- Learn about potential changes to tempered glass strength due to ceramic painted area (CPA)
- Evaluate differences in ANSI 12” x 12” flat pieces and production parts

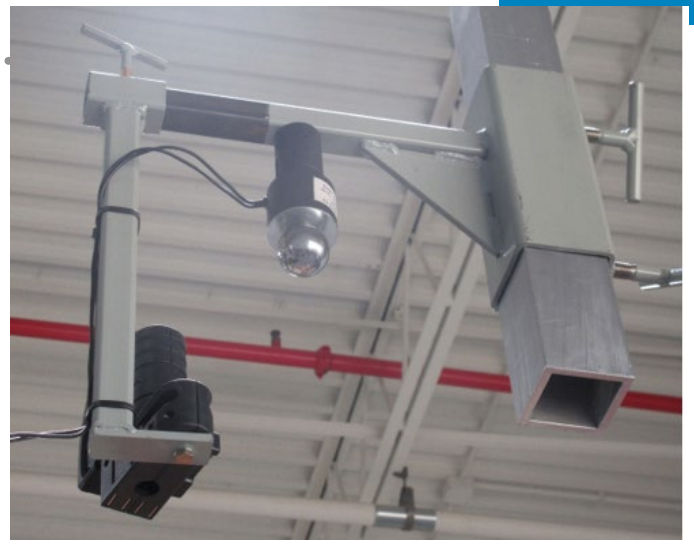
Summary of All Planned Tests

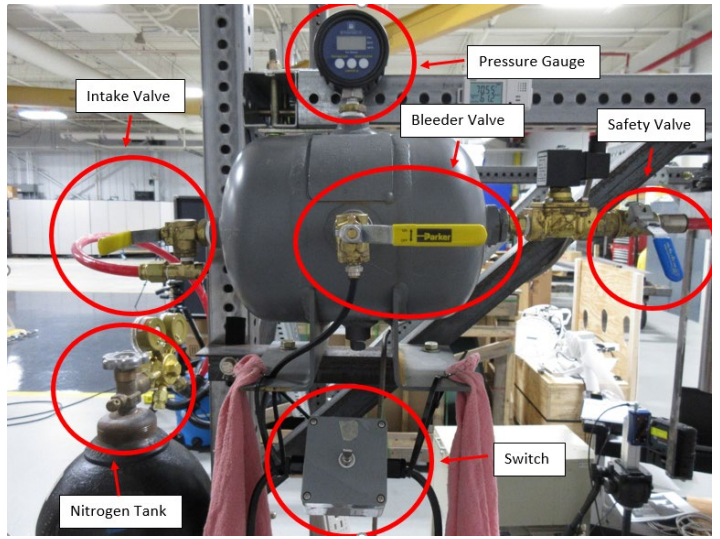
Glazing	Test Type		Height	# of Locations
Rear Quarter (RQ)	ball	sample	10ft	4
			6.6ft	4
			10ft +	4
		production	10ft	4
			6.6ft	4
			10ft +	4
	shot bag (ANSI)	sample	8ft	3
			9ft +	3
		production	8ft	6
	shot bag (modified)	sample	8ft	3
			9ft +	3
		production	8ft	6
	fracture	production	ANSI	center
			NPRM	center, edge
Windshield (WS)	dart	sample	30ft	3
			31ft +	2
		production	30ft	3
			31ft +	2
	ball	sample	30ft	3
			31ft +	2
		production	30ft	3
			31ft +	2
		sample (cold)	27.89ft	3
			30ft +	2
		sample (hot)	29.53ft	3
			30ft +	2
Sunroof (SR)	ball	sample	10ft	4
			6.6ft	4
			10ft +	4
		production	10ft	4
			6.6ft	4
			10ft +	4
	shot bag (ANSI)	sample	8ft	3
			9ft +	3
		production	8ft	6
	shot bag (modified)	sample	8ft	3
			9ft +	3
		production	8ft	6
	fracture	production	ANSI	center
			NPRM	center, edge
Backlight (BL)	ball	sample	10ft	4
			6.6ft	4
			10ft +	4
		production	10ft	4
			6.6ft	4
			10ft +	4
	shot bag (ANSI)	sample	8ft	3
			9ft +	3
		production	8ft	6
	shot bag (modified)	sample	8ft	3
			9ft +	3
		production	8ft	6
	fracture	production	ANSI	center
			NPRM	center, edge

