



Automotive Safety Glazings

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This specification contains the product, property and performance requirements for GM Automotive glazings. It supersedes all GM regional glazing standards.

1.1.1 International GM glazings must meet the requirements of regional legal standards where applicable as listed here, but not limited to:

- Republic Of China - GB 9656
- Europe – UN ECE R43, GTR 6
- North America – Federal Motor Vehicle Safety Standards (FMVSS) 205/Canadian Motor Vehicle Safety Standards (CMVSS) 205
- Brazil – Inmetro 156 and Inmetro 157

1.1.2 Typical Applications. Typical applications include all vehicle front, side, roof and rear glass and sunroof glazing. Other automotive glass for mirrors, bulbs, lenses, etc., do not fall within the realm of this specification.

1.2 Applicability. This document is applicable to all GM automotive glazing for the following types, subclasses and classes.

1.2.1 Glazing Types and Subclasses.

1.2.1.1 Type 1: Clear Safety Glazing. Clear safety glazing has no added tints. This Type of glass is not recommended for use, except in non-air conditioned vehicles in emerging markets.

1.2.1.2 Type 2: Tinted Safety Glazing. Tinted safety glazing is any color other than clear and generally has specified physical properties, such as reduced light transmittance or increased absorption of solar energy. Tinted glazing is available for all classes of glazing.

1.2.1.3 Type 3: Privacy Glazing. All classes of glazing with or without a vacuum deposited or fired-on metallic reflective film. Visible light transmittance is below the 70% FMVSS requirement (see Transmission chart in 3.2.1.1). These windows are only allowed in certain areas as defined by legal standards. Privacy glazing is available in a Green Family and a Gray Family. When sourcing a vehicle, all privacy glazing for a vehicle must be from the same family. Privacy is divided into 4 subclasses as defined by maximum total visible light, TL.

1.2.1.3.1 Subclass I, < 40% TL.

1.2.1.3.2 Subclass II, < 20% TL.

1.2.1.3.3 Subclass III, < 10% TL.

1.2.1.3.4 Subclass IV, < 5% TL.

1.2.1.4 Type 4: Solar Control Glazing. This type of glazing is designed to absorb and/or reflect ultraviolet and infrared light while maintaining visible light requirements. The following describes the 2 subclasses.

1.2.1.4.1 Type 4: Subclass I, Absorbing Glazing. The absorbing characteristics of the glazing material result from the homogeneous composition of the material.

1.2.1.4.2 Type 4: Subclass II, Reflective Glazing. Reflective glazing (coated) is comprised of a clear or a tinted layer of glazing with a single or multilayer metallic reflective coating.

1.2.2 Classes.

1.2.2.1 Class A: Laminated Safety Glass. This glass consists of two layers of float glass which are held together by an interlayer of automotive grade plasticized polyvinyl butyral (PVB) sheeting. The sheeting material may be clear, tinted or shadeband colored.

1.2.2.2 Class B: Tempered Safety Glass. This glass consists of a single sheet of float glass subjected to a specific heat treatment or tempering process to produce safety characteristics. Due to internal stresses set up by the tempering process, any attempt to further cut, drill, or edge after treatment will cause fracture.

1.2.2.3 Class C: Glass-Plastic Safety Glazing. A laminate of one or more layers of glass and one or more layers of plastic in which a plastic surface of the glazing faces inward when the glazing is installed in a vehicle.

1.2.2.4 Class D: Plastic Safety Glazing. Glazing comprised of single or multiple layers of plastic materials, as specified on the engineering drawing.

1.2.2.5 Class E: Acoustic Windshield Glass. Annealed laminated glass with improved sound level attenuation for use in windshields. Class E glass is divided into the following categories:

- Class E-I: Homogenous Acoustic PVB
- Class E-II: Trilayer Acoustic PVB

See Appendix C (Table C1 and Table C2) for Acoustic Performance Specification of this product.

