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

Standard
ANSI/SAE Z 26.1-2007

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Foreword

(This foreword is not part of American National Safety Standard Z26.1-2007.)

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 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. 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 hoped 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 the safety glazing materials in motor vehicles and motor vehicle equipment coming within their jurisdiction, or for incorporation in their regulations; that they may serve as a guide to automobile manufacturers as to the safety glazing materials which will be acceptable to such officials; and that they may enable 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 of the prescribed tests for this location, they may also be used; and 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 1.

(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

The Z26 Committee 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.

CONTENTS

CONTENTS (Continued)

1. Definitions

1.1 Bullet-Resistant Glazing

“Bullet-resistant glazing" means a glazing material comprised of one or more layers of glass bonded together with one or more layers of transparent plastic or plastic material, solid or laminated, that can meet the requirements for bullet resistance of this standard (Test 21, Ballistics).

Bullet-resistant glazing for motor vehicles operating on land highways is available in various levels of resistance as specified in ANSI/UL 752-2005, Standard for Bullet-Resisting Equipment, Levels 1 through 8 and supplementary shotgun.

Laminates or homogeneous glazing materials that meet the appropriate requirements of this standard in the location as specified may be used as bullet-resistant glazing for the foregoing levels provided that they satisfactorily meet the requirements of ANSI/UL 752-2005, Standard for Bullet-Resisting Equipment.

1.2 Bullet-Resistant Shield

“Bullet-resistant shield" means 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.

1.3 Bus

“Bus" means a motor vehicle with motive power (except a trailer) designed to carry more than ten occupants.

1.4 Camper

“Camper" means a structure 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.

1.5 Conductors

“Conductors” means features applied to glazing used to carry electrical current for lighting, antennas, to facilitate communication, special sensors, and heating to promote vision through the removal of moisture, condensation, ice films, or snow. For the purpose of testing, conductors do not include any metallic components (e.g. connectors, terminals) which may be subsequently attached.

1.6 Glass-Plastic Glazing Material

“Glass-plastic glazing material" means 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 mounted in a vehicle.

1.7 Laminated Glass

“Laminated glass" means two or more pieces of float glass bonded together by an intervening layer or layers of plastic material. It will crack or break under sufficient impact, but the pieces of glass tend to adhere to the plastic. If a tear or opening is produced, the edges are likely to be less exposed than would be the case with ordinary annealed glass.

1.8 Manufacturer

“Manufacturer" means one who fabricates, laminates, or tempers safety glazing material.

1.9 Model Number

“Model number" means a designation assigned by a manufacturer to a safety glazing material and shall be related by the manufacturer to a detailed description of a specific glazing material.

1.10 Most Difficult Part or Pattern

“Most difficult part or pattern” means the worst-case product (e.g. size, thickness, geometry) within a glazing model number with respect to fracture (Test 6) performance. The most difficult part or pattern is the part from each model number that typically has the largest fragments when broken in accordance with Test 6. When there is no difference in fragment size among several parts, the largest part shall be tested. Specimens shall be fracture tested (Test 6) without any hardware, soldered connectors, moldings, or encapsulation applied.

1.11 Motorhome

“Motorhome" means a multipurpose passenger vehicle that provides living accommodations for occupants.

1.12 Motor Vehicle

“Motor vehicle" means 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.

1.13 Multiple Glazed Unit

“Multiple glazed unit" means two or more components of glazing material separated by an airspace or spaces and glazed in a common mounting. 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.

1.14 Multipurpose Passenger Vehicle

“Multipurpose passenger vehicle (MPV)" means 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.

1.15 Passenger Car

“Passenger car" means a motor vehicle with motive power, except a multipurpose passenger vehicle, motorcycle, or trailer, designed for carrying ten persons or less.

1.16 Pickup Cover

“Pickup cover" means a camper having a roof and sides but without a floor, designed to be mounted on and removable from the cargo area of a truck by the user.

1.17 Plastic

“Plastic" means a 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.

1.18 Readily Removable Windows

“Readily removable windows" means 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 (10,000 lbs), 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.

1.19 Safety Glass

“Safety glass" means safety glazing materials predominantly ceramic in character that meet the applicable requirements of this standard, including (but not limited to) laminated glass and tempered glass.

1.20 Safety Glazing Materials

“Safety glazing materials**”** means a product consisting of organic and/or inorganic materials so constructed or treated to reduce, in comparison with annealed float glass, the likelihood of injury to persons as a result of contact with these safety glazing materials when used in a vehicle, and for which special requirements such as visibility, strength, and abrasion resistance are set forth.

1.21 Safety Glazing Plastics

"Safety glazing plastics" includes 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.

1.22 Slide-in Camper

“Slide-in camper" means 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.

1.23 Tempered Glass

“Tempered glass" or “toughened glass” means a single piece of specially treated float glass possessing mechanical strength substantially higher than annealed glass and when broken, at any point, the entire piece breaks into small pieces that have relatively dull edges as compared to those of broken pieces of annealed glass.

1.24 Trailer

“Trailer" means a motor vehicle with or without motive power, designed for carrying persons or property and for being drawn by another motor vehicle.

1.25 Truck

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

2. General

2.1 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.

2.2 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.

2.3 Purpose of Tests

The tests described in Section 5 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.

2.4 Referenced Standards

This standard is intended for use in conjunction with the following standards:
ASTM D 471-06, Standard Test Method for Rubber Property – Effect of Liquids
ASTM D 841-02, Standard Specification for Nitration Grade Toluene
ASTM D 618-05, Standard Practice for Conditioning Plastics for Testing
ASTM D 1003-00, Method of Test for Haze and Luminous Transmittance of Transparent Plastics
ASTM D 1044-05, Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion
ASTM D 1415-06, Standard Test Method for Rubber Property—International Hardness
ASTM D2699-06a, Standard Test Method for Research Octane Number of Spark-Ignition Engine Fuel
ASTM D3699-06, Standard Specification for Kerosine
ASTM D 4329-05, Standard Practice for Fluorescent UV Exposure of Plastics
ASTM D 5854-96(2005), Standard Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
ASTM G154-06, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
SAE J578 DEC06, Color Specification
SAE J673 OCT05, Automotive Safety Glazing
SAE J2020 FEB03, Accelerated Exposure of Automotive Exterior Materials Using a Fluorescent UV and Condensation Apparatus
ISO 3536:1999, Road vehicles - Safety glazing materials - Vocabulary
ISO 3537:1999, Road vehicles - Safety glazing materials - Test methods for mechanical properties
ISO 3538:1997, Road vehicles - Safety glazing materials - Test methods for optical properties
ISO 3917:1999, Road vehicles - Safety glazing materials - Test methods for resistance to radiation, high temperature, humidity, fire, and simulated weathering
ISO 4892-1:1999, Plastics – Methods of exposure to laboratory light sources - Part 1: General guidance
ISO 4892-2:2006, Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps
ISO 4892-3:2006, Plastics – Methods of exposure to laboratory light sources – Part 3: Fluorescent UV lamps
ISO 4892-4:2004, Plastics – Methods of exposure to laboratory light sources – Part 4: Open-flame carbon-arc lamps
OSHA Standard 29 CFR 1910.106 – "Handling, Storage and Use of Flammable Combustible Liquids"
FMVSS 210, 49 CFR § 571.210, Seat Belt Assembly Anchorages
ANSI/UL 752-2005, Standard for Bullet-Resisting Equipment

3. Specimens To Be Tested

3.1 General

3.1.1 Variation in Required Specimens

The specimens required vary according to the different groups of tests that must be met by safety glazing materials. Sufficient specimens to meet these various tests shall be furnished as described in the test procedures of Section 5.

3.1.2 Requirements for All Specimens

All specimens of safety glazing materials shall be furnished representative of the model number with the edges finished, holes drilled where necessary, and masked, if desired, 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 $\pm$ 10 mm (0.39 in.).

