



SURFACE VEHICLE STANDARD

SAE J3097™/ANSI Z26.1

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Standard for Safety Glazing Materials for Glazing Motor Vehicles and
Motor Vehicle Equipment Operating on Land Highways - Safety Standard

RATIONALE

This revision includes updates to technology, editorial corrections, revised or new definitions, practical enhancements, addition, deletion, or clarification of test method details of the SAE J3097/ANSI Z26.1 MAY 2019 Glazing Standard. This is a comprehensive standard including glass and plastic glazing materials, with allowable installation locations, created as an optimum set of requirements reflecting the testing and performance specifications of the major international standards for safety glazing materials. This standard organizes methods and requirements according to the traditional style of an American National Standard. This style is familiar to safety glazing manufacturers and provides ease of use with straightforward language.

NOTICE

Use of Descriptive Terms

As the definition indicates, safety glazing materials, in comparison with annealed float glass, are intended to reduce the likelihood of injury or the severity of injury in the event of their breakage. Therefore, terms such as “nonbreakable,” “nonscatterable,” and “nonsplinterable” should not be interpreted by the driving public as meaning that absolute protection is afforded to the occupants of the vehicle by the safety glazing materials so described, as the descriptive terms might seem to warrant. No such terms are used in this standard.

Bullet-resistant glazing should not be termed “bulletproof,” since no bullet-resistant glazing is completely resistant to penetration by all types of missiles fired from all types of armament.

Degree of Safety

One safety glazing material may be superior for protection against one type of hazard, whereas another may be superior against another type. Since accident conditions are not standardized, no one type of safety glazing material can be shown to possess the maximum degree of safety under all conditions, against all conceivable hazards.

Purpose of Tests

The tests described in Section 7 of this standard are for the purpose of determining whether a safety glazing material has certain desirable and achievable qualities for its acceptance under this standard. Many of the tests are of such severity that a satisfactory product may show occasional failures to an extent limited by the requirements of the test.

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Conformity of Production

Glazing manufacturers need to assure that initial and ongoing production meets the applicable performance and other criteria set forth in this automotive glazing standard. To achieve this, it is expected that glazing manufacturers will implement practical methods such as (but not limited to) process controls, statistical analysis techniques, and sample testing protocols to demonstrate that glazing (from initial production through the entire production period) meets the applicable requirements of this standard, and that they will maintain documentation of the data that demonstrates compliance with this standard, and retain the documentation for a reasonable period of time, or as required by applicable regulation.

Technology Neutrality

Glazing constructions identified in this standard are those commonly known as of the time of this publication. However, it is not the intention of this document to limit additional constructions that are capable of meeting the performance specifications of this standard for various installation locations in motor vehicles and motor vehicle equipment.

Surrogate Data

Some of the tests required for this standard need not be repeated for every new product. If an item of glazing material with the same composition and production process has demonstrated compliance within 2 years (from the original test date to the production date of the glazing), then these results can be used as surrogate data. Otherwise, new tests shall be performed and use of surrogate data shall not be permitted.

Surrogate data will be acceptable for tests related to the material performance only and not for tests designed for the final product, as in this case the result is also related to the process and geometry of the glazing material.

Surrogate data shall not be used for any test which requires curved glazing material or actual parts, such as: Fragmentation, Test 7, or Optical Power and Secondary Image Separation, Test 15.

FOREWORD

(This foreword is not part of American National Safety Standard SAE J3097™/ANSI Z26.1-2025 but is included for justification, rationalization, clarification, editorial comment, and historical information.)

The American National Standard Safety Standard Z26.1-1938 was developed by a sectional committee, national in scope, functioning under the procedure of the American National Standards Association (now the American National Standards Institute) and under the joint sponsorship of the National Bureau of Casualty and Surety Underwriters (now the American Insurance Association) and the National Bureau of Standards (now the National Institute of Standards and Technology). It was the first of several separate standards to be developed within the scope of Standards Committee Z26 on Specifications and Methods of Test for Safety Glazing Materials. That scope was as follows:

Specifications and methods of test for safety glazing material (glazing material designed to promote safety and reduce or minimize the likelihood of personal injury from flying glazing material when the glazing material is broken) as used for windshields, windows, and partitions of land and marine vehicles and aircraft.

Since the original formulation of the American National Safety Standard Z26.1-1938, the development of synthetic plastic materials has advanced so far that a number of them appear to be practical for certain uses as safety glazing materials for glazing motor vehicles operating on land highways; therefore, in the 1966 edition of this standard, the foreword and code were modified to the extent necessary to include these synthetic plastic materials along with glass under the general term of "safety glazing materials," reserving the use of the word "glass" as applying only to the ceramic material and of the word "plastic" as applying only to synthetic, organic, polymeric materials.

Early in its deliberations, the Z26 Committee recognized the fact that no one set of specifications or methods of testing would apply to safety glazing materials as used for all purposes. Therefore, the members decided to prepare a separate standard for each of the major usages included in the scope of the main project. In keeping with that decision, this standard, as its title indicates, pertains only to "Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways." Such motor vehicles and motor vehicle equipment shall include passenger cars, multipurpose passenger vehicles, trucks, buses, motorcycles, slide-in campers, pickup covers designed to carry persons while in motion, motorhomes, and trailers.

It is the intent that the test procedures and performance requirements detailed in this standard may be uniformly adopted by motor vehicle commissioners and other interested regulatory officials as the basis for their approval of or incorporation into their regulations for safety glazing materials in motor vehicles and motor vehicle equipment. These protocols and standards may serve as a guide to automobile manufacturers as to the safety glazing materials which will be acceptable to such officials and to the consumer (the commercial operator and the general public) to have assurance that the safety glazing materials in the motor vehicle that is purchased should reduce, in comparison with glazing of ordinary types, the likelihood of injury to persons riding in such motor vehicles and motor vehicle equipment by these safety glazing materials.

It is the purpose of this standard to prescribe the functional properties of safety glazing materials in such a manner that they can be used in any place in motor vehicles and motor vehicle equipment for which they possess those mechanical or optical properties, or both, that are requisite and appropriate. For example, safety glazing materials for windshields must pass a specified group of test requirements, all of which currently can be met only by certain laminated safety glazing; however, if and when other safety glazing materials are developed which possess properties such that they, too, fulfill the requirements for this location, they may also be used. In some cases, a good faith effort to meet all the requirements will permit temporary use of the new material.¹ However, the test requirements for this standard are material specific, and for that reason the properties and test results for any new safety glazing material need to be reviewed by the SAE Glazing Materials Standards Committee and assigned a specific item number and test protocol. Similar reasoning would apply for other locations.

This standard is designed to serve two purposes: (1) to afford a basis for standards for adoption in regulations by governmental regulatory bodies; or (2) for use by motor vehicle commissioners or others as reference standards in such cases as they may have discretionary authority to adopt these or other standards in connection with the approval of safety glazing materials or other items of use in or on motor vehicle equipment.

This standard, which is the result of extended and careful consideration of available knowledge and experience on the subject, is intended to provide minimum requirements that are recommended for use, adoption, and enforcement by federal, state, and local administrative authorities.

Caution should be exercised not to make laws and regulations dealing with this subject so inflexible as to preclude subsequent adoption of technological advancements in the development of safety glazing materials.

Except for special requirements for specified locations, safety glazing materials of seven general types can meet some or all requirements detailed in this standard. Each of them possesses distinct performance characteristics. The seven types are listed below and defined in Section 3.

1. Laminated Glass
2. Glass-Plastic Glazing Material
3. Tempered Glass
4. Plastic
5. Multiple Glazed Unit (Class 1 and Class 2)
6. Bullet-Resistant Glazing
7. Bullet-Resistant Shield

¹ 49 U.S. Code § 30113 Safety Act – General exemptions (b) (3) (B)

The SAE 3097/ANSI Z26.1-201905 standard was developed by the American National Standard (ANS) Task Force under the authority of the SAE Glazing Materials Standards Committee and designed to harmonize testing procedures with the Global Technical Regulation 6 (GTR6) for Glazing Materials, which had previously been adopted as the basis of legal standards by several governmental bodies, notably for UNECE R43. It also followed the lead of the Department of Transportation (DOT) National Highway Traffic Safety Administration (NHTSA), which proposed rulemaking to adopt the methods of GTR6 into the Federal Motor Vehicle Safety Standard 205 (FMVSS205) - Glazing Materials in a Notice of Proposed Rulemaking (NPRM) dated June 21, 2012. In this regard, the current standard continues to use some language from these standards and ISO Standards for glazing materials. In particular, sections providing alternate abrasion test methods for some rigid plastic glazing materials are taken in their entirety, with minimal changes, from UNECE Regulation No. 43, Revision 3, Amendment 4, which was submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) by the Working Party on General Safety Provisions (GRSG), based on the work of the Informal Group on Plastic Glazing (IGPG), and which entered into force on October 8, 2015. The ANS Task Force appreciates the work of the IGPG and thanks GRSG for the use of the text for the test methods and other technical material in this standard.