1.2.2.6 Class F Heat Strengthened Laminated Glass. This glass consists of two layers of heat strengthened float glass, which are held together by an intervening layer of automotive grade PVB sheeting. This glass is for use in openings other than windshields, typically for improving sound attenuation. Class F glazing is divided into the following categories:

1.2.2.6.1 Class F. Heat strengthened laminated glass, standard PVB.

1.2.2.6.2 Class F-I. Heat strengthened laminated glass, homogenous acoustic PVB.

1.2.2.6.3 Class F-II. Heat strengthened laminated glass, trilayer acoustic PVB.

1.2.2.6.4 Class F-III. Heat strengthened laminated glazing, Enhanced Technology Glass (ETG).

1.2.2.7 Class G Chemically Tempered Laminated Glass. This glass consists of two or more layers of chemically tempered glass, which are held together by an intervening layer of automotive grade PVB sheeting or automotive grade interlayer material. This glass is for use in fixed openings other than windshields. The typical use of this construction is for lightweight applications. Class G glazing is divided into the following categories:

1.2.2.7.1 Class G. Chemically tempered laminated glass, standard PVB.

1.2.2.7.2 Class G-I. Chemically tempered laminated glass, trilayer Acoustic PVB.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM C813-90	GTR 6	ISO 8510-2	UN ECE R 43
CMVSS 205	Inmetro 156	ISO 13837	USCAR40
DIN 52305	Inmetro 157	SAE J1113/26	VDA 280
FMVSS 205	ISO 4892-1	SAE J1545	
GB 9656	ISO 4892-2	SAE J2527	

2.2 GM Standards/Specifications.

GMW3041	GMW14173	GMW14865	GMW15959
GMW3043	GMW14264	GMW15016	GMW15960
GMW3059	GMW14333	GMW15443	GMW16005
GMW3091	GMW14334	GMW15648	GMW16016
GMW3286	GMW14618	GMW15650	GMW16500
GMW14124	GMW14650	GMW15671	GMW16598
GMW14172	GMW14729	GMW15730	GMW16956

2.3 Additional References.

- Best Practice FXGLASS-24 Glass Pre-Prime – Source Applied
- Best Practice FXGLASS-53 Heated Back Window Defogger Component Test
- Best Practice FXGLASS-69 Criteria for Holes in Glass
- Best Practice FXGLASS-73 Heated Back Window Power Requirements (Includes CG3707)

Note: The supplier shall work with the GM Design Release Engineer to comprehend all Fixed Glass Best Practice requirements.

- Electromagnetic Compatibility (EMC), EMC 26
- GM Document Drawing 15050265 – Monogram Drawing
- GM Document Drawing 25642821 – Edge Type Drawing

Note: These documents can be found in Unigraphics (UG) VIS Mockup, part of GM Teamcenter.

- GM Color Standard WA-8555, Black
- Service Technology Group (STG) Serviceability Guidelines
- Statement of Requirements (SOR)
- Wiper System Subsystem Technical Specifications (SSTS)

3 Requirements

3.1 General Requirements. All deviations to this specification require GM engineering approval and must be documented on the engineering drawing and/or in the Advanced Vehicle Development Process (AVDP).

3.1.1 Regulatory. Vehicle glazings are to be FMVSS, United Nations Economic Commission for Europe (UNECE), China Compulsory Certification (CCC), and Brazil Inmetro Certified. Glazings may require other regulatory certification(s) dependent upon manufacturing location and the market of sale.

3.1.2 Glass Manufacturers. The glass manufacturer must be capable of using computer-generated surface and optical calculation tools (math data) in order to proof the feasibility of the product.

3.1.3 Printed Glazing, Glass Blackout (Frit).

3.1.3.1 Appearance. No change in the appearance of the black printed frit is allowed when viewed from the inside or outside of the glass. There shall be no bleed-through of successive, multiple prints. Single or multiple prints and coats shall not show any changes in color. Any iridescence or opalescence in paint bands must be agreed to by GM Engineering.

3.1.3.1.1 Visual Evaluation. Incandescent "A", D65 daylight and F11 (TL84) fluorescent light sources shall be used for visual evaluation. The light intensity shall not exceed 900 Lux.

3.1.3.1.2 Color Change. Measure the L*, a* and b* color coordinates per SAE J1545 (CIELAB color space, 10° observer, metering orifice ≤ 10 mm, illuminant D65, specular component included). The maximum allowable deviation is $\Delta L^* \leq 1.6$ max, $\Delta a^* \leq 0.3$ max and $\Delta b^* \leq 0.6$. **Note:** Visual color change that is considered objectionable shall override the Δ measurement.

3.1.3.2 Black-out Color. Target: WA-8555 Black. The color of the glass blackout in comparison to the standard shall be viewed from the outside of the vehicle in full sun daylight.

3.1.3.3 Surface Roughness. The maximum surface roughness (R_a) of the paint band must be $\leq 1.5 \mu\text{m}$ (microns).

3.1.3.4 Coated Windows. Reflective coated glazings must have a homogeneous color and appearance over the complete area and shall not be iridescent when viewed from inside or outside. No corrosion, coating degradation or color/appearance change is permitted.