3.2 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 1.13 for multiple glazed unit classification.

3.3 Condition of Specimens

Tests shall be applied to specimens only when in the condition as shipped by the manufacturer, except that any temporary protective material shall be removed prior to conducting the tests.

4. Application of Tests

4.1 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) Other than multiple glazed units, Tests 1, 2, 3, 4, 9, 10, 13, and 20.
(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 which complies with Tests 1, 2, and 10.
(c) Multiple glazed units, Class 2, Tests 1, 2, 3, 4, 8, 9, 10, 13, and 20.

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, 9 and 13
(b) Tempered Tests 1, 2, 5, 6 and 13
(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 which complies with Tests 1 and 2
(d) Multiple glazed units, Class 2 (Laminated), Tests 1, 2, 3, 4, 8, 9 and 13;
(e) Multiple glazed units, Class 2 (Tempered), Tests 1, 2, 3, 4, 5, 6, 8 and 13
(f) Rigid Plastics, Tests 1, 2, 3, 4, 7, 9, 11, 12, 13, 14, 15, 16, 18 and 19

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 in the following locations at levels 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 all windows, including rear window, all interior partitions, and all apertures created for window purposes.
(a) Laminated Tests 1, 3, 4 and 9
(b) Tempered Tests 5, and 6
(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 which complies with Test 1.
(d) Multiple glazed units, Class 2 (Laminated), Tests 1, 3, 4, 8 and 9
(e) Multiple glazed units, Class 2 (Tempered), Tests 1, 3, 4, 5, 6 and 8
(f) Rigid Plastics, Tests 3, 4, 7, 9, 11, 12, 13, 14, 15, 16, 18 and 19

Item 4. Safety Glazing Materials for Use in Motor Vehicles Only in the Following Specific Locations. Safety glazing materials that comply with Tests 2, 7, 9, 11, 12, 14, 15, 16, 18 and 19 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 (10,000 lb), 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, 7, 9, 11, 12, 13, 14, 15, 16, 18 and 19 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; and

(ii) The forwardmost 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 *Seat belt assembly anchorages*) 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 7, 9, 11, 14, 15, 16, 18 and 19 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 (10,000 lb), 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 in) 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, 11, 14, 15, 17, 18 and 19 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 11, 14, 15,17,18 and 19 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, 8, 9 and 13 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 1, 3, 4, 8, and 9, 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 Motor Vehicle. Bullet-resistant glazings that comply with Tests 13[1], 21, 22, 23, 24, 25 and 26 may be used anywhere in a motor vehicle.

Item 11A. Safety Glazing Material for Use Where Bullet Resistance is Required in Motor Vehicle Except Windshields. Bullet-resistant glazings that comply with Tests 13[1], 21, 22, 23, 24 and 25 may be used anywhere in a motor vehicle except windshields.

Item 11B. Safety Glazing Material for Use Where Bullet Resistance is Required in 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 14[1], 15[1], 16[2], 19[2], 21, 22[3] and 23[3], 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, 12,14,15, 16,19, 21, 22, 23, 24 and 26 and the labeling requirements of Section 7 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 7, 9, 11, 14, 15, 16 and 19, 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 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 in) 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.

Item 13. Flexible Plastics. Safety plastic materials that comply with Tests 11, 14, 15, 17, 18 and 19, 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 in) 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, 9, 10, 11, 12, 13, 14, 19, 20 and 22 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, 9, 11, 12, 13, 14, 19 and 22 may be used anywhere in a motor vehicle except the windshield.

[1] Flat representative specimens of 6.35 mm (1/4 in) are to be used.
[2] Except for monolithic configurations, where specimens of 6.35 mm (1/4 in) thickness are to be used, the specimen thickness is to correspond to that used in Test 21.
[3] Test not required for monolithic configurations.

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, 5, 6, 11, 12, 13, 14, 19 and 22 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, 9, 11, 14, 19, and 22 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, 5, 6, 11, 14, 19 and 22 may be used in a motor vehicle in all locations not requisite for driving visibility.

4.2 Vehicle Type And Location

Refer to Table A1 – Glazing Material Applicability - for Vehicle Type and Glazing Locations for AS Items of Glazing Material.

5. Test Specifications

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, they may be used interchangeably with any other safety glazing materials meeting the requirements of the same group of tests.

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.

Interpretation of results should be made immediately following completion of the test.

Unless otherwise specified, measurements for all test parameters shall be accurate to $\pm$ 1%. This tolerance is intended to comprehend variation in manufacturing, process, and/or measurement accuracy.

5.1 Light Stability, Test 1

5.1.1 Purpose of Test. The purpose of this test is to determine the regular (parallel) luminous transmittance of the safety glazing material or multiple glazed unit before and after irradiation, to determine whether or not it is adversely affected by exposure to simulated sunlight over an extended period of time.

5.1.2 Procedure

5.1.2.1 Three 305 mm x 305 mm (12 in x 12 in) or three 76 mm x 305 mm (3 in x 12 in) substantially flat specimens shall be tested for regular (parallel) luminous transmittance at normal incidence calculated to International Commission on Illumination "Illuminant A." [4]

5.1.2.2 After the regular (parallel) luminous transmittance has been determined, the same three specimens shall be subjected to ultraviolet radiation.[5,6,7,8] Approximately one-half (1/2) 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 at 44 ^{O}C $\pm$ 2 ^{O}C (110 ^{O}F $\pm$ 3 ^{O}F)
(c) Duration 100 hours
(d) UV lamp(s) facing the specimen surface corresponding to the vehicle exterior

5.1.2.3 Average irradiance at specimen(s) throughout the test shall be 0.83 W/m^2/nm $\pm$ 7% measured at 340 nm. The radiometer used to measure irradiance must have a detector which can be placed in the specimen plane of the apparatus. The detector must be calibrated for the specific lamp being used. [9]

5.1.2.4 If irradiance deviates more than $\pm$ 15% from 0.83 W/m^2/nm at 340 nm, suspend the test until the cause of the deviation has been determined, corrected, and documented.

5.1.2.5 Maintain and calibrate the apparatus to the manufacturer's specifications.

5.1.2.6 The irradiated specimens shall then be tested for regular (parallel) luminous transmittance at normal incidence calculated to International Commission on Illumination "Illuminant A."

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[4] International Commission on Illumination "Illuminant A" consists of a tungsten lamp operated at a correlated color temperature of 2856 ^{O}K. Suitable lamps properly aged and calibrated are obtainable from the Intertek Testing Services, 3933 Route 11, Cortland, NY 13045-0950.

[5] This irradiance can be achieved with (1) a UV arc test cabinet and an H12T3 lamp, or with UVA-351 lamps or equivalent UV lamps in (2) a QUV (Q-Panel Lab Products Company) or (3) a DPW (Suga Test Instruments Co., Ltd.) or (4) a UVCON (Atlas Material Testing Technology LLC) Accelerated Weathering Tester, or equivalent.

[6] Ref. SAE J2020 Accelerated Exposure of Automotive Exterior Materials using a Fluorescent UV and Condensation Apparatus - Appendix B: Measurement of Irradiance.

[7] Ref. ASTM G 154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

[8] Ref. ASTM D 4329, Standard Practice for Fluorescent UV Exposure of Plastics.

[9] A (1) CR20 (Q-Panel Lab Products Company) or (2) IL1400 (International Light Company) or equivalent meets this requirement.

5.1.3 Interpretation of Results. The regular (parallel) luminous transmittance of the irradiated specimens shall not be reduced by more than 5% from its original value, as shown below. A slight discoloration, noticeable only when specimens are placed on a white background, is permissible.