"+" means greater than ANSI drop height

Test Equipment

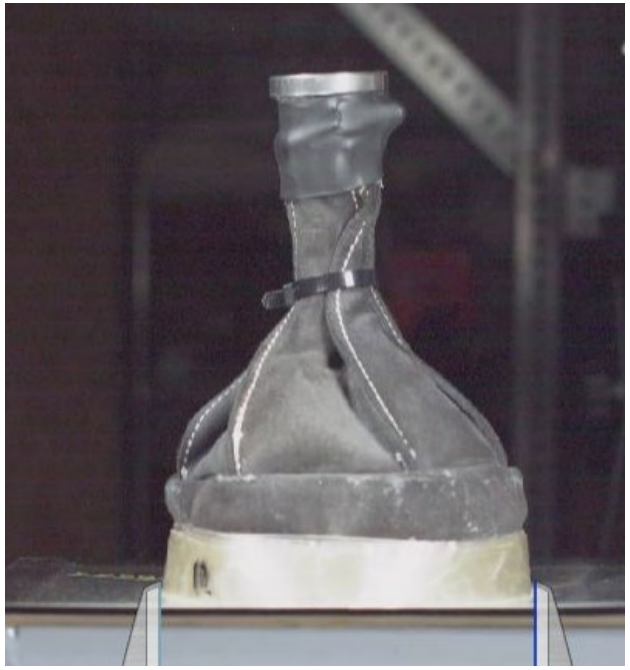
- Drop tower
  - Electromagnet on adjustable collar
    - Connected to switch to trigger release and camera capture
  - Laser sight for targeting
- Pneumatic gun
  - 30 ft height not available at VRTC, therefore a pneumatic gun was fabricated to induce speeds equivalent to a 30 ft drop
  - Two barrels created – one for ball tests, one for dart tests
  - Pressure supplied by nitrogen
  - Speed to be measured using light trap placed between gun and glass
  - Still in development





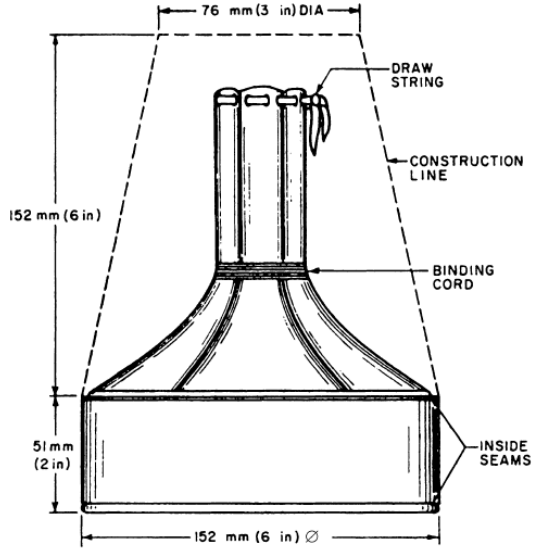
Drop Items

- 227 gram ball
- 5 kg shot bag
  - ANSI Z26.1-1996 specified bag
  - Modified bag (stiffened sidewalls)
- 198 gram dart (still under evaluation for use with gun fixture only)



Modified Shot Bag Method

- Modified method
  - Strapping tape – thin tape with reinforcement filaments that run lengthwise through tape
  - Wrapped to make bag diameter 6 inches (ANSI specification is 6 inches)
  - Put max amount of tape layers allowable to stay below weight tolerance – 12 layers
- Weight: 5.016 kg
  - Within weight tolerance
- Observations of bag:
  - Tape wraps around bottom but does not stick to bottom
  - Holds shape
- Monitored shape of bag and how tape was holding up throughout testing