3.1.3.5 Heated Backlights. Conductive silkscreen patterns are normally used for defrost or defog. Silver printed elements must be printed on the tin side of the glass.

3.1.3.6 Antenna Windows. Antenna windows must meet all component drawing and math data requirements. Antenna performance must be evaluated using all production intent materials after the glazing is installed in the vehicle according to the subjective rating scale in GMW14264. The Heated back window and antenna grid shall be tested for vehicle level performance according to GMW15650 and GMW15648. Electromagnetic Compatibility (EMC) performance is tested according to SAE J1113/26 and GMW3091 Electrostatic Discharge (ESD).

3.1.3.7 Frit Performance, GMW15959. Glass with frit must meet the performance requirements of GMW15959, "Qualification of Blackout Coating (Frit) for Automotive Glazing".

3.1.3.8 Preprimed Glass. Preprimed parts must be supplied according to and meet the requirements of Best Practice FXGLASS-24 Glass Pre-Prime – Source Applied and GMW3041.

3.1.4 Infrared Reflective (IRR) Glass.

3.1.4.1 Corrosion. To avoid corrosion of the IRR coating, edge deletion or removal of the coating or polyethylene terephthalate (PET) film a deletion to the glass edge of 5.0 mm minimum is required. The appearance of the edge of this deletion shall be smooth and continuous. Unless otherwise specified on the drawing, the tolerance for the characteristic line is ± 3 mm maximum. The tolerance can only be used once per edge.

3.1.4.1.1 Edge Deletion. On windows with reflective coated PVB or PET film, a deletion to the glass edge of 5.0 mm minimum is required. The deleted edge shall have a smooth and continuous appearance.

3.1.4.1.2 Test Method. Windshields (WS) will be exposed as following:

- 288 h High Humidity Environment Test according to GMW14729, Option A or B
- 24 h at $+23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
- 144 h Salt Spray Fog Test according to GMW3286
- 24 h at $+23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$

The above conditions consists of 1 cycle. Each sample will be subjected to 3 cycles. After each cycle, the sample(s) will be visually assessed for corrosion at the edge zone.

3.1.4.1.3 Requirement. After two cycles, the sample(s) shall show no corrosion. After the third cycle, 0.5 mm maximum corrosion along the edge is permissible.

3.1.4.2 IRR Product Specific Deviations (PSD).

3.1.4.2.1 Test Fields.

- Area A according to UN ECE R 43
- Outside of Area A

3.1.4.2.2 Surface Shaped PSD.

- All PSD with a width ≥ 0.3 mm

3.1.4.2.3 Hairline Shaped PSD.

- All PSD with a width ≤ 0.3 mm and a length of $\geq 10 \times$ width

3.1.4.2.4 Requirements.

3.1.4.2.4.1 Surface Shaped PSD. In Area A, no more than one defect ≤ 0.7 mm is permissible. In the rest of the window, "Outside Area A", including the blackout, no more than two PSDs ≤ 0.7 mm are permissible. There must be a distance ≥ 500 mm between them. PSDs ≤ 0.3 mm are permitted if there are ≤ 5 per cm^2 .

3.1.4.2.4.2 Hairlines. In Area A, one single defect with an extension of ≤ 15 mm is permissible. In the area Outside Area A, two single defects ≤ 20 mm are permitted if there is a distance between them ≥ 500 mm.

3.1.4.2.4.3 Suction Cups. Suction cups are permissible if not visible on window glazing under conditions like fogging, frost, humidity, light relations.

3.1.4.2.4.4 Haze-Effects and Inconsistent Color. IRR-WS shall have a uniform appearance when looked at it from outside. Color differences, Haze-effects as well as Orange peel are not permitted from any viewing direction with light sources D65, A, and F11. The light force shall not exceed 900 lux.

3.1.4.2.4.4.1 Test Method. On 6 positions of the window, the color coordinates L^* , a^* and b^* according to VDA 280, part 6 will be measured in reflection. On each window the deviation $dL^* \leq 1.6$, $da^* \leq 0.3$ and $db^* \leq 0.6$ is allowed.

3.1.4.2.4.5 Visual Inspection. The supplier is responsible for 100% control of their product. For spot checks, final control at the car, the test conditions according to the following test method are valid.