5.1.3.1 Calculation. Percent reduction of regular (parallel) luminous transmittance is calculated as follows:

%Tb -%Ta = %ΔT
Where:
%Tb is the luminous transmittance before irradiation
%Ta is the luminous transmittance after irradiation
% ΔT is the reduction of transmittance
(Negative if %Ta > %Tb)

5.1.4 Additional Procedure. This additional procedure is not applicable to multiple glazed units or tempered glass. After the transmission measurements have been made, the same three irradiated specimens shall be immersed, vertically on edge, in water at 66 ^{o}C (150 ^{o}F) for 3 minutes and then quickly transferred to and similarly immersed in boiling water. The specimens shall be kept in the boiling water for 10 minutes and then removed. The first immersion is intended to reduce the possibility of thermal shock breakage and is optional.

5.1.5 Interpretation of Results of Additional Procedure. No bubbles or other noticeable decomposition shall develop in the irradiated portion.

5.2 Luminous Transmittance, Test 2

5.2.1 Purpose of Test. The purpose of this test is to determine the regular (parallel) luminous transmittance of safety glazing materials intended for use in motor vehicles at levels requisite for driving visibility.

5.2.2 Procedure. When safety glass is being tested, the data obtained from Test 1 (through 5.1.3) shall be used. When plastic or glass plastic is being tested, the data obtained from Test 11 (through 5.11.3) shall be used. Except for Item 11C glazing, no additional samples other than those tested in Test 1 or 11 are required in this test. For Item 11C glazing, luminous transmittance shall be measured at normal incidence through both the shield and the vehicle glazing.

5.2.3 Interpretation of Results. Safety glazing materials or multiple glazed units intended for use at levels requisite for driving visibility in the motor vehicle shall show regular (parallel) luminous transmittance of not less than 70% of the light, at normal incidence, both before and after irradiation (Test 1) or weathering (Test 11), as applicable. For Item 11C glazing, the combined regular (parallel) luminous transmittance shall be at least 60%.

5.3 Humidity, Test 3

5.3.1 Purpose of Test. The purpose of this test is to determine whether the safety glazing material will withstand the effect of moisture in the atmosphere over an extended period of time.

5.3.2 Procedure. Three 305 mm X 305 mm (12 in X 12 in) specimens shall be stored for 2 weeks in a closed container over water. The temperature of the air in the container shall be maintained within the limits of 49 ^{o}C and 54 ^{o}C (120 ^{o}F and 130 ^{o}F). These conditions give a relative humidity of approximately 100%.

5.3.3 Interpretation of Results. Upon removing the samples from the humidity chamber, no separation of materials shall have developed, except for occasional small areas, no one of which shall extend inward from the adjacent edge of the specimen to a depth of more than 6.35 mm (1/4 in).

5.4 High Temperature, Test 4

5.4.1 Purpose of Test. The purpose of this test is to determine whether the safety glazing material will withstand exposure to high temperatures over an extended period of time.

5.4.2 Procedure. Three 305 mm X 305 mm (12 in x 12 in) specimens shall be heated to 100 ^{o}C (212 ^{o}F) for 2 hours; then allow the specimens to cool to room temperature. This temperature exposure may be achieved either by baking in an oven or by immersion in boiling water, as follows:

Bake - The specimens shall be placed in an oven at 100 ^{o}C (212 ^{o}F) and maintained at that temperature for 2 hours. If the specimens are multiple-glazed units having an air or gas layer between panes, the seal shall be vented.

Boil - The specimens shall be immersed, vertically on edge, in water at 66 ^{o}C (150 ^{o}F) for 3 minutes and then quickly transferred to and similarly immersed in boiling water for 2 hours. The first immersion is intended to reduce the possibility of thermal shock breakage and is optional.

5.4.3 Interpretation of Results. The specimen may crack in this test, but no bubbles or other defects shall develop more than 13 mm (1/2 in) from the outer edge of the specimen or from any cracks that may develop. Any specimen that cracks to an extent confusing the result shall be discarded without prejudice, and another specimen shall be tested in its stead.

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 Class 1	Multiple Glazed Unit Class 2	Laminated Glass	Tempered Glass	Multiple Glazed Unit Class 1	Multiple Glazed Unit Class 2 Any Group (L)	Multiple Glazed Unit Class 2 Any Group (T)	Rigid Plastics	Laminated Glass	Tempered Glass	Multiple Glazed Unit Class 1	Multiple Glazed Unit Class 2 Any Group (L)	Multiple Glazed Unit Class 2 Any Group (T)	Rigid Plastics	Rigid Plastics	Rigid Plastics
1	Light Stability	1	1	1	1	1	1	1	1	1	1		1	1	1			
2	Luminous transmittance	2	2	2	2	2	2	2	2	2							2	2
3	Humidity test	3		3	3			3	3	3	3			3	3	3		
4	High Temperature	4		4	4			4	4	4	4			4	4	4		
5	Impact, Ball, 3.05 m (10 ft.)					5			5			5			5			
6	Fracture test					6			6			6			6			
7	Impact, Ball Drop, Plastics									7						7	7	7 (x)
8	Impact, Ball Drop, Variable			8				8	8					8	8			
9	Impact, Variable Temperature	9		9	9			9		9	9			9		9	9	9 (x)
10	Optical Deviation and Distortion	10	10	10														
11	Simulated Weathering									11						11**	11**	11 (x)
12	Abrasion Resistance, Interior									12**						12**	12**	12* (i)**
13	Abrasion Resistance, Exterior	13		13	13	13		13	13	13**								13*(x)**
14	Chemical Resistance, Non-Stressed									14						14	14	14
15	Chemical Resistance, Stressed									15						15	15	15
16	Dimensional Stability									16						16	16	16
17	Flexibility																	
18	Flammability, ≤ 1.27 mm									18						18	18	18
19	Flammability test, > 1.27 mm									19						19	19	19
20	Penetration Resistance	20		20														
21	Ballistics																	
22	Resistance to Temperature Change																	
23	Impact, Ball 6.1 m (20 ft.)																	24
24	Light Stability																	
25	Luminous transmittance																	
26	Optical Deviation and Distortion																	

Note 1: For convenience, each column on this table (as well as the text of the tests that follow) designates the specific type of material that will meet the enumerated tests if it is of satisfactory quality. If and when other materials are developed that possess properties so that they also meet one or another of the prescribed groups of tests, they may be used interchangeably with the corresponding materials specified in this table.

Note 2: Under Items 2 and 3, Multiple Glazed Units, Class 2, Any Group, (L) = Laminated Glass, and (T) = Tempered Glass.

* Flat representative specimens of 6.35 mm (¼-in) thickness shall be used.

** Use specimens from Test 11

Table 1 (Continued)
Grouping of Tests

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
			Multiple Glazed Unit	Multiple Glazed Unit			
Rigid Plastics	Flexible Plastics	Flexible Plastics	Class 2	Class 2		Laminated Glass	Plastics
			1	1			
	2		2				
			3	3			
			4	4			
7							
			8	8			
9			9	9			
11	11	11					
			13		13*	13*	
14	14	14					14*
15	15	15					15*
16							16†
	17	17					
18	18	18					
19	19	19					19†
					21	21	21
					22	22	22‡
					23	23	23‡
					24	24	
					25	25	
					26		

* Flat representative specimens of 6.35 mm (¼-in) thickness shall be used.
** Use specimens from Test 11
† Except for monolithic configurations, where specimens of 6.35 mm (¼-in) thickness shall be used, specimen thickness shall correspond to that used in Test 27.
‡ Test not required for monolithic configurations.