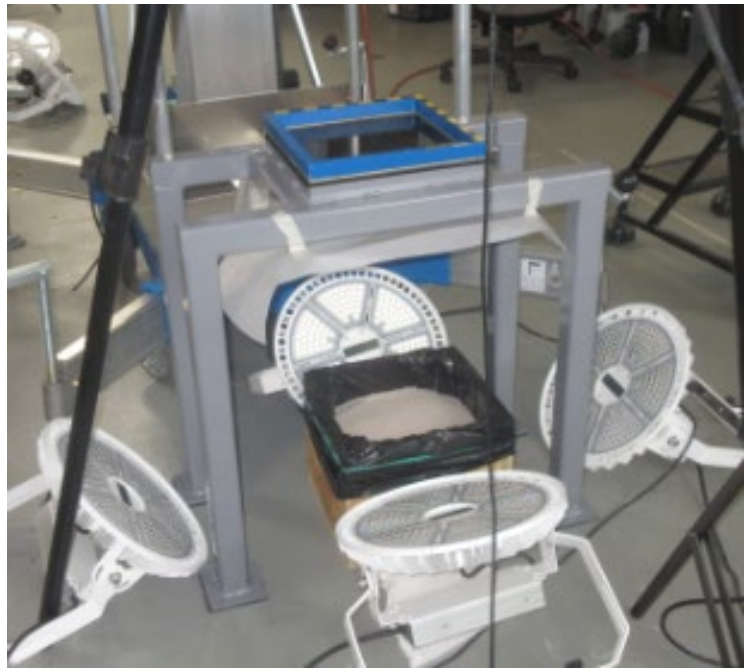
NOTE: Bag to be made of 0.79 mm (1/32 in) thick flexible leather. Use lead shot, BB size (4.57 mm in diameter). Total weight of bag and shot to be 4.961 to 5.018 kg (11 lb ± 1 oz).

Figure 2

5 kg (11 lb) Shot-Bag Safety Glazing Material Tests

Sample Holding Frame

- Sample box (specified in ANSI Z26.1-1996) was not able to allow video collection so new frame was created.
- New frame used same top frame and had same contact surface dimensions on bottom frame
  - Raised from floor to allow lighting underneath



Production Holding Frames

Base Fixture

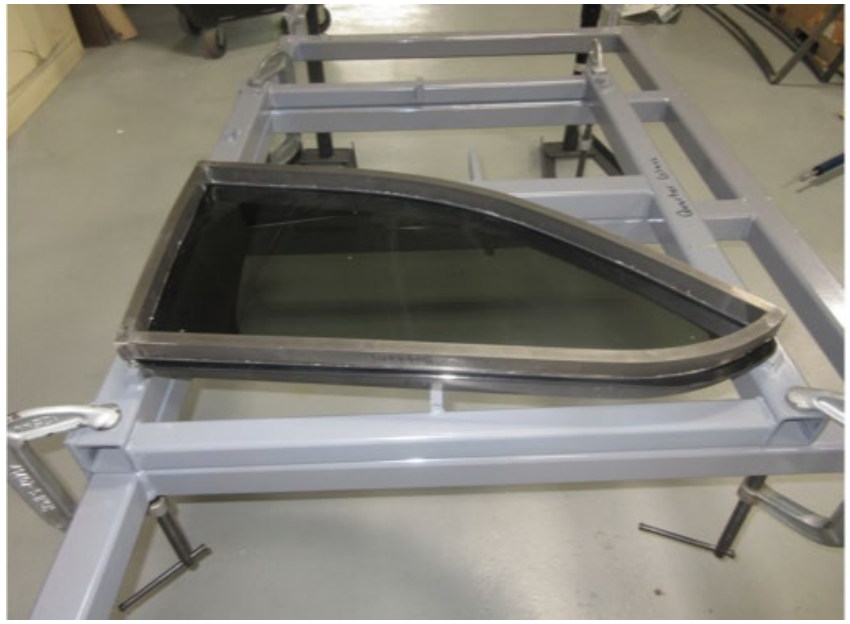
Rear Quarter Frame Fixture

Rear Quarter Frame

FINAL SETUP:

1. Base Fixture
2. Rear Quarter Frame Fixture
3. Rear Quarter Frame (bottom)
4. Glass
5. Rear Quarter Frame (top)

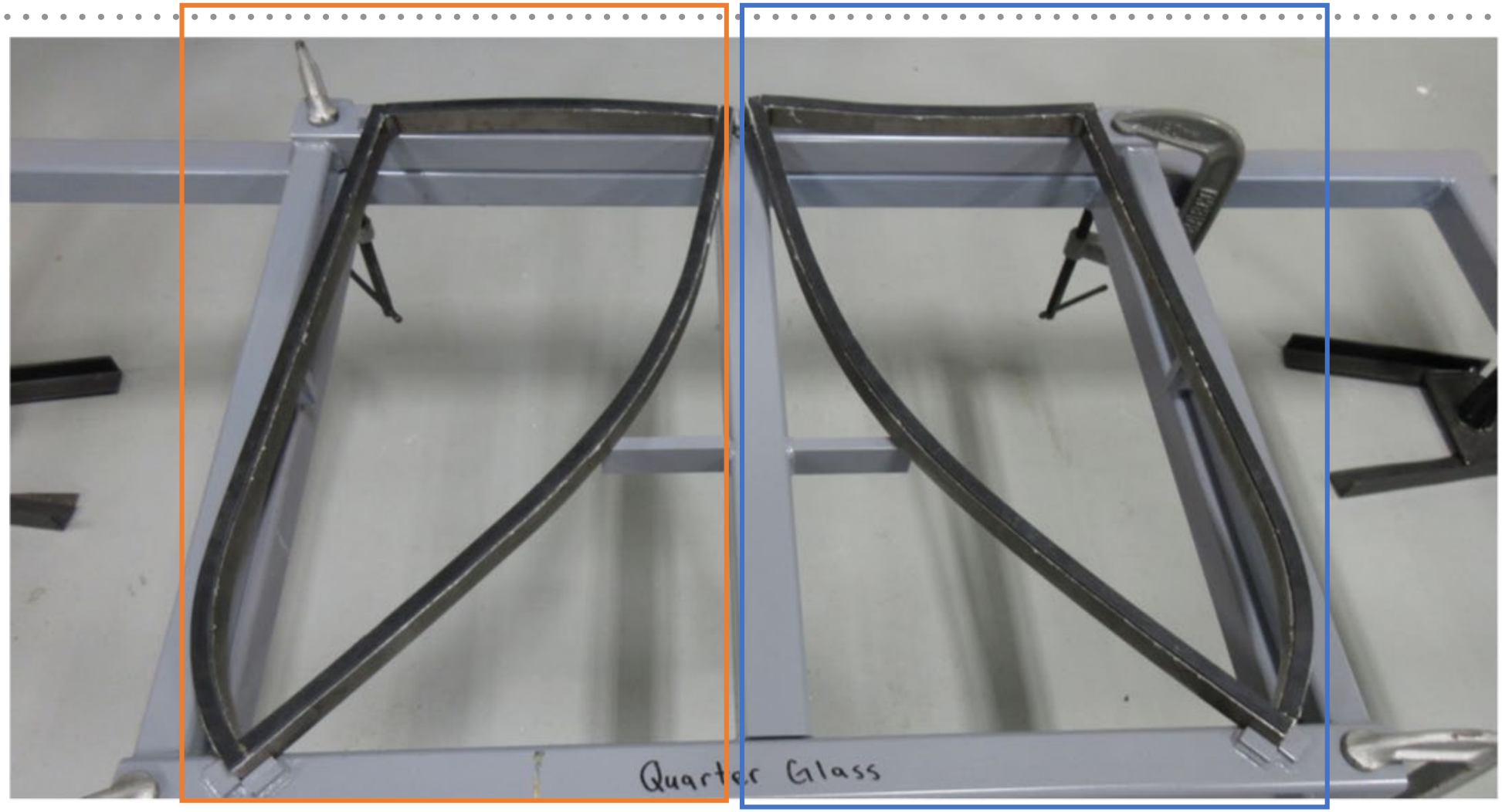
*Frames also created for Sunroof, Windshield and Backlight glass