3.1.4.2.4.5.1 Test Method. PSD of the coating are usually only recognizable in reflection (plan view). For testing IRR-windows and assessment of PSD, the following conditions are valid:

- The window shall be installed in vehicle position
- The observation distance shall be agreed to by the responsible GM Engineering Group

- Lighting system shall be diffused day light D65
- The background shall be dark gray to matte black
- There is a visual inspection time limit of 60 seconds for each glass position

3.1.5 Glass Trim, Encapsulation and Extrusions.

3.1.5.1 Visible Defects. Visible defects in the encapsulation or extrusion are not permitted. Visible defects include, but are not limited to, orange peel, wrinkles, scratches, sink marks, cracks, mismatches or changes in color or gloss level, gaps, or loss of adhesion.

Gating is not permitted on Class A surface. Any trimming operation must not affect Class A surface.

3.1.5.2 Adhesion. Parts bonded to glass shall not be detrimental to the performance of the glass. Trim on glass shall meet the following adhesion requirements based upon the trim application.

3.1.5.2.1 GMW15960, Performance Requirements of Primed and Bonded Glass Lace and Reveal Moldings, Non-Pressure Sensitive.

3.1.5.2.2 GMW15671, Performance Requirements of Bonded Exterior Trim, Pressure Sensitive.

3.1.5.2.3 GMW16005, Adhesion Requirements for Modular, Encapsulated Glass Assemblies.

3.1.5.3 Plastic Trim (GMW14650). Exterior plastic trim on glass shall meet the performance requirements of GMW14650.

3.2 Product Characteristics.

3.2.1 Light Transmission. See Tables E1 thru E8 in Appendix E.

3.2.2 Identification. An indelible monogram shall be easily visible from outside the vehicle. The exact location of the mark shall be shown in the component drawing or math data and shall appear as shown on the GM Document Drawing 15050265.

3.2.3 Dimensional Requirements. The edge finish of windows (laminated, heat strengthened laminated and tempered) must conform to GM Document drawing 25642821. The window glazing shall meet the requirements as defined in the math data and on component drawing for the following items:

- Glazing thickness
- Dimensional requirements

3.2.3.1 Component Dimensional Inspection. All glazing suppliers shall check the glazing on an approved gauge before shipping per the quality inspection plan. Compliance to the gauge must be confirmed for every shipment. The data collected from the quality inspection plan must be traceable and kept on record at the glazing supplier's location.

The inspection shall be done on a gauge with electronic detectors. Critical points will be identified by both GM and the glazing supplier and documented on the engineering drawing or in the math data. All glazings must conform to bilateral tolerancing supported on a standoff fixture. Contact the program Supplier Quality Assurance Engineer for agreement of the bending and final fixture.

3.2.3.2 Part to Tool Traceability. Each glass forming tool shall bear a unique identifying number that allows tracking of dimensional, stress, and field warranty information.

Each windshield shall be marked with the unique tool number from which it was produced. The marking on the windshield shall be located such that the marking is not visible once the part is installed in the vehicle. It shall remain on the part for its installed life. The mark should not be covered by the urethane bond, but may be covered by other components that can be removed or are removable during repair (i.e., foam support strips, etc.)

3.2.3.3 PVB Laminate. Unless otherwise specified on the engineering drawing, the thickness of the PVB laminate must be $\pm 10\%$ of its nominal design thickness (example 0.76 mm $\pm 10\%$) in the finished assembly. If a different PVB thickness is required, it must be specified on the glass component drawing. If the PVB includes a shade band, it must conform to FMVSS 205, GB9656, InMetro 156/157 and UN ECE R 43.

3.2.3.4 Glazing Thickness. Global nominal thicknesses values are in Table 1:

Table 1: Glazing Thickness

Tempered (mm)	Laminated Single Glass Plys (mm)
	0.7
	1.6 1.7
	1.8
2.85	2.0
3.15 (3.2 mm)	2.1
3.50	2.3 2.5
3.85 (4 mm)	2.6
4.85 (5 mm)	3.15
	3.85

Laminated windshield construction shall follow the Global Glass Strategy. Glass constructions to be used are as follows:

- 5.0 mm (2.1/0.8/2.1) Baseline construction
- 5.4 mm (2.3/0.8/2.3) Performance construction
- 4.8 mm Asymmetric (2.3/0.8/1.7) Lower Mass construction
- 4.5 mm Asymmetric (2.1/0.8/1.6) Lower Mass construction
- 3.6mm Asymmetric (2.1/0.8/0.7) Lower Mass construction SLG + Chemically tempered

Heat Strengthened Laminated glass shall follow the following construction:

- 5.0 mm (2.1/0.8/2.1)
- 4.8 mm (2.0/0.8/2.0)

Chemically Tempered glass shall follow the following construction:

- 2.2mm (0.7/0.8/0.7)

Thickness Tolerances:

- ± 0.1 mm for Monolithic Glasses (Tempered and single glass plys of Laminated)
- ± 0.28 mm for laminated construction

3.2.4 Visual Requirements. Upon delivery to the GM assembly center, the glazing components shall not have any visible defects, which may adversely affect the strength or appearance when installed in the vehicle.