Table 1 (Continued)
Grouping of Tests

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 in) 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 in) 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.
Plastics	Rigid Plastics	Flexible Plastics	Glass-Plastics	Annealed Glass-Plastics	Tempered Glass-Plastics	Annealed Glass-Plastics	Tempered Glass-Plastics
			1	1	1		
2			2	2	2		
			3	3	3	3	3
			4	4	4	4	4
					5 (x)		5 (x)
					6 (x)		6 (x)
	7						
	9		9 (x)	9 (x)		9	
			10				
	11	11	11 (x)	11 (x)	11 (x)	11	11
12			12 (i)	12 (i)	12 (i)		
			13 (x)	13 (x)	13 (x)		
14	14	14	14 (i)	14 (i)	14 (i)	14 (i)	14 (i)
15	15	15					
16	16						
		17					
		18					
19	19	19	19 (i)	19 (i)	19 (i)	19 (i)	19 (i)
			20 (i)				
21							
22			22	22	22	22	22
23							
24							
26							

(i) means Interior Surface (x) means Exterior Surface

5.5 Impact, Test 5 (Ball Drop 3.05m [10 ft])

5.5.1 Purpose of Test. The purpose of this test is to determine whether the safety glazing material has a certain level of resistance to impact from exterior projectiles.

5.5.2 Procedure. Twelve 305 mm x 305 mm (12 in x 12 in) substantially flat specimens shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 ^{O}C to 29 ^{O}C (70 ^{O}F to 85 ^{O}F) for at least 4 hours immediately preceding the test, thereby ensuring a uniform temperature throughout each specimen when tested. The specimen shall be supported in a steel frame made in accordance with Figure 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact. A 227 g $\pm$ 3 g (0.5 lb $\pm$ 0.1 oz) smooth, steel sphere shall be dropped from a height of 3.05 meters (10 ft) once, freely and from rest, striking the specimen within 25 mm (1 in) of its center. The steel sphere shall strike the face of the specimen representing the exterior of the vehicle.

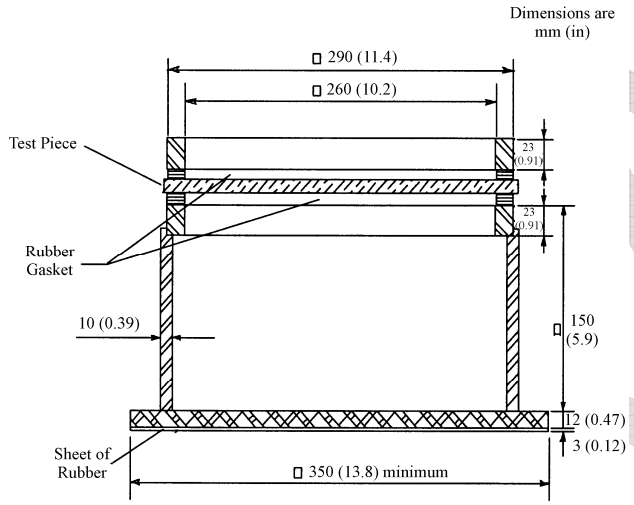


FIGURE 1

STEEL HOLDING FIXTURE FOR DROP TEST

Note: The rubber gasket shall be made of rubber 3 mm (0.12 in) thick of hardness (50 $\pm$ 5) IRHD (International Rubber Hardness Degrees).

5.5.3 Interpretation of Results. Not more than two of the twelve test specimens shall crack or break as a result of this test.

5.6 Fracture, Test 6

5.6.1 Purpose of Test. The purpose of this test is to verify that the fragments produced by fracture of safety glazing materials are such as to minimize the risk of injury.

5.6.2 Specimens to be Tested. Six specimens from each model number representing the most difficult part or pattern shall be tested. Specimens shall be tested following the tempering process, before application of any hardware, soldered connectors, moldings, or encapsulation.

5.6.3 Procedure. The specimens to be tested shall not be rigidly secured. Each may be placed horizontally in a support frame or be taped to an identical specimen. The fracture origin or breakpoint shall be the geometric center of the specimen.

To obtain fracture, a spring-loaded center punch or a hammer of about 75 g (2.65 oz), each with a point having a radius of curvature of 0.2 mm ± 0.05 mm (0.008 in ± 0.002 in), shall be used.

The area of 75 mm (3 in) radius centered on the point of impact and also a strip 20 mm (3/4 in) around the periphery of the specimen shall be excluded from examination.

NOTE: Photographic paper may be placed under the test specimen for a permanent record of the fracture pattern.

5.6.4 Interpretation of Results. No individual fragment free from cracks and obtained from the non-excluded areas within 3 minutes subsequent to test shall weigh more than 4.25 g (0.15 oz).

5.7 Impact, Test 7 (Ball Drop, Plastics, Table 2)

5.7.1 Purpose of Test. The purpose of this test is to determine the behavior of safety glazing material when impacted by a small, hard object.

5.7.2 Procedure. Twelve 305 mm x 305 mm (12 in x 12 in) substantially flat specimens shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 ^{O}C to 29 ^{O}C (70 ^{O}F to 85 ^{O}F) for at least 4 hours immediately preceding the test, thereby ensuring a uniform temperature throughout each specimen when tested. The specimen tested shall be supported in a steel frame made in accordance with Figure 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact. A 227 $\pm$ 3 g (0.5 lb $\pm$ 0.1 oz) solid, smooth steel sphere shall be dropped from a height in accordance with Table 2 once, freely and from rest, striking the specimen within 25 mm (1 in.) of its center on the face that would be mounted to the exterior of the vehicle. The ball shall be allowed to make only one impact with the specimen.

5.7.3 Interpretation of Results. The impact may produce a large number of cracks in the specimen. However, with no more than two of the specimens shall the ball pass completely through the specimen within a 5 second interval after impact, either by what could be described as a puncture of the specimen or by means of the specimen fracturing into relatively large pieces that subsequently fold aside to permit passage of the ball.

At the point immediately opposite the point of impact, small fragments of plastic may leave the specimen, but if laminated, the small area thus affected shall expose less than 645 mm^2 (1 in^2) of reinforcing or strengthening material, the surface of which shall always be well covered with tiny particles of tightly adhering plastic. Total separation of plastic from the reinforcing or strengthening material shall not exceed 1935 mm^2 (3 in^2) on either side.

TABLE 2
HEIGHT OF DROP FOR BALL IMPACT TESTS OF PLASTIC SPECIMENS*

Nominal Thickness of Plastic Specimen		Height of Drop	
		Meters	Feet
Millimeters	Inches	± 25 mm	± 1 in.
3.18 or less	0.125 or less	1.83	6
3.81	0.150	2.74	9
4.75	0.187	3.66	12
5.59	0.220	4.57	15
6.35 or more	0.250 or more	5.49	18

*For the purpose of determining the height of drop to be used, thickness of the plastic specimen measured 25 mm (1 in) from the edge at any point shall not differ from the nominal thicknesses given in the table. The height of drop for materials of nominal thicknesses between those listed in the table shall be calculated proportionately to the adjacent values given in the table.

5.8 Impact, Test 8 (Ball Drop, Variable) (Multiple Glazed Unit, Class 2 Only)

5.8.1 Purpose of Test. The purpose of this test is to determine the behavior of multiple-glazed units when impacted by a small, hard object.

5.8.2 Procedure. Twelve 305 mm x 305 mm (12 in x 12 in) substantially flat specimens of multiple glazed units, which are symmetrical in construction rather than in shape, shall be tested. For asymmetrical constructions, twenty-four 305 mm x 305 mm (12 in x 12 in) specimens shall be tested on both sides, using a separate specimen for impacting opposite sides. Specimens to be tested shall be separated and kept at a temperature of 21 ^{o}C to 29 ^{o}C (70 ^{o}F to 85 ^{o}F) for at least 4 hours immediately preceding the test, thereby ensuring a uniform temperature throughout each specimen when tested. The specimen tested shall be supported in a steel frame made in accordance with Figure 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact. A 227 ± 3 g (0.5 lb ± 0. 1 oz) solid, smooth steel sphere shall be dropped 9.14 m ± 25 mm (30 ft ± 1 in), once, freely and from rest striking the specimen within 25 mm (1 in) of its center. The weight of the ball or the height of drop, or both, may be increased to effect fracture of all component layers other than reinforcing or strengthening material in an interlayer.