Screws to attach Rear Quarter Frame to Frame Fixture

Exterior Impact Side

Interior Impact Side

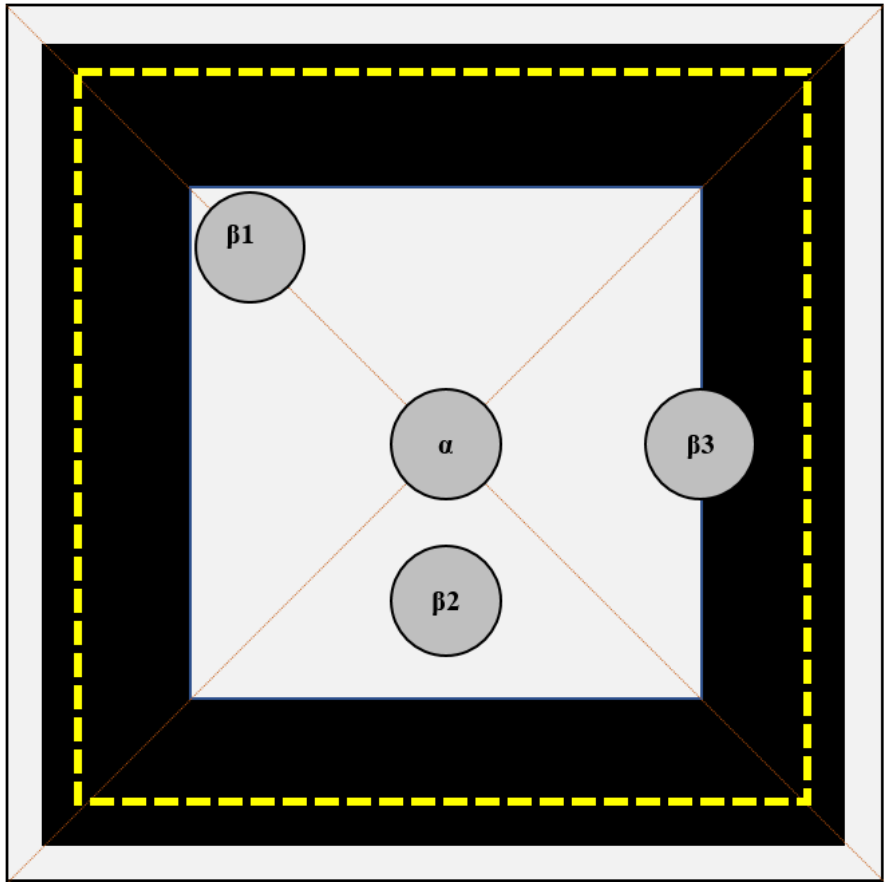


Depending on the type of test to be run (ball vs shot bag) the glass will be oriented to either impact the exterior or interior surface. The opposite side frame will be used as the top frame for the test