Product specific deviations (PSD) are permitted in specific areas of the glazing, as defined in Appendix A, Table A1 and Table A2. Visible printing flaws are not permitted on conductive elements.

3.2.4.1 Viewing Conditions.

- View the subject window at installation position
- Unless otherwise specified, the observation distance shall be 1 to 4 meters
- Lighting system shall be diffuse daylight D65. The light intensity shall not exceed 900 lux
- The background shall be dark gray to matte black for grid boards. Projected patterns light to white surface
- There is a visual inspection time limit of 60 seconds for each glass position

3.2.4.2 Printing Flaws. The print must be even, without voids or holes. It must not be blurred or blotchy, and the edges must not be wavy or streaked. With multiple prints, there shall not be any bleed through of successive prints. Repairs, if needed, shall be done using the same material and process as the original printing and shall

not be visible on the finished part. For applications in which the printing is exposed to the environment, testing must also take place at the component level.

For exposed edges of glass, the frit or paint band material must not run or bleed onto, or otherwise become deposited on the edge grind.

3.2.4.2.1 Printing Flaws in Visible Areas. No flaws > 0.8 mm are permitted. A single flaw ≤ 0.3 mm is permitted in addition to those shown below.

Side windows and glass sunroofs may allow the following printing flaws:

- 1 flaw ≤ 0.8 mm
- 2 flaws ≤ 0.5 mm
- 3 flaws ≤ 0.4 mm

Windshields and rear windows may allow the following printing flaws:

- 2 flaws ≤ 0.8 mm
- 4 flaws ≤ 0.5 mm
- 6 flaws ≤ 0.4 mm

3.2.4.2.2 Printing Flaws in Areas Covered After Vehicle Assembly (Moldings, Encapsulations, Appliqués, etc.) No flaws > 5 mm are permitted. A single flaw ≤ 1 mm is permitted in addition to those shown below.

Side windows and glass sunroofs may allow the following printing flaws:

- 1 flaw ≤ 5.0 mm
- 2 flaws ≤ 3.5 mm
- 3 flaws ≤ 2.0 mm

Windshields and rear windows may allow the following printing flaws:

- 2 flaws ≤ 5.0 mm
- 4 flaws ≤ 3.5 mm
- 6 flaws ≤ 2.0 mm

3.2.4.3 Coating Flaws. For applications in which the coating will be exposed to the environment, testing must also take place at the component level. For coated glazing, no corrosion of the coating from the edges is permitted. No flaws are permitted in Zone A of coated windscreens. In all other windows and roofs, single flaws size ≤ 0.2 mm and:

No flaws are permitted in Zone A of coated windshields (see Appendix A for definition of Zone A). In all other glazings, flaw size of ≤ 0.2 mm and:

- 3 flaws ≤ 0.35 mm + 1 flaw ≤ 0.2 mm, or
- 2 flaws ≤ 0.35 mm + 2 flaws ≤ 0.2 mm, or
- 1 flaw ≤ 0.35 mm + 3 flaws ≤ 0.2 mm are permitted

Reflected color of coatings must meet the requirements of the Light Transmission Table 1.

3.2.4.4 Impressions and/or Surface Blemishes. The vehicle glazing components shall not have any visible defects that may influence the strength. Tool marks on glazing are only permissible if they are not visible after installation in the vehicle.

The window glazing shall not have any impressions and/or surface blemishes, even if these are only visible at special climatic and/or light conditions. Reflectance caused by quench or temper pattern must be evaluated per GMW14264 to an acceptable value of seven or better.

3.2.4.5 Edge Finish. The edge finish shall comply with the drawing requirements as listed on GM Drawing No. 25642821. The edge finish required for windshields shall be Type 4 "ground edge" construction or better per this drawing.

3.2.5 Glazing Chemical Resistance. GMW14333 and GMW14334. There shall be no objectionable degradation or surface discoloration when tested per fuel resistance, GMW14333 or fluid resistance, GMW14334.

3.2.6 Mechanical Strength and Stress. Visible defects that influence glazing strength are not permitted.

Window glazing manufactured from tempered or heat strengthened glass must be prestressed and free from any microcracks, surface defects, edge defects, or abrupt changes in stress profile/pattern which could impair either its optical properties or mechanical strength.