5.8.3 Interpretation of Results. No single fragment of glazing material free from cracks or separated from reinforcing or strengthening material shall exceed 1290 mm^2 (2 in^2) in area.

5.9 Impact, Test 9 (Variable Temperature Ball Drop)

5.9.1 Purpose of Test. The purpose of this test is to determine the behavior of safety glazing material when impacted by a small, hard object at high and low temperatures.

5.9.2 Specimens to be Tested. Except for Item 2 laminated glazing and Item 3 laminated glazing, twenty-four 305 mm x 305 mm (12 in x 12 in) substantially flat specimens shall be tested. Twelve of the specimens shall be separated and kept at a temperature of 38 ^{o}C to 42 ^{o}C (100 ^{o}F to 108 ^{o}F) for at least 4 hours immediately preceding the test, thereby ensuring a uniform temperature throughout each specimen when tested. The other twelve specimens shall be separated and kept at a temperature of -18 ^{o}C to -22 ^{o}C (0 ^{o}F to -8 ^{o}F) for at least 4 hours immediately preceding the test, thereby ensuring a uniform temperature throughout each specimen when tested.

For Item 2 laminated glazing and Item 3 laminated glazing, twelve specimens shall be kept at a temperature of 21 ^{o}C to 29 ^{o}C (70 ^{o}F to 85 ^{o}F) for at least 4 hours immediately preceding the test, thereby ensuring a uniform temperature throughout each specimen when tested.

5.9.3 Procedure. All specimens are to be tested at their pre-conditioned temperature. Test specimens shall be supported in a steel frame made in accordance with Figure 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact. A 227 ± 3 g (0.5 lb ± 0.1 oz) solid, smooth steel sphere shall be dropped 9.14 m ± 25 mm (30 ft ± 1 in), once, freely and from rest striking the specimen within 25 mm (1 in) of its center on the face that would be mounted to the exterior of the vehicle. The ball shall be allowed to make only one impact with the specimen. (NOTE: When testing plastics, the applicable drop height from Table 2 shall be used.)

5.9.4 Interpretation of Results. The impact may produce a large number of cracks in the specimen. However, with no more than two of the specimens shall the ball pass completely through the specimen within a 5 second interval after impact, either by what could be described as a puncture of the specimen or by means of the specimen fracturing into relatively large pieces that subsequently fold aside to permit passage of the ball.

At the point immediately opposite the point of impact, small fragments may leave the specimen, but the small area thus affected shall expose less than 645 mm^2 (1 in^2) of reinforcing or strengthening material, the surface of which shall always be well covered with tiny particles of tightly adhering glass. Total

separation from the reinforcing or strengthening material shall not exceed 1935 mm^2 (3 in^2) on either side.

Spalling of the specimen opposite the point of impact and adjacent to the area of impact is acceptable.

5.10 Optical Deviation and Visibility Distortion, Test 10

5.10.1 Purpose of Test. The purpose of this test is to measure the optical deviation and visibility distortion effects of flat or curved safety glazing materials or both. To this end, the procedure is divided into two parts: Optical Deviation (5.10.2.1) and Visibility Distortion (5.10.2.2).

5.10.2 Procedure. Ten 305 mm x 305 mm (12 in x 12 in) substantially flat specimens of the safety glazing material and in the case of curved glazings, three approximately 305 mm x 305 mm (12 in x 12 in) additional curved specimens of the minimum radius, shall be tested for optical deviation (see 5.10.2.1) and visibility distortion (see 5.10.2.2) before being subjected to other tests. That area of each specimen within 25 mm (1 in) of any edge shall be covered with a suitable opaque mask.

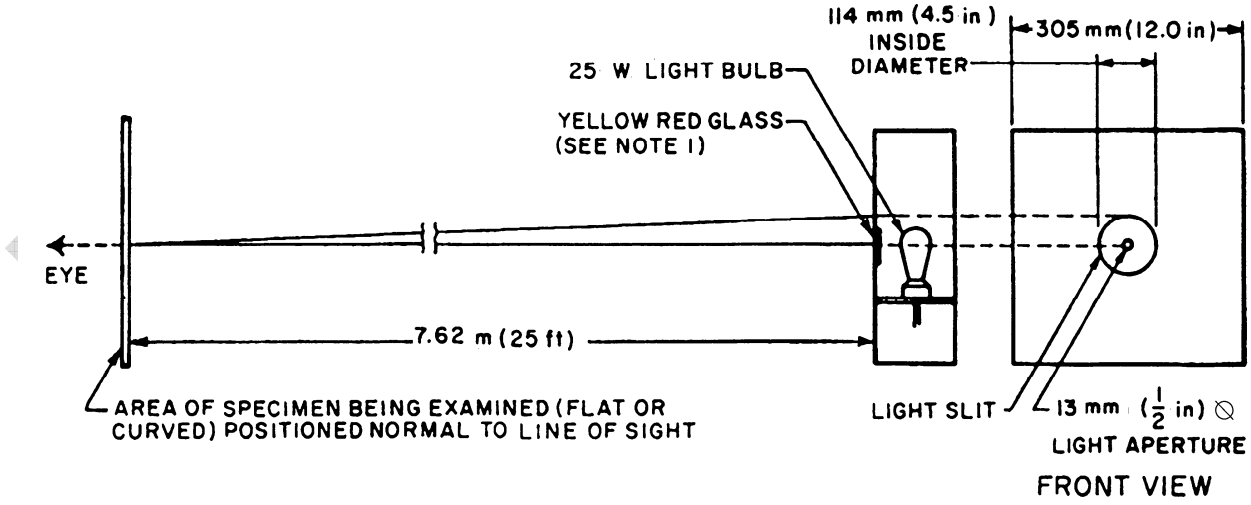
5.10.2.1 Optical Deviation. The equipment for this test consists of the illuminated box as shown in Figure 2. The illuminated box shall be placed in a dark or semi-dark room so that the secondary image and the white circle shall be distinctly visible. The specimen shall be placed 7.62 m (25 ft) from the face of the box and positioned so that the area of the specimen being examined will be normal to the line of vision between the light source and the examiner's eye (one eye only). The entire unmasked area of the specimen shall be surveyed. In testing of asymmetrical glazing materials, such as glass-plastic laminates, the surface of the specimen representing the face mounted to the exterior of the vehicle shall face the illuminated box.

5.10.2.2 Visibility Distortion. The equipment for this test consists of:

(1) A slide projector or a similar assembly of light source and lenses that is capable of projecting a sharply defined image on a screen at a distance of 7.62 m (25 ft). The objective lens of this system shall have an aperture approximately 51 mm (2 in) in diameter and a focal length of 305 mm (12 in). The light source output shall produce at least 1000 lumens and be white according to SAE J-578.

(2) A square, clean, matte, white projection screen that lies substantially in one plane, measuring at least 1.62 m (5 ft) on each side.

(3) A darkroom of sufficient length to accommodate the setup.



NOTES:
(1) Such as Corning Number 3480 or the equivalent.
(2) Not to scale.

FIGURE 2

OPTICAL DEVIATION METHOD

The slide projector shall be focused on the screen 7.62 m (25 ft) distant. The specimen shall be placed between the projector and the screen, close to and as parallel with the screen as possible. The specimen shall be positioned so that the surface of the specimen representing the face mounted to the exterior of the vehicle faces the screen. The specimen shall be moved toward the projector in steps of 127 mm (5 in), always as parallel to the screen as possible, and the shadow on the screen observed. When light and dark patches begin to appear throughout the entire area of the shadow, the distance from the screen to the specimen shall be noted. The entire unmasked area of the specimen shall be surveyed.

5.10.3 Interpretation of Results. Throughout the area surveyed under 5.10.2.1 there shall be no shift of the secondary image beyond the point of tangency with the inside edge of the circle.