The NHTSA Notice of Proposed Rulemaking that proposed the adoption of certain provisions of GTR6 was withdrawn April 4, 2019. However, the ANS Task Force continues to see value in harmonization with GTR6 in several areas, many of which were described in the NPRM. Adoption of common test methods will continue the availability of a standard which is comprehensive, including materials, performance, and installation, rather than a patchwork of standards that would have resulted from the adoption of the NPRM.

The ANS Task Force continued development of the joint SAE J3097/ANSI Z26.1 standard in 2023 to 2025 and decided to take a step back and make this standard more directly related to the ANSI/SAE Z26.1-1996 standard, which was the last version incorporated by reference into FMVSS205, with which compliance has been required since September 1, 2006. During the deliberations of the Task Force, it was determined that linking this revised document more closely to the ANSI/SAE Z26.1-1996 standard would provide better continuity and clarity to the users of the test methods herein. This was accomplished by restoring the number sequence of the 1996 test methods while continuing the test method elimination and consolidation of the 2019 version. This numbering is explained in the paragraph at the end of this foreword and the table in Appendix H.

The following three paragraphs were in the initial version of SAE J3097/ANSI Z26.1 in 2019 but continue to apply to the current version.

The current standard also addresses the use of rigid plastic glazing materials for the windshield of motor vehicles, which was the impetus for the IGPG to develop the alternate abrasion methods. In the current standard, the ANS Task Force determined that the inclusion of Item 1 plastic safety glazing material would not be appropriate at this point in time (see Appendix G). Item 2 and Item 3 plastic safety glazing material, however, are included and will have the choice of the standard Taber method or the package of the three alternate abrasion test methods.

This standard makes the first known attempt to define the concept of “glazing,” in addition to the items of safety glazing materials, to better define what constitutes “glazing,” since this standard is for safety glazing materials for glazing motor vehicles and motor vehicle equipment operating on land highways. This attempt to define what is and is not glazing may not be all-encompassing, but the task force believes that it will provide a guide to what uses of glazing materials should be considered “glazing” for practical purposes and for SAE J3097.

The ANS Task Force and the Secretariat believe that this standard reflects the best current technology in the art of automotive glazing. It is recognized that new developments are to be expected in safety glazing materials and that revisions of the standard will be necessary as the art progresses and as further experience is gained.

Suggestions for improvement of this standard are welcome. They should be sent to the Secretariat at the Society of Automotive Engineers, Inc., 755 West Big Beaver Road, Suite 1600, Troy MI 48084, USA. This standard was processed and approved for submittal to ANSI by the Society of Automotive Engineers Glazing Materials Standards Committee. Committee approval of the standard does not necessarily imply that all committee members voted for its approval.

TEST ELIMINATION AND CONSOLIDATION

Some test methods in this standard have been eliminated or consolidated. See Appendix H for a summary of the changes in comparison to the ANSI/SAE Z26.1-1996 Safety Standard, which was the last glazing standard incorporated by reference into FMVSS205. In Section 7 of this standard, test numbering follows the sequence of ANSI/SAE Z26.1-1996, with placeholders included for those obsolete tests which have been eliminated. In this way, all remaining tests keep the same number as the original ANSI/SAE Z26.1 standard of 1996.

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1. SCOPE

Specifications, test methods, and usage provisions for safety glazing materials used for glazing of motor vehicles and motor vehicle equipment operating on land highways.

1.1 Purpose

It is the purpose of this standard to prescribe the functional properties of safety glazing materials in such a manner that they can be used in any place in motor vehicles and motor vehicle equipment for which they possess those mechanical or optical properties, or both, which are requisite and appropriate.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (U.S. and Canada only) or +1 724-776-4970 (outside U.S. and Canada), www.sae.org.

SAE J100	Class "A" Vehicle Glazing Shade Bands
SAE J182	Motor Vehicle Fiducial Marks and Three-Dimensional Reference System
SAE J578	Chromaticity Requirements for Ground Vehicle Lamps and Lighting Equipment
SAE J673	Automotive Safety Glazing Materials
SAE J826	Devices for Use in Defining and Measuring Vehicle Seating Accommodation
SAE J1050	Describing and Measuring the Driver's Field of View
SAE J1100	Motor Vehicle Dimensions

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9500, www.astm.org.

ASTM D471	Standard Test Method for Rubber Property - Effect of Liquids
ASTM D841	Standard Specification for Nitration Grade Toluene
ASTM D1003	Method of Test for Haze and Luminous Transmittance of Transparent Plastics
ASTM D1044	Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion by the Taber Abraser
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2616	Standard Test Method for Evaluation of Visual Color Difference With a Gray Scale
ASTM D2699	Standard Test Method for Research Octane Number of Spark-Ignition Engine Fuel

ASTM D3699	Standard Specification for Kerosine
ASTM D5854	Standard Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
ASTM G151	Standard Practice For Exposing Nonmetallic Materials In Accelerated Test Devices That Use Laboratory Light Sources

2.1.3 ISO Publications

Copies of these documents are available online at www.iso.org/store.

ISO 565	Test sieves - Metal wire cloth, perforated metal plate and electroformed sheet - Nominal sizes of openings
ISO 3537	Road Vehicles - Safety Glazing Materials - Test Methods for Mechanical Properties
ISO 3538	Road Vehicles - Safety Glazing Materials - Test Methods for Optical Properties
ISO 4892-1	Plastics - Methods of Exposure to Laboratory Light Sources - Part 1: General Guidance and requirements
ISO 4892-2	Plastics - Methods of Exposure to Laboratory Light Sources - Part 2: Xenon-Arc Lamps (Including Amendment 1: 2021 Classification of daylight filters)
ISO 11998	Paints and Varnishes - Determination of Wet-Scrub Resistance and Cleanability of Coatings
ISO 12103-1	Road vehicles - Test contaminants for filter evaluation - Part 1: Arizona test dust
ISO 20566	Paints and varnishes - Determination of the scratch resistance of a coating system using a laboratory-scale car-wash

2.1.4 Code of Federal Regulations (CFR) Publications

Copies of these documents are available online at www.ecfr.gov.

29 CFR 1910.106	Occupational Safety and Health Standards - Flammable Liquids
49 CFR 571.210	Federal Motor Vehicle Safety Standards – Seat belt assembly anchorages
49 CFR 571.3	Federal Motor Vehicle Safety Standards – Definitions

2.1.5 UL Publications

Available from UL, 333 Pfingsten Road, Northbrook, IL 60062-2096, Tel: 847-272-8800, www.ul.com.

UL 752	Testing and Certification for Bullet-Resistant Materials
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2.1.6 Other Publications

49 U.S. Code § 30113 Safety Act - General exemptions (b) (3) (B)

FMVSS205, Glazing Materials, Notice of Proposed Rulemaking, Docket No. NHTSA-2012-0083, Federal Register, June 21, 2012

Global Technical Regulation No. 6, Safety Glazing Materials for Motor Vehicles and Motor Vehicle Equipment

NHTSA Interpretation Files, Letter from S.P. Wood (NHTSA) to M. Turner (Diamond Star Motors), June 26, 1989
<https://www.nhtsa.gov/interpretations/nht89-220>



Documents

Document Sharing Hub

ANSI/SAE Z26.1-2007 Standard for Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways - Safety Standard, §5.6 <https://www.citsa.com.mx/images/Normas/Z-26.pdf>

United Nations Economic Commission for Europe, Regulation No. 43, Uniform provisions concerning the approval of safety glazing materials and their installation on vehicles, Revision 3, Amendment 4, and Revision 4, Amendment 2

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (U.S. and Canada only) or +1 724-776-4970 (outside U.S. and Canada), www.sae.org.

SAE J1796	Spectral Transmission Test
SAE J2020	Accelerated Exposure of Automotive Exterior Materials Using a Fluorescent UV and Condensation Apparatus
SAE J2081	Test Procedure for Determining the Resistance of Safety-Glazing Materials, of which One Surface is Plastic, to Simulated Weathering
SAE J3103	Benchmark H-Point Procedure

2.2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9500, www.astm.org.

ASTM D1415	Standard Test Method for Rubber Property - International Hardness
ASTM D4329	Standard Practice for Fluorescent Ultraviolet (UV) Lamp Apparatus Exposure of Plastics
ASTM G154	Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials

2.2.3 ISO Publications

Copies of these documents are available online at www.iso.org/store.

ISO 3536	Road Vehicles - Safety Glazing Materials - Vocabulary
ISO 3917	Road Vehicles - Safety Glazing Materials - Test Methods for Resistance to Radiation, High Temperature, Humidity, Fire, and Simulated Weathering
ISO 4892-3	Plastics - Methods of Exposure to Laboratory Light Sources - Part 3: Fluorescent UV Lamps
ISO 4892-4	Plastics - Methods of Exposure to Laboratory Light Sources - Part 4: Open-Flame Carbon-Arc Lamps

3. DEFINITIONS

3.1 BULLET-RESISTANT GLAZING

A glazing material constructed so as to be resistant to firearms that can meet the requirements for bullet resistance of this standard (see 7.27).