Impact Locations – 12” Sample

Rear Quarter - Ball

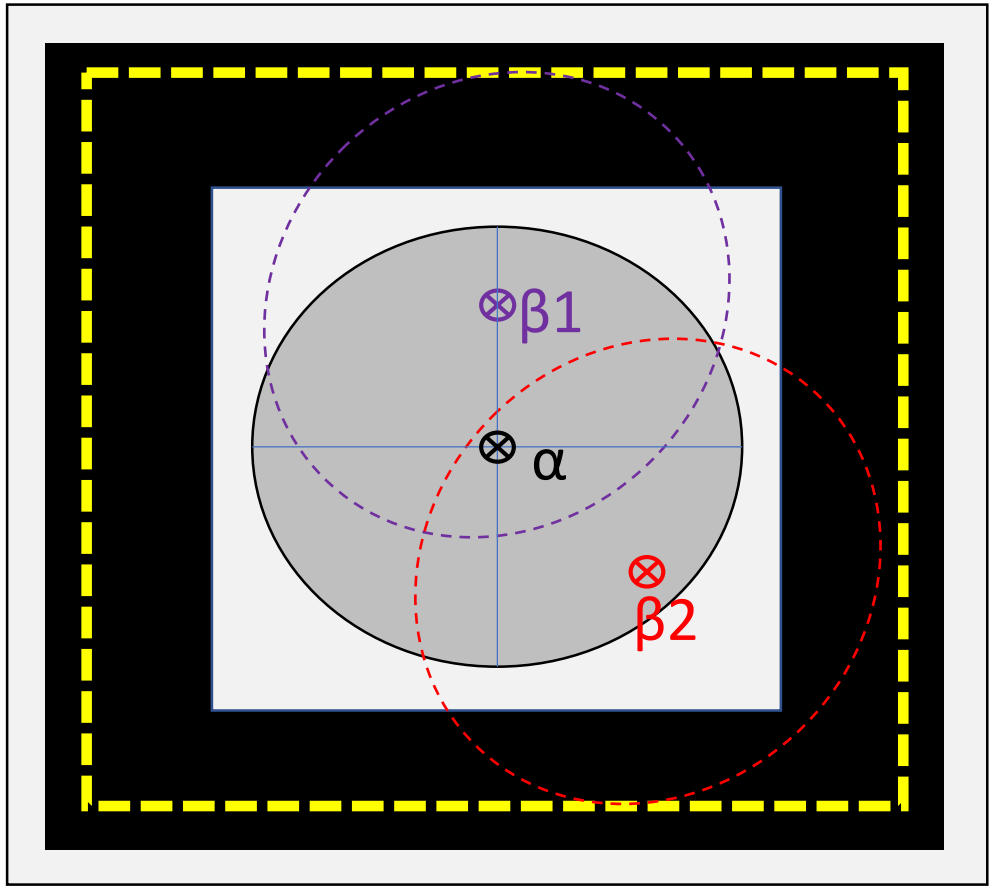
Exterior Surface



a: ANSI Z26.1 impact point
b1: sphere’s shadow tangent to both paint edges at a clear glass corner
b2: sphere shadow one sphere radius from CPA edge, midpoint glass width
B3: sphere impact point on CPA to clear class transition edge, midpoint glass

Rear Quarter – Shot Bag

Interior Surface

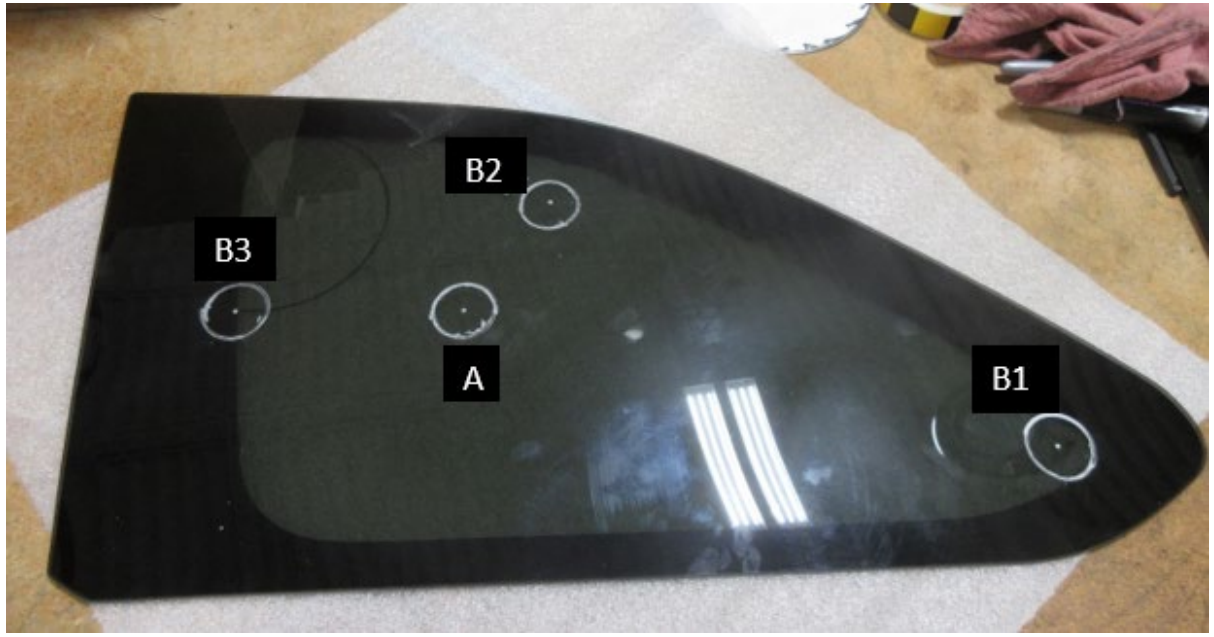


a: ANSI Z26.1 impact point
b1: bag’s outer diameter tangent to mid-point of fixture inner support edge
b2: bag’s outer diameter tangent to two of fixture inner support edges