NOTE: An image shift to the point of tangency of the inside edge of the 114 mm (4.5 in) circle represents a direct vision deviation of 3.95 minutes of arc or 8.9 mm (0.35 in) at 7.62 m (25 ft).

Under 5.10.2.2, no light and dark patches, existent over the entire area, shall appear in the shadow of the unmasked area of the specimen before the specimen has been moved to a distance equal to or less than 635 mm (25 in) from the screen.

Specimens shall comply with both 5.10.2.1 and 5.10.2.2 to meet the requirements of this test.

5.11 Simulated Weathering, Test 11

5.11.1 Purpose of Test. The purpose of this test is to determine whether safety glazing materials, of which at least one surface is plastic, will withstand exposure to simulated weathering conditions over an extended period of time.

5.11.2 Procedure

5.11.2.1 Apparatus. The exposure apparatus[10] shall use a long arc xenon lamp as the source of the radiation, which shall comply with ISO 4892. The long arc xenon lamp can, when correctly filtered and maintained, yield a spectrum approximating that of natural sunlight. To this end, the quartz xenon burner tube shall be fitted with suitable borosilicate glass optical filter(s)[11]. The xenon lamps employed shall be operated, from a suitable 50 Hz or 60 Hz power supply, through suitable reactance transformers and electrical equipment.

The UV radiation distribution shall be as specified in ISO 4892 Table 1, "Relative Spectral Irradiance for Artificial Weathering (Method A)". The exposure apparatus shall include equipment necessary for measuring and/or controlling the following:

(a) Irradiance
(b) Black standard temperature
(c) Water spray
(d) Operating schedule or cycle

The exposure apparatus shall be made from inert materials that do not contaminate the water employed in the test.

Irradiance shall be measured at the specimen surface and shall be controlled according to the recommendation of the exposure apparatus manufacturer.

Total ultraviolet radiant exposure[12], in joules per square meter, shall be measured or computed and shall be considered the primary measurement of test specimen exposure.

5.11.2.2 Method of Test. Three 102 mm x 102 mm (4 in x 4 in) flat specimens, having both surfaces substantially plane and parallel shall be tested for regular (parallel) luminous transmittance (International Commission on Illumination "Illuminant A") at normal incidence. These specimens shall then be exposed with the surface representing the face mounted to the exterior of the vehicle facing the light source for a total ultraviolet irradiance of 306 MJ/m^2 as follows:

(1) The irradiance shall not vary more than $\pm$ 10% over the whole specimen.
(2) At appropriate intervals, clean lamp filters by washing with detergent and water. Xenon arc filters shall be replaced according to the recommendations of the equipment manufacturer.
(3) The temperature within the exposure apparatus during the dry portion of the cycle shall be controlled by circulation of sufficient air to maintain a constant black standard temperature.
This temperature shall be 67 ^{o}C to 73 ^{o}C (152 ^{o}F to 163 ^{o}F) as indicated by a Black Standard Thermometer[13] or equivalent. The thermometer is preferably mounted on a support for a test panel in such a way that it receives the same radiation and cooling conditions as a specimen surface on the same support. It may also be located at a fixed distance position different from the specimen distance and calibrated for temperature at the specimen distance.

[10] Such as Atlas Ci or Xenotest Series or Suga X or SX Series. These are trade names. This information is given for the convenience of users of this standard and does not constitute an endorsement of the product named trade names. Equivalent products may be used if they can be shown to lead to the same results.
[11] Borosilicate glass filters such as Coming 7740 and Atlas Type S and Atlas Suprax have been found satisfactory. (See Footnote 10 on trade names).
[12] Total ultraviolet is considered to be all radiation of wavelength less than 400 nm.
[13] The Black Standard Thermometer (BST) is defined by ISO 4892.

(4) The relative humidity within the exposure apparatus shall be controlled at 50% ± 5% during the dry portions of the cycle.
(5) The deionized water used in the spray cycle shall contain less than 1 ppm silicon dioxide solids and shall leave no permanent deposit or residue on the specimens which would interfere with subsequent measurements.
(6) The pH of the water shall be between 6.0 and 8.0, and the conductivity shall be less than 5 mS.
(7) The temperature of the water in the line where it enters the exposure apparatus shall be the ambient water temperature.
(8) The water shall strike the specimens in the form of a fine spray in sufficient volume to wet the specimens uniformly, immediately upon impact. Water spray will be directed only against the specimen surfaces facing the light source. No recirculation of the spray water or immersion of the specimens in the water shall be permitted.
(9) The specimens shall be rotated about the arc in order to provide uniform distribution of light. All positions in the exposure apparatus shall be filled with specimens or surrogates to ensure that a uniform temperature distribution is maintained. The specimens shall be held in frames with backs exposed to the cabinet environment. However, reflections from cabinet walls shall not be permitted to strike the back surface of the specimens. If necessary, samples may be backed to block such reflections; the backing must not be in direct contact with the specimen and must not impede the free circulation of air at the specimen surface.
(10) The exposure apparatus shall be operated to provide continuous light and intermittent water spray in 2 hour cycles. Each 2 hour cycle, in accordance with ISO 4892, shall be divided into periods during which the specimens are exposed to light without water spray for 102 minutes and to light with water spray for 18 minutes.

After exposure, the specimens may be cleaned, if necessary, by a practice recommended by their manufacturer to remove any residues present. The irradiated specimens shall be conditioned prior to testing for a minimum time of 48 hours at 22 ^{o}C to 24 ^{o}C (71 ^{o}F to 75 ^{o}F) and 50% ± 2% relative humidity. The irradiated specimens shall again be tested for regular (parallel) luminous transmittance (International Commission on Illumination "Illuminant A") at normal incidence.

5.11.3 Interpretation of Results. The regular (parallel) luminous transmittance of the exposed specimens shall be reduced no more than 5% from its original value. Any increase in regular (parallel) luminous transmittance is acceptable. Some discoloration is permissible. No bubbles or other visible decomposition shall develop in the irradiated specimens.

5.12 Abrasion Resistance, Test 12 (Interior)

5.12.1 Purpose of Test. The purpose of this test is to determine whether the interior surface of the safety glazing material, as mounted in the vehicle, has a certain minimum resistance to abrasion.

5.12.2 Procedure

5.12.2.1 Apparatus

(1) The apparatus for the abrasion shall be the Taber Abraser[14] or its equivalent. A vacuum pickup nozzle is required with nozzle openings of 11 mm (7/16 in). A load of 500 g shall be employed on each wheel.
(2) The fine side of a Taber ST-11 refacing stone or equivalent shall be used for resurfacing the abrasive wheels. It is important that the turntable platform runs true on the abraser and that the refacing stone lies flat on the turntable platform.

NOTE: The fine side of the ST-11 refacing stone has a limited useful life and therefore the stone should be replaced after 10,000 cycles (approximately 400 refacings).

(3) An abrasive wheel designated CS-10F (or the equivalent), meeting the following requirements at the time of the test shall be used:
(a) The wheel shall not be used after the date stamped on it.
(b) Wheels shall be 12.7 ± 0.3 mm wide and have an external diameter of 51.9 ± 0.5 mm when new and in no case less than 44.4 mm.
(c) New wheels, or wheels trued using a diamond tool refacer, shall be broken in by 100 cycles on the fine side of the ST-11 refacing stone (or equivalent) followed by 500 cycles on the material to be tested. Before conducting the next test, reface the wheels according to section 5.12.2.4 (3).

(4) An integrating sphere, photoelectric photometer (hazemeter) conforming to the requirements shown below shall be used to measure the light scattered by the abraded track. If haze measurements are made with other devices or by other methods, a correlation shall be established with the results obtained with the apparatus and method described in ASTM D 1003.