3.2.6.1 Stress in Laminated Windows, GMW16598. In order to protect the glass from mechanical forces, which may be imparted to it during handling and installation, laminated safety glass, must be manufactured with a defined stress system in an edge zone up to 20 mm wide. Edge compression stress in laminated glass shall be a minimum of 8 MPa (1160 psi). For edge compression stresses higher than 55.2 MPa (8000 psi), a comprehensive process control plan with scribe or sand paper abrasion testing (GMW16598) shall be approved by the GM Design Release Engineer (DRE) and Supplier Quality Engineer (SQE). The maximum tensile stress anywhere in the laminated glass shall be less than 7.0 MPa (1015 psi). Abrupt variations are not permitted in stress levels.

Measure the stress values with stress measurement equipment approved by GM.

For measuring the compressive stress of the laminated windows, cutouts of the enamel print may be permitted in such areas which are covered after installation.

3.2.7 Optical Requirements. All visual inspection of a glass shall be done with the glass in installation position. Machine inspection of glass shall be per machine setup parameters. Machine inspection shall use a filter setting of 4mm which correlates to UN ECE R 43 $\Delta x = 4 \text{ mm}$.

The draw lines on windshields and backlights must run vertically. If the curvature of the window requires a different draw line orientation, it must be agreed upon with GM Engineering and must be indicated on the component drawing. Side glazing shall have horizontal draw line orientation.

3.2.7.1 Windshield Distortion. The requirement for optical distortion shall be made in accordance with the procedures described in Regional Legal Documents, such as FMVSS 205, UN ECE R 43, CCC and Inmetro.

The optical distortion (local refractive power = D) shall not exceed the limits shown in Table 2 with Zones defined as follows: Zone A (UN ECE R 43 A18/test area A mirrored Left and Right + remainder between.), Zone B (UN ECE R 43 A18), Zone C is the remaining DLO, excluding a 15 mm zone inboard of the paint band.

Table 2: Windshield Distortion Limits

Zone	Dabsolute in mdpt	Rate of Change (ROC) in mdpt
A	≤ 75	≤ 100
B	≤ 110	≤ 125
C	≤ 150	≤ 150

mdpt = Millidiopter

3.2.7.1.1 Optical Drive Evaluation. Prior to a vehicle program launch, vehicle glass will be evaluated via a vehicle ride evaluation, per the Optical and Vision Evaluation procedure, GMW16500. At the successful conclusion of the ride, GM Engineering and Supplier Quality will sign an acceptably rated glass component to become the minimal acceptance limit for optical quality.

3.2.7.1.2 Zebra Test. Windshields shall show no distortion which could adversely affect the driver's field of view in the straight ahead position, or at angles up to 50° laterally. The test shall be carried out as follows:

1. A line shall be marked vertically on the centerline of the window glass to be tested.
2. A line shall be marked 15 mm inboard (into the Day Light Opening (DLO)) from the paint band.
3. A slide projector (per UN ECE R 43, Appendix 3, paragraph 9.2.1.2.1) shall be used to project a slide of a line pattern (reference Zebraraster slide, AZ per DIN 52305) on to a white screen at a distance of 8 m. The black lines are 12 mm wide when correctly focused.
4. The window is placed in a fixture such that the center of the window is at a distance of 4 m from the projector. The fixture shall be capable of being rotated about its vertical axis by up to $\pm 50^\circ$.

5. To perform the test, the glass component shall be inclined to the installation angle and for the test of the driver's field, rotated about the vertical axis to position 1. See Figure 1. Turn the glass component to position 2 for the test in the passenger field.
6. The projector, or the slide, is rotated until the lines of the projected pattern are parallel with the centerline previously marked on the window for each of these positions.
7. The following shall be observed during measurement: When correctly focused, black grid lines with sharp edges will appear on the screen. If the window causes distortion, the parallel black lines, when projected through the glass, will have variable widths and may show color variation. Color variation is to be considered a gray edge. The narrowest fully black line, excluding the gray edge, and the widest black line, including the gray edge, shall be measured.