Impact Locations – RQ Production

Rear Quarter - Ball

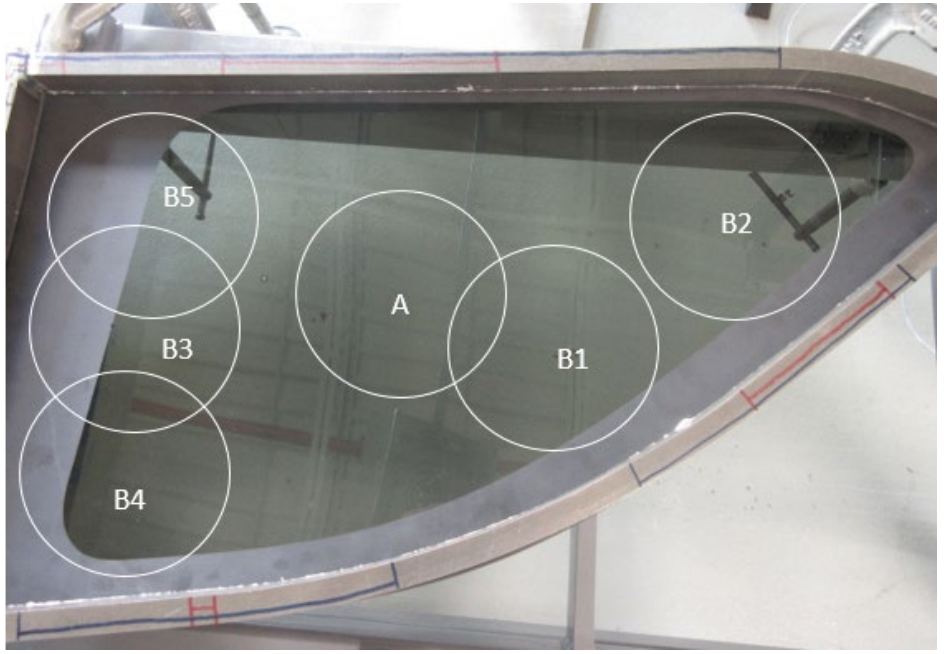
Exterior Surface



A: uniformly tempered portion
B1: corner of panel, strength transition zone of CPA to uniformly tempered, sphere shadow on CPA edge(s)
B2: sphere radius from CPA edge, mid-width of panel.
B3: impact point on CPA edge, mid-width of panel

Rear Quarter – Shot Bag

Interior Surface



A: center of fully tempered portion
B1: edge near CPA to tempered transition zone
B2: corner of panel, bag diameter to frame edge
B3: edge of CPA, mid-width of panel
B4: corner of panel, bag diameter to frame edge
B5: corner of panel, bag diameter to frame edge

Perpendicular Impact Procedure

1. Mark glass with impact point
2. Turn on laser on tower and line up with center of electromagnet
3. Adjust glass so that impact point roughly lines up with impact point
   - Make sure top and bottom frames are directly on top of each other
4. Place the bubble level on the impact location and turn the cranks on the base fixture so that bubble level is close to being at level
5. Using the reflectance board shine the laser from the tower down through the hole in the board and observe the reflectance
6. Adjust the cranks on the base as needed to get the reflectance dot within the first 2 circles on the reflectance board
   - Reflectance should be inside red circle (2” radius) (~3 degrees) but ideally within inner 2 circles (1” radius) (~1.25 degrees)
7. Clamp all the holding fixtures down
8. Adjust the height of the tower by using the laser measurer placed on the impact point

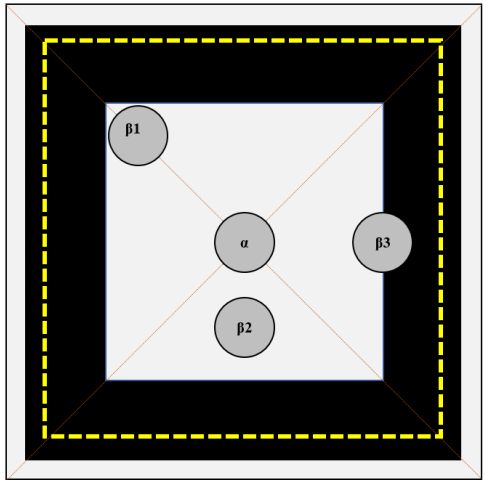
Concentric circles are increasing ½ inch radius

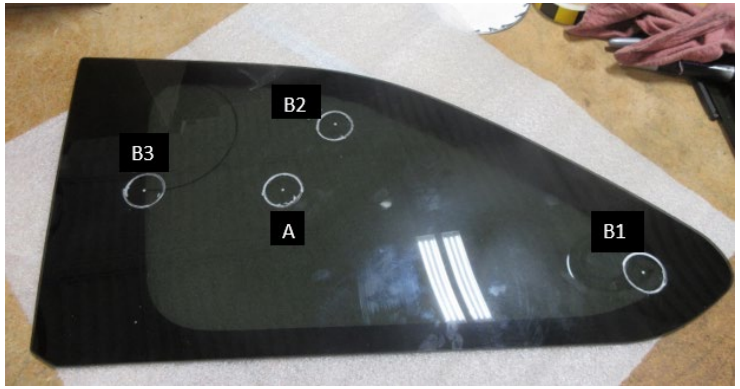
Results

Rear quarter glass – 227 gram ball and shot bag results

227 gram Ball Results

- 10 ft drop height
- Breaks on painted glass at location B3 (edge of CPA) for both sample and production glass
  - No breaks at same location on unpainted glass