(a) Per ASTM D 1003, haze is defined as that percentage of transmitted light which in passing through the specimen deviates from the incident beam by forward scattering. For the purpose of this test method, only light flux deviating more than 0.044 radians (2.5°) on the average is considered to be haze.
(b) An aperture or diaphragm shall be inserted in the optical beam of the apparatus so that the light beam to the abraded area is limited in size. The light beam shall be of any regular shape but shall have a maximum dimension along the radial axis of the sample of 7 mm ±1 mm (0.28 in ±0.04 in).
(c) When the reduced light beam is unobstructed by a specimen, its cross section at the exit port shall be approximately circular, sharply defined, uniformly bright, and concentric within the exit

[14] According to ASTM D 1044-05.

port, leaving an annulus of 0.023 ±0.002 radians (1.3 ±0.1°) subtended at the entrance port.
(d) A suitable specimen holder shall be used to permit positioning the abraded specimen so that the light beam is centered in the abraded track and the specimen is flush at the measurement port.
(e) The integrating sphere shall be clean of all debris and dust and have at least 90% reflectance.

5.12.2.2 Specimens
(1) Three 102 mm x 102 mm (4 in x 4 in) flat specimens, having both surfaces substantially plane and parallel, shall be tested. Specimens may be cut from sheets in thickness up to 12.7 mm (1/2 in). A 6.3 mm (1/4 in) hole can be centrally drilled in each specimen.
(2) For glazing materials which are subject to both Test 11 and Test 12, the specimens subjected to Simulated Weathering, Test 11 shall be used for a post-weathering abrasion test.
(3) Before testing, any protective masking material shall be removed, and the specimens shall be cleaned by a practice recommended by the manufacturer.
(4) After cleaning, the specimens shall be handled only by their edges and shall be stored in a suitable rack or in clean envelopes to prevent damage to, or contamination of, their surfaces.

5.12.2.3 Conditioning of Specimens. The specimens shall be conditioned prior to testing for a minimum time of 48 hours at 22 ^{O}C to 24 ^{O}C (71 ^{O}F to 75 ^{O}F) and 50% $\pm$ 5% relative humidity.[15]

5.12.2.4 Method of Test. The test method shall be as follows:

(1) Specimens shall be tested in the same environment as they were conditioned, or immediately after removal from the conditioning atmosphere.

(2) The pair of abrasive wheels to be used shall be mounted on their respective flange holders (see Note), taking care not to unduly handle them by their abrasive surfaces. The load to be used is 500 g on each wheel.

NOTE: The wheels are marked "righthand" and "lefthand."

(3) Using the fine side of an ST-11 refacing stone (or equivalent), reface the wheels for 25 cycles before abrading each specimen. Prior to refacing, ensure the vacuum pick-up nozzle is adjusted to 0.8 to 1.6 mm above the ST-11 refacing stone and the vacuum suction force is set at 100. Caution: Do not brush or touch the surface of the wheels after they are refaced. A thin fin of wheel material may form on the left hand edge of the wheel as the main body of the wheel wears down. To remove, gently rub the edge of the wheel. Avoid touching the running surface of the wheel.

NOTE: The time between refacing and testing should not exceed 2 minutes.

(4) As an operational qualification step for the instrumental measurement of transmission haze, it is recommended to measure the haze percentage value with no sample present and verify that the reading of the hazemeter is 0. The specimen holder should be removed during this measurement. Forward-scattering standards can be used to check that the optical system of the hazemeter is properly adjusted. Uniformity of the light intensity is usually checked by observing the beam through thin bond paper placed at the exit port.

(5) Place the unabraded specimen in the hazemeter sample holder with the side to be abraded facing the entrance port of the integrating sphere. Measure the initial haze of the specimen at a minimum of four equally spaced points in the unabraded area in accordance with 5.12.2.4 (8) (a). The results shall be averaged for each specimen.

(6) Mount the specimen on the abraser turntable platform[16] with the side to be abraded facing up, and adjust the height of the vacuum pick-up nozzle to within 0.8 - 1.6 mm (1/32 - 1/16 in) of the specimen surface. Use a vacuum suction level of 100. The specimen shall be mounted so that it rotates substantially in a plane and is subjected to abrasion for 100 cycles.

NOTE: The type of material being tested and number of test cycles may influence the temperature of the running surface of the wheel, and have an affect on the final haze measurement. To reduce any variability due to this temperature effect, it is suggested that the wheel surface temperature be stabilized prior to performing actual measurements. This may be accomplished by conducting multiple refacings on an ST-11 refacing stone, followed by a test on the sample material to be tested (results to be discarded).

(7) After abrasion, handle test pieces by their edges to prevent contamination of their surfaces. Using a soft bristle, anti-static brush, lightly brush off any debris adhered to the surface of the test specimen. Clean the specimen following the manufacturer's recommendation. If none is specified, use an Isopropyl alcohol (IPA) soaked lint free cloth to gently wipe both surfaces of the specimen to remove any remaining particulate.

(8) Place the abraded specimen in the hazemeter sample holder with the abraded side against the entrance port of the integrating sphere. The specimen holder should be positioned so that no portion of the light beam is within 1 mm of the inside or outside edge of the track. Measure the light scattered by the abraded track at a minimum of four equally spaced points along the track in accordance with 5.12.2.4 (8) (a). The results shall be averaged for each specimen. The average initial haze determined by

[15] According to ASTM D 618-05.

[16] When using a dual table abraser and one of the tables is not in use, mount a dummy-specimen to the unused turntable platform and adjust the vacuum pickup nozzle to 0.8 to 1.6 mm (1/32 – 1/16 in) above the specimen surface.

5.12.2.4 (5) shall be subtracted from the average total light scattered as measured by 5.12.2.4 (8), the difference representing the light scatter resulting from abrading the specimen.

(a) Percent haze, as defined by ASTM D 1003, is calculated as follows:

$$[Td / Tt] \times 100$$

where Tt = total transmittance and Td = diffuse transmittance

5.12.3 Interpretation of Results. The arithmetic mean of the initial haze level of the three specimens to be tested shall not exceed 1.0%. The arithmetic mean of the percentages of light scattered by the three specimens after being subjected to abrasion shall not increase from the original mean level by more than 9%. For glass-plastic specimens, the arithmetic mean of the percentages of light scattered by the three specimens after being subjected to abrasion shall not increase from the original level by more than 4%.

5.12.4 Calibration

(1) Verify calibration of the Taber abraser as directed by the equipment manufacturer.

(a) Wheel Alignment and Tracking - The wheels should be spaced equally on both sides from the wheel-mounting flange to the center of the specimen holder. When resting on the specimen, the wheels will have a peripheral engagement with the surface of the specimen, the direction of travel of the periphery of the wheels and of the specimen at the contacting portions being at acute angles, and the angles of travel of one wheel periphery being opposite to that of the other. Wheel internal faces shall be 52.4 ±1.0 mm apart and the hypothetical line through the two spindles shall be 19.05 ±0.3 mm away from the central axis of the turntable (Figure 5).

(b) Wheel Bearings Condition - The Taber abraser wheel bearings should be able to rotate freely about their horizontal spindles and not stick when the wheels are caused to spin rapidly by a quick driving motion of the forefinger.

(c) Vacuum Suction Force - Must be at least 137 millibar (55 inches of water column), as measured by a suction gage. Vacuum suction force may be influenced by the condition of the collection bag, which must be emptied or replaced on a regular basis. Any connection or seal leaks will also influence suction force. Also, the binder used to manufacture the Calibrase wheels can become lodged along the walls of the vacuum suction nozzle. Frequent inspection of the vacuum nozzle orifices and throat are recommended. Any debris in the flow path should be cleaned using a brush.

(d) Turntable Platform Position – The vertical distance from the center of the pivot point of the Taber abraser arms to the top of the turntable platform should be approximately 25 mm. The turntable platform shall rotate substantially in a plane with a deviation at a distance of 1.6 mm (1/16 in.) from its periphery of not greater than ±0.051 mm (±0.002 in.).