3.2.7.1.2.1 Zebra Test Requirement. When tested in all positions (perpendicular to projection axis, +50° and -50° rotations):

1. All lines shall be continuous.
2. Within the zone from the paint band to the line 15 mm inboard of the paint band, the distortion of the black grid lines on the screen due to the windscreen shall not exceed ± 5 mm.
3. Within the remaining DLO, the distortion of the black grid lines on the screen due to the windscreen shall not exceed ± 3 mm. Within any square field of 25 cm², the difference between the maximum measured line width and the minimum measured line width shall be no greater than 4 mm. A distortion limit sample(s), agreed to by GM Product Engineering, GM Supplier Quality, and the Supplier, must be approved and maintained as a master limit sample.

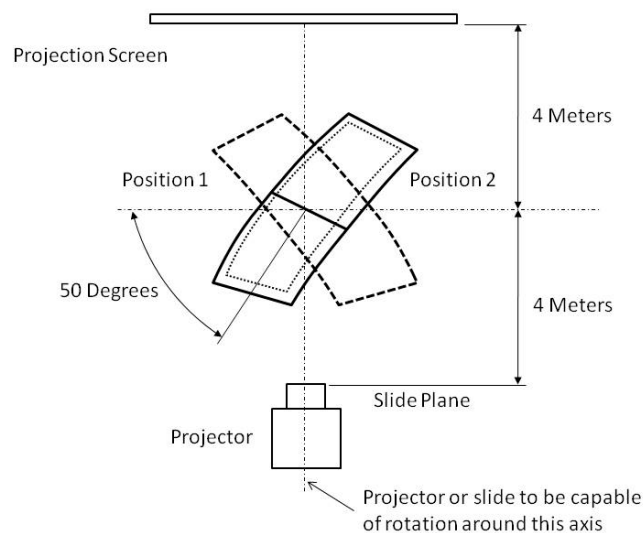


Figure 1: Plan View of the Test Setup

3.2.7.2 Side Glass Distortion. Side windows shall not show any distortion which could adversely affect the driver's field of view in the exterior mirror on either side of the vehicle. The test shall be carried out as follows. See Figure 2.

Lines shall be marked on the window glass to be tested, 25 mm from the periphery. The region from the edge of the glass to this line is considered an exclusion zone and is not subject to the distortion measurement. Additionally, the area beginning 25 mm below the belt line molding is not in the day light opening and is considered an exclusion zone. See Figure 3.

A slide projector (per UN ECE R 43, Optical Distortion Test) shall be used to project a line pattern (reference Zebraraster slide, per DIN 52305) on to a white screen, at a distance of 8 m. The Zebraraster slide is to be oriented to provide vertical black lines. The black lines are 12 mm wide when correctly focused.

The window is placed in its fixture parallel to the light rays, such that the center of the window is a distance of 4 m from the projector slide and the screen.

To perform the test, the window glass shall be inclined in the test fixture by 20° relative to a vertical line (creating a 20° inclination of the glass toward centerline of vehicle) and rotated about the vertical axis to a position relative to the light beam of 30°. Orientation of the part will place the inside surface of the glass closest to the projector.

The following shall be observed during measurement: When correctly focused, black grid lines with sharp edges will appear on the screen. If the window causes distortion, the parallel black lines, when projected through the glass, will have variable widths and may show color variation. Color variation is to be considered a gray edge. The narrowest fully black line, excluding the gray edge, and the widest black line, including the gray edge, shall be measured.

3.2.7.2.1 Requirements. All lines shall be continuous. The distortion of the black grid lines on the screen due to the window shall be ± 5 mm maximum. Within any square field of 25 cm², the difference between the maximum measured line width and the minimum measured line width shall be no greater than 8 mm. In test position, the window shall be moved vertically to the point at which the maximum line variation can be measured. Alternative: The window may be moved in the vertical axis to achieve the same result.

A distortion limit sample(s), agreed to by GM Product Engineering, GM Supplier Quality, and the Supplier, must be approved and maintained as a **master limit sample**.