Bullet-resistant glazing for motor vehicles operating on land highways is available in various levels of resistance as specified in UL 752 12th Edition, Standard for Bullet-Resisting Equipment, Levels 1 through 10 and supplementary shotgun.

3.2 BULLET-RESISTANT SHIELD

A shield or barrier that is installed completely inside a motor vehicle behind and separate from glazing materials that independently comply with the requirements of this standard.

3.3 BUS

A motor vehicle with motive power (except a trailer) designed to carry more than ten occupants.

3.4 CAMPER

A structure with roof, walls, and a floor designed to be mounted in the cargo area of a truck, or attached to an incomplete vehicle with motive power, for purposes of providing shelter for occupants.

3.5 CONDUCTORS

Features applied to glazing used to carry electrical current. (For the purpose of testing, conductors do not include any metallic components [e.g., connectors, terminals] which may be subsequently attached.)

3.6 DESIGN GLAZING OUTLINE

The design maximum unobstructed vehicle aperture designated to be glazed before the glazing is installed or mounted, including all trims.

3.7 DESIGN SEAT - BACK ANGLE

The angle between the vertical line through the Seating Reference Point (SgRP) and the torso line defined by the vehicle manufacturer.

3.8 DOUBLE WINDOW

An assembly of two individual panes separately installed within the same opening in the vehicle.

3.9 EYE-POINT

The O-point (see 3.30).

3.10 GLASS-PLASTICS

Any glazing material comprised of one layer of glass and one or more layers of plastic in which a plastic surface of the product faces inward toward the vehicle passenger compartment when the glazing is mounted in a vehicle. It is sometimes interpreted to mean that the construction becomes safety glazing only when the plastic layer(s) are applied to the glass layer.

3.11 GLAZING

Glazing, as used in this document, means a component made of glass and/or plastic for use in automotive applications that is designed to fulfill one or more of the following purposes:

1. Provide the vehicle driver and/or other occupants with a view through the material to the external or internal environment.
2. Separate the vehicle occupant compartment from the external environment or separate different areas within the occupant compartment from each other (which can be transparent or opaque).
3. Filter harmful solar energy elements; shield vehicle occupants from wind and other external elements that may be encountered while the vehicle is being operated.
4. Enhance intrusion resistance, personal security, and/or occupant containment.

For purposes of this document, glazing does not include glass and/or plastic materials used in the following automotive applications:

1. Exterior vehicle lighting
2. Reflective mirrors
3. Controls, displays, bezels, and lighting normally included in the instrument panel, instrument panel cluster, and other occupant compartment locations
4. Video, camera, and touchscreen displays
5. Decorative decals and emblems
6. Components that are separated from vehicle occupants by non-glazing materials under all normal (non-crash) driving conditions
7. Structural vehicle body panels made of fiberglass or other polymers

3.12 GLAZING REQUISITE FOR THE DRIVER'S FORWARD FIELD OF VISION

All of the glazing forward of a plane as determined by SAE J1050, and perpendicular to the longitudinal median plane of the vehicle, through which the driver can view the road when driving or maneuvering the vehicle.

3.13 GLAZING REQUISITE FOR THE DRIVER'S REARWARD FIELD OF VISION

All of the glazing rearward of a plane as determined by SAE J1050, and perpendicular to the longitudinal median plane of the vehicle, through which the driver can view the road when driving or maneuvering the vehicle.

3.14 H-POINT

The pivot center of the torso and thigh on the three-dimensional device in SAE J826 used in defining and measuring vehicle seating accommodation, as defined in SAE J1100. The coordinates of the H-point are determined in relation to the fiducial marks defined by the vehicle manufacturer, according to the three-dimensional system corresponding to SAE J182.

3.15 HEAD INJURY CRITERIA, "HIC"

A value to represent the characterization of skull-brain injury arising from the deceleration forces which result from an impact with the glazing material.

3.16 HEIGHT OF SEGMENT, “H”

The maximum distance, measured at right angles to the glazing material, separating the inner surface of the glazing material from a plane passing through the ends of the glazing material (see Figure 1 and Appendix D).

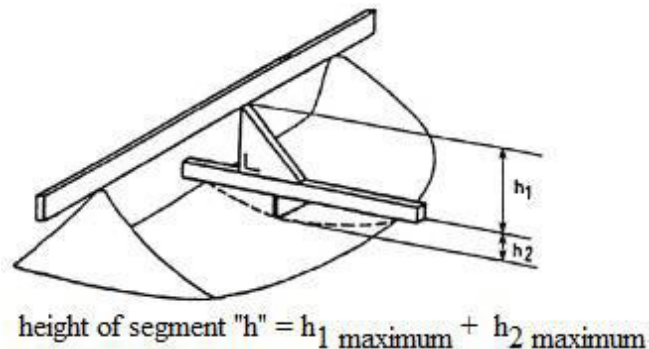


Figure 1 - Height of segment “h”

3.17 INNER SIDE

The side of the glazing which is facing toward the passenger compartment when the material is mounted in the vehicle.

3.18 INTERLAYER

Any material used to hold together the component layers of laminated glass. An interlayer may also provide additional functionality.

3.19 LAMINATED GLASS

Glazing consisting of two or more layers of glass bonded together by one or more interlayers.

NOTE: Two types are recognized:

- Ordinary: When none of the layers of glass, of which it is composed, has been treated, i.e., normal annealed glass.
- Treated: When at least one of the layers of glass, of which it is composed, is tempered safety glass or glass which has been treated in any controlled process in order to give it increased resistance to mechanical and thermal stress.

3.20 LUMINOUS REFLECTANCE

The ratio of the reflected luminous flux to the incident luminous flux at a specified wavelength, λ , over a specified wavelength interval, $\Delta \lambda$, or for a specified illumination source (see 3.21).

3.21 LUMINOUS TRANSMITTANCE, “T(λ),”

Luminous transmittance, “T(λ),” means the ratio of the transmitted luminous flux, F, which has passed through the glazing material to the incident luminous flux, Fo, normal (perpendicular) to the surface at a specified wavelength, λ , over a specified wavelength interval, $\Delta \lambda$, or for a specified illumination source (see Figure 2).

$$T = F/F_o$$

NOTE: Two types are recognized:

- Diffuse Luminous Transmittance: The ratio of transmitted diffuse (scattered) light flux to the incident flux
- Regular Luminous Transmittance: The ratio of transmitted non-diffuse (non-scattered) light flux to the incident flux

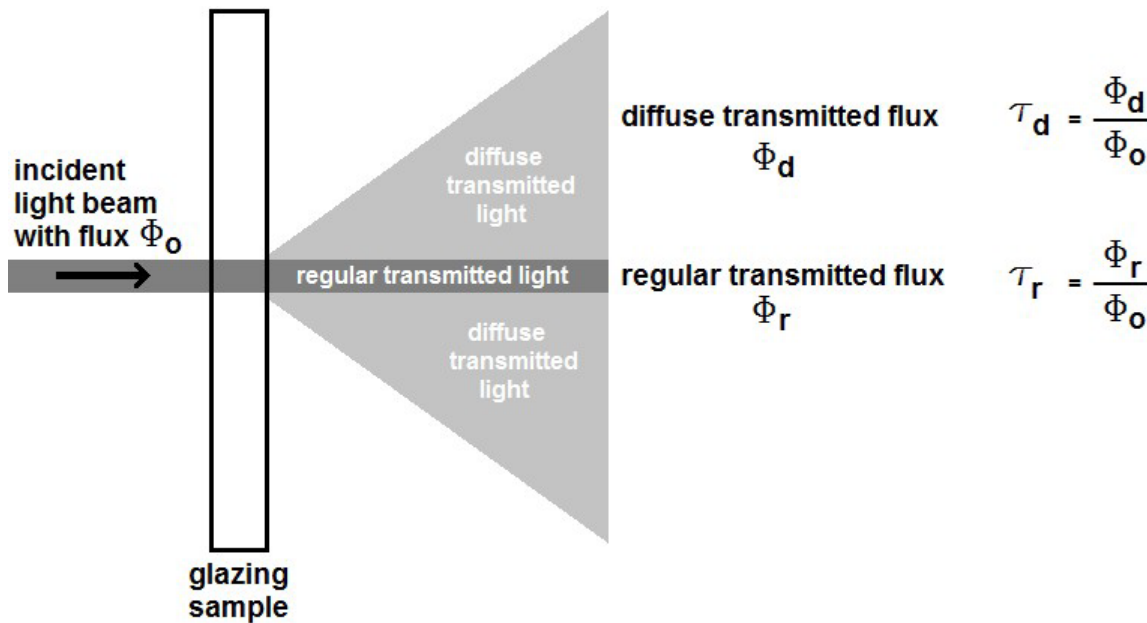


Figure 2 - Luminous transmittance

3.22 MODEL NUMBER

A designation which is assigned by the manufacturer of the safety glazing material and shall be related by the manufacturer to a detailed description of a specific glazing material and is a required marking on Items of safety glazing (see Section 10, footnote 30).