Rear Quarter - ball drop							
Height: 10 ft							
Sample				Production			
Location	trial	Paint	No Paint	Location	trial	Paint	No Paint
a	1	x	x	A	1	x	x
	2	x	x		2	x	x
	3	x	x		3	x	x
	4	x	x	B1	1	x	x
	5	x	x		2	x	x
	6	x	x		3	x	x
b1	1	x	x	B2	1	x	x
	2	x	x		2	x	x
b2	1	x	x		3	x	x
	2	x	x	B3	1	x	x
	3	x	-		2	x	x
b3	1	x	x		3	x	x
	2	x	x				

x	Tested
x	full break

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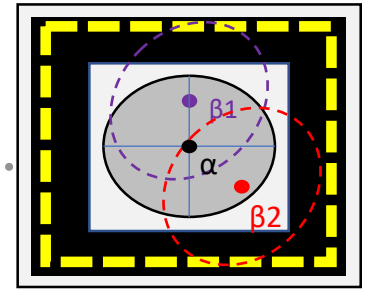
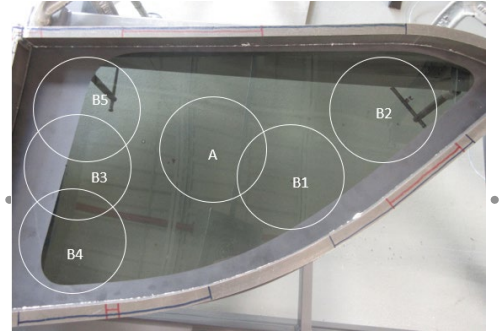
- Video recorded at 200,000 frames per second
- Tempered 12” sample - Painted - Exterior surface
- 10 ft drop - Position b3

Still image of fracture – fracture can be seen moving outward from initiation point

Shot Bag





x	Tested
x	full break

Rear Quarter - shot bag							
Height: 8 ft							
Sample				Production			
Location	trial	Paint	No Paint	Location	trial	Paint	No Paint
a	1	x	x	A	1	x	x
	2	x	x		2	x	x
b1	1	x	x		3	x	x
	2	x	x	B1	1	x	x
b2	1	x	x		2	x	x
					3	x	x
				B2	1	x	x
					2	x	x
					3	x	x
				B3	1	x	x
					2	x	x
					3	x	x

Rear Quarter - modified shot bag							
Height: 8 ft							
Sample				Production			
Location	trial	Paint	No Paint	Location	trial	Paint	No Paint
a	1	x	x	A	1	x	x
	2	x	x		2	x	x
	3	x			3	x	x
b1	1	x	x	B1	1	x	x
	2	x	x		2	x	x
b2	1	x	x		3	x	x
				B2	1	x	x
					2	x	x
					3	x	x
				B3	1	x	x
					2	x	x
					3	x	x
				B4	1	x	x
					2	x	x
					3	x	x
					4	x	x
				B5	1	x	x
					2	x	x
					3	x	x
					4	x	x

- All breaks occurred on painted glass, no breaks on unpainted
- Breaks occurred at production B2 (corner) for both ASB and MSB
- MSB had additional breaks at sample b1 (transition zone) and production B1 (transition zone)

Shot Bag Videos

- Left: ANSI shot bag
- Right: modified shot bag

- Compare performance of bags
- Observe wave patterns of glazing

Shot Bag Videos

Still image: Crack initiation can be estimated using the video.

Status and Next Steps

- Ongoing research
  - Fracture test
  - Additional glass types and tests with drop tower
    - Glass: sunroof and backlight
    - Additional heights to be evaluated with ball

- 30 ft drops development (pneumatic gun) and testing
  - Glass: windshield
  - Hot (40° C [104° F]) and cold tests (-20° C [-4° F])

Thank you for your attention
Questions?

Contact Information:

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