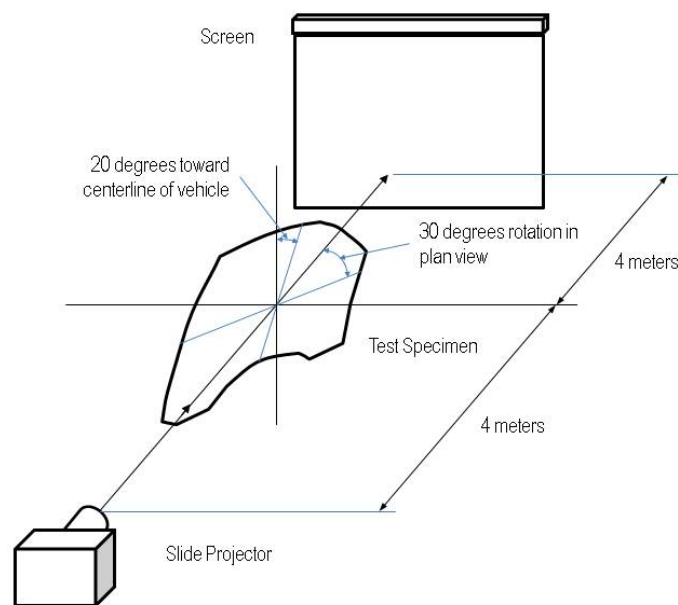


Figure 2: Test Setup

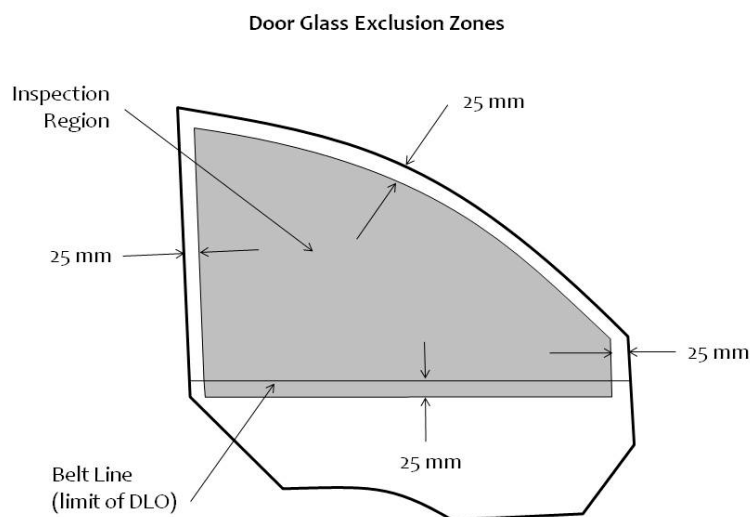


Figure 3: Exclusion Zones

3.2.7.3 Rear Glass Distortion. Rear Glass or Backlights shall not show any distortion which could adversely affect the driver's field of view in the interior mirror on either side of the vehicle.

Lines shall be marked 15 mm inboard (into the Day Light Opening (DLO)) from the paint band. The region from the edge of the glass to this line is considered an exclusion zone and is not subject to the distortion measurement.

The test shall be carried out as follows:

1. A slide projector (per UN ECE R 43, Optical Distortion Test) shall be used to project a slide of a line pattern (reference Zebraraster slide, AZ per DIN 52305) on to a white screen at a distance of 8 m. The black lines are 12 mm wide when correctly focused.
2. The window is placed in a fixture such that the center of the window is at a distance of 4 m from the projector, parallel to the screen. The fixture shall be capable of being rotated about its vertical axis by up to $\pm 40^\circ$.
3. The projector, or the slide, is rotated until the lines of the projected pattern are horizontal.
4. To perform the test, the window glass shall be inclined to the installation angle and during the test be rotated about the vertical axis up to a maximum of $\pm 40^\circ$ from parallel to the screen.
5. The window shall be rotated about the vertical axis $\pm 40^\circ$ in the test position so that the maximal change of the grid lines can be measured.
6. The following shall be observed during measurement: When correctly focused, black grid lines with sharp edges will appear on the screen. If the window causes distortion, the parallel black lines, when projected through the glass, will have variable widths and may show color variation. Color variation is to be considered a gray edge. The narrowest fully black line, excluding the gray edge, and the widest black line, including the gray edge, shall be measured.

3.2.7.3.1 Requirement.

3.2.7.3.1.1 In all test positions (perpendicular to projection axis, $+40^\circ$ and -40° rotations), all lines shall be continuous and the distortion of the black grid lines on the screen due to the window shall not exceed ± 5 mm.

3.2.7.3.1.2 A distortion limit sample(s), agreed to by GM Product Engineering, GM Supplier Quality, and the Supplier, must be approved and maintained as a master limit sample.

3.2.7.4 Reflective Distortion, All Glazings. Reflective distortion is not permitted, including areas non-requisite for driving visibility. In cases where window shape may affect line pattern parallelism, a limit sample, agreed to by GM Engineering and GM Supplier Quality, must be created and maintained by Supplier as a **master limit sample**.

3.2.7.4.1 Test Procedure. The glass to be tested shall be placed on a dark surface in front of a screen with horizontal black and white lines. The width of the dark lines on the screen shall be 12 mm to 15 mm. The dark

© Copyright 2016 General Motors Company All Rights Reserved