3.23 MOST DIFFICULT PART OR PATTERN

The most difficult part or pattern is the worst-case product considering size, thickness, geometry, printing, etc., within a glazing model number with respect to fragmentation (Test 7) performance. It is the part from each model number that typically has the largest fragments when broken in accordance with Test 7. When there is no difference in fragment size among several parts, the most difficult part or pattern is the largest part. Specimens shall be fracture tested (Test 7) without any hardware, soldered connectors, moldings, or encapsulation applied and, in the case of glass-plastic glazing material, before any plastic layers are applied.

3.24 MOTORCYCLE

A motor vehicle with motive power having a seat or saddle for the use of the rider and designed to travel on not more than three wheels in contact with the ground. "Motor-driven cycle" means a motorcycle with a motor that produces 5-brake horsepower or less (refer to 49 CFR 571.3).

3.25 MOTORHOME

A multipurpose passenger vehicle that provides living accommodations for occupants.

3.26 MOTOR VEHICLE

A vehicle driven or drawn by mechanical power and manufactured primarily for use on public streets, roads, and highways, but does not include a vehicle operated only on a rail line.

3.27 MULTIPLE GLAZED UNIT (MGU)

An assembly of two or more parallel panes of glazing material permanently assembled in manufacture, separated by an airspace or spaces, and glazed in a common mounting.

- Symmetrical Multiple Glazed Unit: A multiple glazed unit where all component panes are identical (e.g., all uniformly tempered glass)
- Asymmetrical Double-Glazed Unit: A multiple-glazed unit other than a symmetrical multiple-glazed unit

For the purposes of this standard, multiple glazed units are divided into two classes:

- a. Class 1 comprises multiple glazed units in which each component single layer or laminated layer complies with the applicable requirements of this standard.
- b. Class 2 comprises multiple glazed units in which any component single layer or laminated layer does not comply with the applicable requirements of this standard.

3.28 MULTIPURPOSE PASSENGER VEHICLE, "MPV"

A motor vehicle with motive power, except a trailer, designed to carry ten persons or less, which is constructed either on a truck chassis or with special features for occasional off-road operation.

3.29 NOMINAL THICKNESS

The manufacturer's design thickness with a tolerance of $\pm(n \times 0.2 \text{ mm})$, where n equals the number of glass layers in the glazing.

3.30 O-POINT

The eye-point located 625 mm (26.61 inches) above the R-point (see 3.41) of the driver's seat in the vertical plane parallel to the longitudinal median plane of the vehicle for which the windshield is intended, passing through the axis of the steering wheel (see 9.2).

3.31 OPAQUE OBSCURATION

Any area of the glazing preventing light transmission, including any screenprinted area, whether solid or dot printed, but excluding any shade band.

3.32 OPTICAL DEVIATION

The angle between the true and the apparent direction of a point viewed through the windshield, with the magnitude of the angle being a function of the angle of incidence of the line of sight, the thickness and inclination of the glazing, and the radius of curvature "r" at the point of incidence.

3.33 OPTICAL DISTORTION

A nonuniform magnification of objects as viewed through the safety glazing.

3.34 OPTICAL POWER

The measure of how much a lens or other optical system bends or refracts light. It is essentially the ability of the system to converge or diverge light, with higher optical power corresponding to greater refraction. It is the reciprocal of the focal length of an optical system. The units are diopters.

3.35 OUTER SIDE

The side of glazing which is facing away from the passenger compartment when the material is mounted in the vehicle.

3.36 PANE

Any single piece of glazing other than windscreen to the exclusion, however, of glazing for lighting and light signaling devices and instrument panels.

- Curved Pane: A pane with a height of segment “h” (see 3.16) greater than 10 mm per linear meter.
- Flat Pane: A pane with a height of segment “h” equal to or less than 10 mm per linear meter.

3.37 PASSENGER CAR

A motor vehicle with motive power, except a multipurpose passenger vehicle, motorcycle, or trailer, designed for carrying ten persons or less.

3.38 PICKUP COVER

An enclosure having a roof and sides but without a floor, designed to be mounted on and removable from the cargo area of a pickup truck by the user. Also called a truck cap or topper.

3.39 PLASTIC

A glazing material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state, and, at some stage in its manufacture or processing into finished articles, can be shaped by flow.

NOTE: Two types are recognized:

- Flexible Plastic Glazing: A plastic glazing material which deflects vertically more than 50 mm in the flexibility test (see Appendix B).
- Rigid Plastic Glazing: A plastic glazing material which does not deflect vertically more than 50 mm in the flexibility test (see Appendix B).

3.40 PRIME GLAZING MANUFACTURER

A manufacturer that laminates, tempers, or fabricates, and certifies safety glazing materials.

3.41 PROTECTIVE FILM

A protective film is a plastic layer applied to the exterior surface, not the interior surface, of the glazing. Protective films are intended to prevent or limit damage to the substrate layer due to impacts from stones or other objects and from abrasion. They are sacrificial in nature and must be replaced when damage or deterioration limits optical quality or visibility through the glazing or renders haze or light transmission noncompliant with prescribed limits.

3.42 R-POINT

The “Seating Reference Point,” as used in international standards, which is a design point defined by the vehicle manufacturer for each seating position and established with respect to the three-dimensional reference system.

3.43 RADIUS OF CURVATURE

The smallest radius of arc of the glazing material as measured in the most curved area.

3.44 RAKE (INSTALLATION) ANGLE

Rake, or installation, angle means the angle between a vertical line and a straight line passing through the top and bottom edges of the inner side of the glazing material, where both lines are contained in the vertical plane through the longitudinal axis of the vehicle.

3.45 READILY REMOVABLE WINDOWS

Windows that can be quickly and completely removed from the motor vehicle without tools. Readily removable windows also include windows that remain hinged at one edge in buses having a GVWR of more than 4536 kg (10000 pounds), which are required to have push-out windows and windows mounted in emergency exits that can be manually pushed out of their location in the vehicle without tools.

3.46 REGULAR LIGHT TRANSMITTANCE

Light transmittance measured perpendicularly to the glazing. Luminous transmittance (see 3.21).

3.47 SAFETY GLASS

Safety glazing materials predominantly inorganic in composition that meet the applicable requirements of this standard, including (but not limited to) laminated glass and tempered glass.

3.48 SAFETY GLASS FACED WITH PLASTICS

A specific glass-plastic consisting of tempered safety glass or laminated safety glass with a layer of plastic on the inner side.

3.49 SAFETY GLAZING MATERIALS

A product consisting of organic and/or inorganic materials so constructed or treated to minimize the likelihood of injury to persons as a result of contact with these safety glazing materials when used in a vehicle and which complies with specified requirements for visibility, strength, and durability.

3.50 SAFETY GLAZING PLASTICS

Any safety glazing material, predominantly synthetic organic in character, that meets the applicable requirements of this standard, including single-ply and laminated products, whether rigid or flexible.

3.51 SEATING REFERENCE POINT (SgRP)

SgRP is a specific and unique H-point established by the manufacturer as the design seat reference point for a given designated seating position which:

- Establishes the rearmost normal design driving or riding position of each designated seating position in a vehicle (considering all modes of seat adjustment – horizontal, vertical, and tilt);
- Has X, Y, Z coordinates established relative to the designed vehicle structure;
- Simulates the position of the pivot center of the torso and thigh; and
- Is the reference point employed to position the 2D drafting template with the 95th percentile leg described in SAE J826 or the HPD described in SAE J4004

Although adjustable seats will have many design H-points within their design H-point travel path, there is one - and only one - H-point defined as the SgRP for any seat/seating position.

The SgRP is fully described in SAE J1100.

3.52 SECONDARY IMAGE

A spurious or ghost image, in addition to the bright primary image, usually seen at night when the object being viewed is very bright in relation to its surroundings; for example, the headlights of an approaching vehicle.

3.53 SECONDARY IMAGE SEPARATION

The angular distance between the primary and secondary images as seen by the driver.

3.54 SHADE BAND

As per SAE J100 Class "A" Vehicle Glazing Shade Bands, an area immediately adjacent to and below the top edge of the vehicle glazing which does not meet the 70% minimum light transmission requirement of Test 2, Luminous Transmittance (see 7.2).

3.55 SLIDE-IN CAMPER

A camper having a roof, floor, and sides, designed to be mounted on and removable from the cargo area of a truck by the user.

3.56 TEST SPECIMEN

Test specimen, or sample, or test piece means a finished product used for testing, a piece cut from a finished product, or a specially prepared piece of glazing material representative of a finished product.

3.57 TRAILER

A motor vehicle with or without motive power, designed for carrying persons or property and for being drawn by another motor vehicle.

3.58 TRANSPARENT AREA OF THE WINDSHIELD

The glazing area contained within the design glass outline, excluding any allowed opaque obscuration but including any shade band.

3.59 TRUCK

A motor vehicle with motive power (except a trailer) designed primarily to transport property or special purpose equipment.

3.60 UNIFORMLY TEMPERED GLASS

Uniformly tempered glass, or toughened glass, means glazing consisting of a single layer of glass which has been subjected to special treatment to increase its mechanical strength and to condition its fragmentation after shattering.

3.61 VISION AREA

The vision area is that part of the installed safety glazing material which shall satisfy special optical requirements and which is used in driving the vehicle. The Primary Vision Area is that part of the vision area immediately in front of the driver through which pass the driver's principal directions of vision.

3.62 WINDSHIELD

Windshield, or windscreen, means the glazing in front of the driver through which the driver views the road ahead.

3.63 ZONE A, ZONE B, ZONE I

Windshield (Windscreen) Regions as defined in United Nations Regulation R43, Global Technical Regulation 6 (GTR6), and this standard.

4. SYMBOLS AND ABBREVIATIONS

4.1	American National Standard	ANS
4.2	American National Standards Institute	ANSI
4.3	ASTM International	ASTM
4.4	American Standard	AS
4.5	Bullet-Resistant Glazing	BRG
4.6	Federal Motor Vehicle Safety Standard	FMVSS
4.7	Informal Group on Plastic Glazing	IGPG
4.8	International Organization for Standardization	ISO
4.9	Multiple Glazed Unit	MGU
4.10	Multipurpose Passenger Vehicle	MPV
4.11	National Highway Traffic Safety Administration	NHTSA
4.12	Occupational Safety and Health Administration	OSHA
4.13	SAE International	SAE
4.14	Underwriters Laboratories, Inc.	UL
4.15	United Nations Economic Commission for Europe	UNECE
4.16	Working Party on General Safety Provisions	GRSG
4.17	World Forum for Harmonization of Vehicle Regulations	WP29
4.18	Celsius (Centigrade)	°C
4.19	Centimeters	cm
4.20	Fahrenheit	°F
4.21	Foot (or Feet)	ft
4.22	Grams	g
4.23	Hertz	Hz
4.24	H-Point design Tool	HPD
4.25	Inch (or Inches)	in
4.26	Kilograms	kg
4.27	Meters	m
4.28	Microsiemens per centimeter	μS/cm



4.29	Millimeters	mm
4.30	Nanometers	nm
4.31	Ounces	oz
4.32	Pounds	lbs
4.33	Square Inch	in ²
4.34	Square Meter	m ²
4.35	Square Millimeters	mm ²
4.36	Ultraviolet	UV
4.37	Watt	W
4.38	Watts per Square Meter per Nanometer	W/m ² /nm

5. SPECIMENS TO BE TESTED

5.1 Variation in Required Specimens

The type, size, and number of specimens required may vary according to the different test requirements that must be met by the safety glazing materials. Sufficient specimens to meet these various tests shall be furnished as described in the test procedures of Section 7.

5.2 Requirements for All Specimens

All specimens of safety glazing materials shall be furnished representative of the product construction (model number). When necessary, the specimens shall have the edges finished and holes drilled and masked, in accordance with the commercial practice of the manufacturer. The specimens shall have the interior or exterior surface so identified if necessary to identify mounted orientation in a vehicle. The samples shall be provided in a shape, size, and quantity as described in individual tests. Unless otherwise specified, the size tolerance on test specimens shall be ± 10 mm (± 0.39 inch).

5.3 Multiple Glazed Units

In the case of multiple glazed units, which for the purposes of this standard are divided into two classes, the specimens shall be furnished as unitary structures in accordance with the commercial practice of the manufacturer. Multiple glazed units are classified only for convenience in designating test procedures. See 3.27 for multiple glazed unit classification.

5.4 Condition of Specimens

Specimens as supplied shall be in a form that is ready for testing, except that any temporary protective material shall be removed prior to conducting the tests.

6. APPLICATION OF TESTS

6.1 Definition of Item Numbers

Safety glazing materials in motor vehicles shall comply with the applicable requirements as defined in this section and listed in Table 1 for the Item number and glazing material being evaluated.

ITEM 1. SAFETY GLAZING MATERIAL FOR USE ANYWHERE IN MOTOR VEHICLE. Safety glazing materials that comply with the following may be used anywhere in a motor vehicle:

- a. Laminated glass, Tests 1, 2, 3, 4, 12, 15, 18, and 26.
- b. Multiple glazed units, Class 1, in which the individual component units comply with the sets of tests designated in (a) and the assembled unit complies with Tests 1, 2, and 15.
- c. Multiple glazed units, Class 2, Tests 1, 2, 3, 4, 12, 14, 15, 18, and 26.

For all ITEM 1 SAFETY GLAZING MATERIALS: The arithmetic mean of the initial haze level of the three specimens to be tested in 7.18 shall not exceed 1.0%.

ITEM 2. SAFETY GLAZING MATERIAL FOR USE ANYWHERE IN MOTOR VEHICLE EXCEPT WINDSHIELDS. Safety glazing materials that comply with the following may be used anywhere in a motor vehicle except windshields:

- a. Laminated Tests 1, 2, 3, 4, 12, and 18.
- b. Tempered Tests 1, 2, 6, 7, and 18.
- c. Multiple glazed units, Class 1, in which the individual component unit complies with one or another of the sets of tests in (a) or (b) and the assembled unit complies with Tests 1 and 2.
- d. Multiple glazed units, Class 2 (Laminated), Tests 1, 2, 3, 4, 12, 14, and 18.
- e. Multiple glazed units, Class 2 (Tempered), Tests 1, 2, 3, 4, 6, 7, 14, and 18.
- f. Rigid plastics, Tests 1, 2, 3, 4, 12, 13, 16, 17, 18, 19, 20, 21, and either 23 or 24.

ITEM 3. SAFETY GLAZING MATERIAL FOR USE ANYWHERE IN MOTOR VEHICLE EXCEPT WINDSHIELDS AND CERTAIN SPECIFIED LOCATIONS. Safety glazing materials that comply with the tests listed in (a), (b), (c), (d), (e), or (f) below may be used anywhere in a motor vehicle except in windshields and except in any of the locations listed in (1) or (2) below if the locations are requisite for driving visibility.

- 1. Buses, trucks, and truck tractors. Glazing of windows to the immediate right and left of the driver and in rearmost window if the latter is used for driving visibility.
 - 2. Passenger cars and taxicabs. Glazing of windows to the immediate right and left of the driver and in rearmost window if the latter is used for driving visibility.
- a. Laminated Tests 1, 3, 4, and 12.
 - b. Tempered Tests 6 and 7.
 - c. Multiple glazed units, Class 1, in which the individual component units comply with one or another of the sets of tests in (a) or (b) and the assembled unit complies with Test 1.
 - d. Multiple glazed units, Class 2 (Laminated), Tests 1, 3, 4, 12, and 14.
 - e. Multiple glazed units, Class 2 (Tempered), Tests 1, 3, 4, 6, 7, and 14.
 - f. Rigid plastics, Tests 3, 4, 12, 13, 16, 17, 18, 19, 20, 21, and either 23 or 24.

ITEM 4. SAFETY GLAZING MATERIALS FOR USE IN MOTOR VEHICLES ONLY IN THE FOLLOWING SPECIFIC LOCATIONS. Safety glazing materials that comply with Tests 2, 12, 13, 16, 17, 19, 20, 21, and either 23 or 24 may be used in a motor vehicle only in the following specific locations:

- a. Interior partitions and auxiliary wind deflectors.
- b. Folding doors.
- c. Standee windows in buses.
- d. Flexible curtains or readily removable windows or in ventilators used in conjunction with readily removable windows.
- e. Openings in the roof not requisite for driving visibility.
- f. Trailers.
- g. Glazing to the rear of the driver in trucks or truck tractor cabs where other means of affording visibility of the highway to the side and rear of the vehicle are provided.
- h. The rear windows of convertible passenger car tops.
- i. The rear doors of taxicabs.
- j. Readily removable windows of buses having a GVWR of more than 4536 kg (10000 pounds), which shall include pushout windows and windows mounted in emergency exits that can be manually pushed out of their location in the vehicle without the use of tools, regardless of whether such windows remain hinged at one edge.
- k. Windows and doors in motorhomes, except for the windshields and windows to the immediate right or left of the driver.
- l. Windows and doors in slide-in campers and pickup covers.
- m. Windows and doors in buses except for the windshield, windows to the immediate right or left of the driver, and rearmost windows if used for driving visibility.

ITEM 4A. SAFETY GLAZING MATERIAL FOR USE IN MOTOR VEHICLES ONLY IN THE FOLLOWING SPECIFIC LOCATIONS. Safety glazing materials that comply with Tests 2, 12, 13, 16, 17, 18, 19, 20, 21, and either 23 or 24 may be used in the following specific locations:

- a. In all areas in which Item 4 safety glazing may be used.
- b. In any side window that meets the following two criteria:
 - i. Is in a vehicle whose rearmost designated seating position is forward-facing and cannot be adjusted so that it is side or rear facing.
 - ii. The forward-most point on the glazing's visible interior surface is rearward of the vertical transverse plane that passes through the shoulder reference point (as described in Figure 1 of 49 CFR § 571.210) of that rearmost seating position.

ITEM 5. SAFETY GLAZING MATERIAL FOR USE IN MOTOR VEHICLE ONLY IN THE FOLLOWING SPECIFIC LOCATIONS AT LEVELS NOT REQUISITE FOR DRIVING VISIBILITY. Safety glazing materials that comply with Tests 12, 13, 16, 19, 20, 21, and either 23 or 24 may be used in a motor vehicle only in the following specific locations at levels not requisite for driving visibility:

- a. Interior partitions and auxiliary wind deflectors.
- b. Folding doors.
- c. Standee windows in buses.
- d. Flexible curtains or readily removable windows or in ventilators used in conjunction with readily removable windows.
- e. Openings in the roof not requisite for driving visibility.
- f. Trailers.
- g. Glazing to the rear of the driver in trucks or truck tractor cabs where other means of affording visibility of the highway to the side and rear of the vehicle are provided.
- h. The rear windows of convertible passenger car tops.
- i. Rear doors of taxicabs.
- j. Readily removable windows of buses having a GVWR of more than 4536 kg (10000 pounds), which shall include pushout windows and windows mounted in emergency exits that can be manually pushed out of their location in the vehicle without the use of tools, regardless of whether such windows remain hinged at one edge.
- k. Windows and doors in motorhomes, except for the windshields and windows to the immediate right or left of the driver.
- l. Windows and doors in slide-in campers and pickup covers.
- m. Windows and doors in buses except for the windshields, windows to the immediate right or left of the driver, and rearmost windows if requisite for driving visibility.
- n. Motorcycle windscreens below the intersection of a horizontal plane 381 mm (15 inches) vertically above the lowest seating position.

ITEM 6. SAFETY GLAZING MATERIAL FOR USE ONLY IN TRAILERS, MULTIPURPOSE PASSENGER VEHICLES, SLIDE-IN CAMPERS, PICKUP COVERS DESIGNED TO CARRY PERSONS WHILE IN MOTION, MOTORHOMES, IN THE REAR WINDOWS OF CONVERTIBLE PASSENGER CAR TOPS, IN WINDSCREENS FOR MOTORCYCLES, IN FLEXIBLE CURTAINS OR READILY REMOVABLE WINDOWS, OR IN VENTILATORS USED IN CONJUNCTION WITH READILY REMOVABLE WINDOWS. Safety glazing materials that comply with Tests 2, 16, 19, 20, 22, and either 23 or 24 may be used in a motor vehicle only in the following specific locations:

- a. Trailers.
- b. The rear windows of convertible passenger car tops.
- c. Windscreens for motorcycles.
- d. Flexible curtains or readily removable windows or in ventilators used in conjunction with readily removable windows.
- e. Windows and doors in motorhomes, except for the windshield, forward-facing windows, and windows to the immediate right or left of the driver.
- f. Windows, except forward-facing windows, and doors in slide-in campers and pickup covers.

ITEM 7. SAFETY GLAZING MATERIAL FOR USE ONLY IN TRAILERS, MULTIPURPOSE PASSENGER VEHICLES, SLIDE-IN CAMPERS, PICKUP COVERS DESIGNED TO CARRY PERSONS WHILE IN MOTION, MOTORHOMES, AND AT LEVELS NOT REQUISITE FOR DRIVING VISIBILITY IN THE REAR WINDOW OF CONVERTIBLE PASSENGER CAR TOPS, IN WINDSCREENS FOR MOTORCYCLES, IN FLEXIBLE CURTAINS OR READILY REMOVABLE WINDOWS, OR IN VENTILATORS USED IN CONJUNCTION WITH READILY REMOVABLE WINDOWS. Safety glazing materials that comply with Tests 16, 19, 20, 22, and either 23 or 24 may be used in a motor vehicle only in house- or property-carrying trailers and at levels not requisite for driving visibility in the following specific locations:

- a. The rear windows of convertible passenger car tops.
- b. Windscreens for motorcycles.
- c. Flexible curtains or readily removable windows or in ventilators used in conjunction with readily removable windows.
- d. Windows and doors in motorhomes, except for the windshield, forward-facing windows, and windows to the immediate right or left of the driver.
- e. Windows, except forward-facing windows, and doors in slide-in campers and pickup covers.
- f. Standee windows in buses.
- g. Interior partitions.
- h. Openings in the roof.

ITEM 8. SAFETY GLAZING MATERIALS FOR USE ONLY IN FOLDING DOORS, STANDEE WINDOWS IN BUSES, TRAILERS, MULTIPURPOSE PASSENGER VEHICLES, SLIDE-IN CAMPERS, PICKUP COVERS DESIGNED TO CARRY PERSONS WHILE IN MOTION, MOTORHOMES, REAR OF DRIVER IN TRUCK OR TRUCK TRACTORS, AND REARMOST WINDOWS IN BUSES. Safety glazing materials in multiple glazed units that comply with Tests 1, 2, 3, 4, 12, 14, and 18 may be used in a motor vehicle only in the following specific locations:

- a. Folding doors.
- b. Standee windows in buses.
- c. Trailers.
- d. Rear of driver in trucks and truck tractors.
- e. Rearmost windows in buses.
- f. Windows and doors in motorhomes, except for the windshield and windows to the immediate right or left of the driver.
- g. Windows and doors in slide-in campers and pickup covers.

ITEM 9. SAFETY GLAZING MATERIAL FOR USE ONLY IN TRAILERS, MULTIPURPOSE PASSENGER VEHICLES, SLIDE-IN CAMPERS, PICKUP COVERS DESIGNED TO CARRY PERSONS WHILE IN MOTION, MOTORHOMES, STANDEE WINDOWS IN BUSES, AND AT LEVELS NOT REQUISITE FOR DRIVING VISIBILITY IN FOLDING DOORS, REAR OF DRIVER IN TRUCKS OR TRUCK TRACTORS, AND REARMOST WINDOWS IN BUSES. Safety glazing materials in multiple glazed units that comply with Tests 2, 3, 4, 12, and 14, may be used in a motor vehicle only in trailers, standee windows in buses, and at levels not requisite for driving visibility in the following specific locations:

- a. Folding doors.
- b. Rear of driver in trucks and truck tractors.
- c. Rearmost windows in buses.

- d. Windows and doors in motorhomes, except for the windshield, and windows to the immediate right or left of the driver.
- e. Windows and doors in slide-in campers and pickup covers.

ITEM 10. SAFETY GLAZING MATERIAL FOR USE WHERE BULLET RESISTANCE IS REQUIRED ANYWHERE IN A MOTOR VEHICLE. Bullet-resistant glazings that comply with Tests 18², 27, 28, 29, 30, 31, and 32 may be used anywhere in a motor vehicle.

ITEM 11A. SAFETY GLAZING MATERIAL FOR USE WHERE BULLET RESISTANCE IS REQUIRED IN A MOTOR VEHICLE EXCEPT WINDSHIELDS. Bullet-resistant glazings that comply with Tests 18¹, 27, 28, 29, 30, and 31 may be used anywhere in a motor vehicle except windshields.

ITEM 11B. SAFETY GLAZING MATERIAL FOR USE WHERE BULLET RESISTANCE IS REQUIRED IN A MOTOR VEHICLE EXCEPT WINDSHIELDS AND GLAZING OF WINDOWS TO THE IMMEDIATE RIGHT OR LEFT OF THE DRIVER AND IN REARMOST WINDOW IF THE LATTER IS REQUISITE FOR DRIVING VISIBILITY. Bullet-resistant glazings that comply with Tests 19¹, 20¹, 21³, 24², 27, 28⁴, and 29³, may be used anywhere in a motor vehicle except windshields, glazing of windows to the immediate right or left of the driver, and in rearmost window if the latter is requisite for driving visibility.

ITEM 11C. SAFETY GLAZING MATERIAL FOR USE IN BULLET-RESISTANT SHIELDS. Bullet-resistant glazing material that complies with Tests 2, 17, 19, 20, 21, 24, 27, 28, 29, 30, and 32 and the labeling requirements of Section 10 may be used only in bullet-resistant shields that can be removed from the motor vehicle easily for cleaning and maintenance. A bullet-resistant shield may be used in areas requisite for driving visibility only if the combined parallel luminous transmittance with perpendicular incidence through both the shield and the permanent vehicle glazing is at least 60%.

ITEM 12. RIGID PLASTICS. Safety glazing materials that comply with Tests 12, 13, 16, 19, 20, 21, and 23 or 24, with the exception of the test for resistance to undiluted denatured alcohol Formula SD No. 30 (in Tests 19 and 20), and that comply with the labeling requirements of Section 10, may be used in a motor vehicle only in the following specified locations at levels not requisite for driving visibility:

- a. Windows and doors in slide-in campers and pickup covers.
- b. Motorcycle windscreens below the intersection of a horizontal plane 381 mm (15 inches) vertically above the lowest seating position.
- c. Standee windows in buses.
- d. Interior partitions.
- e. Openings in the roof.
- f. Flexible curtains or readily removable windows or in ventilators used in conjunction with readily removable windows.
- g. Windows and doors in motorhomes, except for the windshield and windows to the immediate right or left of the driver.
- h. Windows and doors in buses, except for the windshield and windows to the immediate right or left of the driver.

² Flat representative specimens of 6.35 mm (1/4 inch) are to be used.

³ Except for monolithic configurations, where specimens of 6.35-mm (1/4-inch) thickness are to be used, the specimen thickness is to correspond to that used in Test 21.

⁴ Test not required for monolithic configurations.

ITEM 13. FLEXIBLE PLASTICS. Safety plastic materials that comply with Tests 16, 19, 20, 22, and either 23 or 24, with the exception of the test for resistance to undiluted denatured alcohol Formula SD No. 30 (in Tests 14 and 15), and that comply with the labeling requirements of Section 7, may be used in the following specific locations at levels not requisite for driving visibility:

- a. Windows, except forward-facing windows, and doors in slide-in campers and pickup covers.
- b. Motorcycle windscreens below the intersection of a horizontal plane 381 mm (15 inches) vertically above the lowest seating position.
- c. Standee windows in buses.
- d. Interior partitions.
- e. Openings in the roof.
- f. Flexible curtains or readily removable windows or in ventilators used in conjunction with readily removable windows.
- g. Windows and doors in motorhomes, except for the windshield, forward-facing windows, and windows to the immediate right or left of the driver.

ITEM 14. GLASS-PLASTIC GLAZING MATERIAL FOR USE ANYWHERE IN A MOTOR VEHICLE EXCEPT THAT IT MAY NOT BE USED IN THE WINDSHIELDS OF ANY OF THE FOLLOWING VEHICLES: CONVERTIBLES, VEHICLES THAT HAVE NO ROOF, OR VEHICLES WHOSE ROOFS ARE COMPLETELY REMOVABLE. Safety glazing materials that comply with Tests 1, 2, 3, 4, 12, 16, 17, 18, 19, 24, 26, and 28 may be used anywhere in a motor vehicle except that they may not be used in the windshields of the following vehicles: convertibles, vehicles that have no roof, or vehicles whose roofs are completely removable.

ITEM 15A. ANNEALED GLASS-PLASTIC FOR USE IN ALL POSITIONS IN A VEHICLE EXCEPT THE WINDSHIELD. Glass-plastic glazing materials that comply with Tests 1, 2, 3, 4, 12, 16, 17, 18, 19, 24, and 28 may be used anywhere in a motor vehicle except the windshield.

ITEM 15B. TEMPERED GLASS-PLASTIC FOR USE IN ALL POSITIONS IN A VEHICLE EXCEPT THE WINDSHIELD. Glass-plastic glazing materials that comply with Tests 1, 2, 3, 4, 6, 7, 16, 17, 18, 19, 24, and 28 may be used anywhere in a motor vehicle except the windshield.

ITEM 16A. ANNEALED GLASS-PLASTIC FOR USE IN ALL POSITIONS IN A VEHICLE NOT REQUISITE FOR DRIVING VISIBILITY. Glass-plastic glazing materials that comply with Tests 3, 4, 12, 16, 19, 24, and 28 may be used in a motor vehicle in all locations not requisite for driving visibility.

ITEM 16B. TEMPERED GLASS-PLASTIC FOR USE IN ALL POSITIONS IN A VEHICLE NOT REQUISITE FOR DRIVING VISIBILITY. Glass-plastic glazing materials that comply with Tests 3, 4, 6, 7, 16, 19, 24, and 28 may be used in a motor vehicle in all locations not requisite for driving visibility.

6.2 Vehicle Type and Location

See Appendix A, Table A1 for vehicle type and glazing locations for AS Items.

7. TEST SPECIFICATIONS

- a. In many of the following test specifications, it is indicated in the test that specific safety glazing materials are under consideration. At the time of writing, these specific safety glazing materials are known to fulfill the requirements of the specific test. It is intended that if and when other safety glazing materials are developed which possess properties such that they, too, fulfill the requirements of each of the specific tests listed in one or another of the groups of tests for the several items of Table 1, the properties and test results for the new safety glazing material must be submitted to the SAE Glazing Materials Standards Committee to be assigned a material specific test protocol which qualifies it for official inclusion as an Item of glazing under this standard. Upon such official approval and inclusion, the new material may be used interchangeably with other safety glazing materials meeting the requirements for the specific location of use. Temporary exemption from this requirement may be granted by the U.S. Secretary of Transportation (see Footnote 1).
- b. The conditions of the test are, in each instance, designed to show whether the safety glazing material under test conditions approaches the most satisfactory combination of desirable properties. To this end, some tests are written so that occasional failure is allowed. Such tests are better adapted to indicate a satisfactory product than less severe tests allowing no failures.
- c. Unless otherwise specified, interpretation of results should be made immediately following completion of the test.
- d. Unless otherwise specified, measurements for all test parameters shall be accurate to +1%. This tolerance is intended to comprehend variation in manufacturing, process, and/or measurement accuracy.
- e. Unless otherwise specified, the ambient atmospheric conditions shall be: temperature $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ ($68\text{ }^{\circ}\text{F} \pm 9\text{ }^{\circ}\text{F}$), atmospheric pressure 860 to 1060 mbar, relative humidity $60\% \pm 20\%$.

Table 1 - Grouping of tests

		Item 1			Item 2					Item 3					Item 4	Item 4A
		Safety Glazing Material for use Anywhere in Motor Vehicle			Safety Glazing Material for use Anywhere in Motor Vehicle Except Windshields					Safety Glazing Material for use Anywhere in Motor Vehicle Except Windshields and Certain Specified Locations					Safety Glazing Material for use in Motor Vehicle only in Specific Locations	Safety Glazing Material for use in Motor Vehicle only in Specific Locations
Test No.	Test Name	Laminated Glass	Multiple Glazed Unit		Tempered Glass	Multiple Glazed Unit		Rigid Plastics		Laminated Glass	Tempered Glass	Multiple Glazed Unit		Rigid Plastics	Rigid Plastics	Rigid Plastics
			Class 1	Class 2		Class 1	Class 2 Any Group					Class 1	Class 2 Any Group			
						(L)	(T)					(L)	(T)			
1	Light Stability	1	1	1	1	1	1	1		1		1	1			
2	Luminous Transmittance	2	2	2	2	2	2	2							2	2
3	Humidity Test	3		3	3	3	3	3		3			3	3		
4	High Temperature Test	4		4	4		4	4		4			4	4	4	
5	Bake Test															
6	Impact, Ball, 2 m (6.56 feet)				6		6			6			6			
7	Fragmentation (Fracture) Test				7		7			7			7			
8	Impact, Shot Bag, 2.44 m (8 feet)															
9	Impact, Dart 9.14 m (30 feet)															
10	Impact, Dart															
11	Impact, Dart 3.05 m (10 feet)															
12	Impact, Variable Temperature	12		12	12		12	12		12			12	12		
13	Impact, Ball Drop, Plastics							13							13	13 (x)
14	Impact, Ball Drop, Variable (Multiple Glazed Units)			14			14	14				14	14			
15	Optical Power and Secondary Image Separation	15	15	15												
16	Simulated Weathering							16**						16**		16 (x)**
17	Abrasion Resistance, (Plastics)							17**						17**		17* (i)**
18	Abrasion Resistance, (Glass and Specific Plastics)	18		18	18	18	18	18**						18**		18*(x)**
19	Chemical Resistance, Non-Stressed							19						19		19
20	Chemical Resistance, Stressed							20						20		20
21	Dimensional Stability							21						21		21
22	Flexibility															
23	Flammability, ≤1.27 mm							23						23		23
24	Flammability Test, >1.27 mm							24						24		24
25	Egress															
26	Penetration Resistance	26		26												
27	Ballistics															
28	Resistance to Temperature Change															
29	Impact, Ball 6.1 m (20 feet)															
30	Light Stability															
31	Luminous Transmittance															
32	Optical Deviation and Distortion															

** Use specimens from Test 16-

L = Laminated

T = Tempered

NOTE: This table is a summary of 6.1 and the associated test methods of 7.1 through 7.32. In the case of any inconsistency between the text of 6.1 through 7.32 and Table 1, the text of 6.1 through 7.32 shall take precedence.

Shading indicates the test has been eliminated.

	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11A	Item 11B
	Safety Glazing Material for Use in Motor Vehicle, Only in Specific Locations at Levels Not Requisite for Driving Visibility	Safety Glazing Material for Use Only in Trailers, Multipurpose Passenger Vehicles, Slide-in Campers, Pickup Covers Designed to Carry Persons While in Motion, Motorhomes, Rear Windows of Convertible Passenger Car Tops, Windscreens for Motorcycles, Flexible Curtains or Readily Removable Windows, or in Ventilators Used in Conjunction with Readily Removable Windows	Safety Glazing Material for Use Only in Trailers, Multipurpose Passenger Vehicles, Slide-in Campers, Pickup Covers Designed to Carry Persons While in Motion, Motorhomes, and at Levels not Requisite for Driving Visibility in the Rear Windows of Convertible Passenger Car Tops, Windscreens for Motorcycles, Flexible Curtains or Readily Removable Windows, or in Ventilators Used in Conjunction with Readily Removable Windows	Safety Glazing Material for Use Only in Folding Doors, Standee Windows in Buses, Trailers, Multipurpose Passenger Vehicles, Slide-in Campers, Pickup Covers Designed to Carry Persons While in Motion, Motorhomes, Rear of Driver in Truck or Truck Tractors, and Rearmost Windows in Buses	Safety Glazing Material for Use Only in Trailers, Multipurpose Passenger Vehicles, Slide-in Campers, Pickup Covers Designed to Carry Persons While in Motion, Motorhomes, Standee Windows in Buses, and at Levels not Requisite for Driving Visibility in Folding Doors, Rear of Driver in Trucks or Truck Tractors, and Rearmost Windows in Buses	Safety Glazing Material for use where Bullet Resistance is Required Anywhere in Motor Vehicle	Safety Glazing Material for Use Where Bullet Resistance is Required Anywhere in Motor Vehicle Except Windshields	Safety Glazing Material for Use Where Bullet Resistance is Required Anywhere in Motor Vehicle Except Windshields and Glazing of Windows to Immediate Right or Left of Driver and in Rearmost Window if Latter is Requisite for Driving Visibility
				<u>Multiple Glazed Unit</u>	<u>Multiple Glazed Unit</u>			
Test No.	Rigid Plastics	Flexible Plastics	Flexible Plastics	Class 2	Class 2		Laminated Glass	Plastics
1		2		1	1			
2				2	3			
3				3	4			
4				4				
5								
6								
7								
8								
9								
10								
11								
12	12			12	12			
13	13			14	14			
14								
15								
16	16	16	16					
17				18		18*	18*	
18								
19	19	19	19					19*
20	20	20	20					20*
21	21							21†
22		22	22					
23		23	23					
24	24	24	24					24†
25								
26								
27						27	27	27
28						28	28	28‡
29						29	29	29‡
30						30	30	
31						31	31	
32						32		

* Flat representative specimens of 6.35 mm (0.25 inch) thickness shall be used.

** Use specimens from Test 16.

† Except for monolithic configurations, where specimens of 6.35-mm (0.25-inch) thickness shall be used, specimen thickness shall correspond to that used in Test 27.

‡ Test not required for monolithic configuration.

Shading indicates the test has been eliminated.

	Item 11C	Item 12	Item 13	Item 14	Item 15A	Item 15B	Item 16A	Item 16B
	Safety Glazing Material for Use in Bullet-Resistant Shields	Safety Glazing Material for Use Only in Doors and Windows in Slide-in Campers and Pickup Covers, Motorcycle Windscreens Below the Intersection of a Horizontal Plane 381 mm (15 inches) Vertically Above the Lowest Seating Position, Standee Windows in Buses, Interior Partitions, Roof Openings, Flexible Curtains or Readily Removable Windows or Ventilators Used in Conjunction with Removable Windows, Windows and Doors in Motor-Homes and Buses, Except Windshield and Body Glazing Directly to the Right and Left of Driver	Safety Glazing Material for Use Only in Slide-in Camper and Pickup Cover Windows (Not Forward-Facing or Doors), Motorcycle Windscreens Below the Intersection of a Horizontal Plane 381 mm (15 inches) Vertically Above the Lowest Seating Position, Standee Windows in Buses, Interior Partitions, Openings in the Roof, Flexible Curtains or Readily Removable Windows or in Ventilators Used in Conjunction with Readily Removable Windows, Windows and Doors in Motor-Homes, Except for Use in Windshields, Forward-Facing Windows, and the Windows to the Immediate Right or Left of the Driver	Safety Glazing Material for Use Anywhere in a Motor Vehicle, Except the Windshield of Convertibles, Vehicles That Have No Roof, or Vehicles with Roofs That Are Completely Removable	Safety Glazing for Use Anywhere in a Motor Vehicle Except Windshields	Safety Glazing for Use Anywhere in a Motor Vehicle Except Windshields	Safety Glazing Material for Use Anywhere in Motor Vehicle Except Windshields and Certain Specified Locations	Safety Glazing Material for Use Anywhere in Motor Vehicle Except Windshields and Certain Specified Locations
Test No.	Plastics	Rigid Plastics	Flexible Plastics	Glass-Plastics	Annealed Glass-Plastics	Tempered Glass-Plastics	Annealed Glass-Plastics	Tempered Glass-Plastics
1	2			1	1	1		
2				2	2	2		
3				3	3	3	3	3
4				4	4	4	4	4
5								
6						6 (x)		6 (x)
7						7		7
8								
9								
10								
11								
12		12		12 (x)	12 (x)		12 (x)	
13		13						
14				15				
15				16 (x)	16 (x)	16 (x)	16 (x)	16 (x)
16		16	16	17 (i)	17 (i)	17 (i)	17 (i)	17 (i)
17	17			18 (x)	18 (x)	18 (x)	18 (x)	18 (x)
18				19 (i)	19 (i)	19 (i)	19 (i)	19 (i)
19	19	19	19					
20	20	20	20					
21	21	21	21					
22				22				
23		23	23					
24	24	24	24	24 (i)	24 (i)	24 (i)	24 (i)	24 (i)
25								
26				26 (i)				
27	27							
28	28			28	28	28	28	28
29	29							
30	30							
31								
32	32							

(i) means interior surface
(x) means exterior surface

Shading indicates the test has been eliminated.

7.1 Light Stability, Test 1

7.1.1 Purpose of Test

The purpose of this test is to compare the luminous transmittance of the safety glazing material before and after exposure to specified UV wavelengths of simulated sunlight for an extended period of time.

7.1.2 Test Specimens

Samples as described in 7.2.2 shall be used for this testing and their light transmittance shall be measured as described in 7.2.3 (or the same specimens which have already been measured can be used).

7.1.3 Procedure

The measured test specimens shall be subjected to ultraviolet radiation specified below. About half of each specimen shall be protected from the radiation. The operating exposure conditions shall be:

- a. Continuous ultraviolet radiation only (no moisture cycle).
- b. Operating temperature $44\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($110\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$).
- c. Duration 100 hours.
- d. UV lamp(s) facing the specimen surface corresponding to the vehicle exterior.
- e. Average irradiance at specimens throughout the test shall be $0.83\text{ W/m}^2/\text{nm} \pm 7\%$ measured at 340 nm. This irradiance can be obtained with QUV (Q-Lab Corporation)⁵ or any other equipment which is capable of providing the same light intensity and conditions to produce similar results.

7.1.4 Interpretation of Results

The light transmittance of the exposed specimens shall be reduced no more than 5% compared to their pre-exposure transmittance. All three specimens shall meet the requirement. An increase in transmittance is acceptable. Any difference in color between the exposed area and the protected area of the specimens shall be so slight as to only be visible when the specimen is placed on a white background. No other defects shall develop during exposure.

7.2 Luminous Transmittance, Test 2

7.2.1 Purpose of Test

The purpose of this test is to determine the light transmittance of safety glazing materials intended for use in areas in motor vehicles requisite for driving vision.

7.2.2 Test Specimens

Three 305 x 305 mm (12 x 12 inches) or three 76 x 305 mm (3 x 12 inches) substantially flat specimens shall be tested. If the test specimens are cut from complete windshields, they shall be taken from Zone A (i.e., the main driver vision area) of the windshield.

7.2.3 Procedure

The regular (parallel) luminous transmittance at normal incidence shall be measured using International Commission on Illumination "Illuminant A." Equipment and conditions for performing this measurement are described in ISO 3538.

⁵ This information is given for the convenience of users of this standard and does not constitute an endorsement of the product or brand names. Equivalent products may be used if they can be shown to lead to the same results.