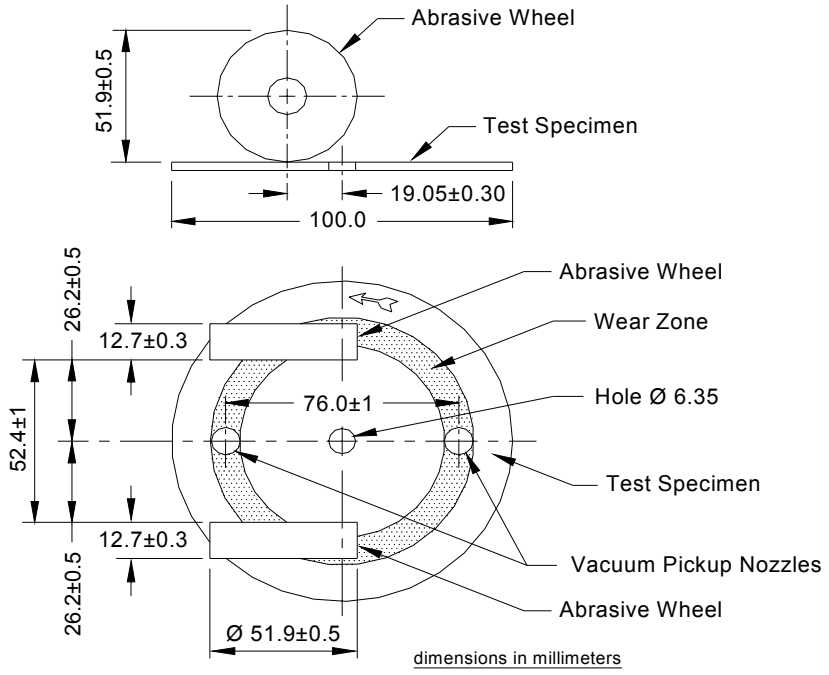


FIGURE 3

DIAGRAMMATIC ARRANGEMENT OF TABER ABRASER TEST SET-UP.

(e) Turntable Speed - The turntable should rotate at either 72 ± 2 rpm for 110v/60Hz or 60 ±2 rpm for 230v/50Hz.
(f) Load - Each accessory mass marked 500g shall weigh 250 ± 1g.

5.13 Abrasion Resistance, Test 13 (Exterior)

5.13.1 Purpose of Test. The purpose of this test is to determine whether the exterior surface of the safety glazing material, as mounted in the vehicle, has a certain minimum resistance to abrasion. To assure durability, all plastic materials which are subject to both Test 11 and Test 13 shall be abraded before and after Simulated Weathering, Test 11. One set of specimens shall be abraded only. A second set of specimens shall be weathered and then abraded.

5.13.2 Procedure. The procedure for this test shall be that described in Test 12 except that the specimens for this test are to be subjected to abrasion for 1000 cycles. Three 102 mm x 102 mm, (4 in x 4 in) flat specimens shall be tested. For plastic glazing materials subject to Test 11 and Test 13, the specimens subjected to Simulated Weathering, Test 11 shall be used for the post-weathering abrasion test.

5.13.3 Interpretation of Results. The arithmetic mean of the initial haze level of the three specimens to be tested shall not exceed 1.0%. The arithmetic mean of the percentages of light scattered by the three specimens after being subjected to abrasion shall not increase from the original mean level by more than 2%.

5.13.4 Modified Procedure for Item 4A, Rigid Plastics
(1) The procedure for this test shall be as described in Test 12 through 5.12.2.4 (5) and as follows.

(2) Mount the specimen on the abraser turntable platform as in described in 5.12.2.4. (6), but with two exceptions:
(i) The exterior side shall face up to be abraded.
(ii) Instead of 100 cycles, the specimen shall be subjected to abrasion for 500 cycles.
Specimens shall be cleaned following the abrasion procedure as stated in 5.12.2.4 (7).

(3) Measure the light scattered by the abraded track at a minimum of four equally spaced points along the track and calculate percentage haze, scattered light, or both, in accordance with 5.12.2.4 (8) (a). The results shall be averaged for each specimen.

5.13.5 Interpretation of Results (For Item 4A). The arithmetic mean of the initial haze level of the three specimens to be tested shall not exceed 1.0%. The arithmetic mean of the percentages of light scattered by the three specimens after being subjected to abrasion shall not increase from the original mean level by more than 9%.

5.14 Chemical Resistance, Test 14 (Non-stressed)

5.14.1 Purpose of Test. The purpose of the test is to determine whether non-stressed transparent plastic or glass-plastic glazing material have a certain minimum resistance to the following chemicals[17], which are likely to be used for cleaning purposes in motor vehicle service:
(1) One percent solution of nonabrasive soap in deioinized water (i.e., potassium oleate or equivalent)
(2) Kerosene No. K- I or K-2[18]
(3) Undiluted denatured alcohol (Formula SD No. 30)[19]
(4) Gasoline[20]
(5) An aqueous solution of isopropanol and a glycol ether solvent, in a concentration of 7.5% $\pm$ 1.5% by weight each and ammonium hydroxide in a concentration of 3% $\pm$ 1%, simulating a commercial windshield cleaner. Alternatively, a commercial glass cleaner meeting these requirements may be used.

5.14.2 Procedure. Two 25 mm x 178 mm (1 in x 7 in), flat specimens shall be tested with each of the chemicals prescribed in 5.14.1 using a new specimen for each test with each chemical. Prior to testing, any protective masking material shall be removed and the specimen shall be cleaned by a practice recommended by the manufacturer.

Multiple glazed units shall be tested on both sides using separate specimens for each side.

Specimens shall be conditioned prior to testing for a minimum time of 48 hours at 22 ^{O}C to 24 ^{O}C (71 ^{O}F to 75 ^{O}F) and 50% $\pm$ 2% relative humidity. The tests shall be conducted in an atmosphere maintained at 22 ^{O}C to 24 ^{O}C (71 ^{O}F to 75 ^{O}F) and 50% $\pm$ 2% relative humidity. Specimens shall be completely immersed in the fluid being tested, held for 1 minute, removed, immediately wiped with absorbent cotton, and examined for evidence of softened or tacky surfaces.
5.14.3 Interpretation of Results. There shall be no tackiness, crazing, or visible loss of transparency in the specimens as a result of chemical immersion. For glass-plastic specimens, only

[17] Caution should be observed in the use of these materials, some of which may be toxic.
[18] As defined by ASTM D 3699-05.
[19] 0ne part 100 % methyl alcohol in 10 parts 190-proof ethyl alcohol by volume.
[20] ASTM Reference Fuel C, which is composed of Isooctane 50 volume percentage and Toluene 50 volume percentage, as specified in ASTM D 471-06, *Standard Test Method for Rubber Property – Effect of Liquids*, Table 3. Isooctane must conform to ASTM D 2699-06a *Standard Test Method for Research Octane Number of Spark-Ignition Fuel*, Paragraph 8.3.1, and Toluene should conform to ASTM D 841-02, *Standard Specification for Nitration Grade Toluene*. ASTM Reference Fuel C must be used as specified in:
(1) ASTM D 5854-96(2005) *Standard Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products*,
(2) The applicable Material Safety Data Sheet; and
(3) OSHA Standard 29 CFR 1910.106 - "Handling Storage and Use of Flammable Combustible Liquids."

the plastic surface facing inward (whether coated or uncoated) is subject to evaluation.

5.15 Chemical Resistance, Test 15 (Stressed)

5.15.1 Purpose of Test. The purpose of this test is to determine whether stressed plastic will have a certain minimum resistance to the following chemicals[17], which are likely to be cleaning purposes in motor vehicle service:

(1) One percent solution of nonabrasive soap in deioinized water (i.e., potassium oleate or equivalent)
(2) Kerosene No. K- I or K-2[18]
(3) Undiluted denatured alcohol (Formula SD No. 30)[19]
(4) Gasoline[20]
(5) An aqueous solution of isopropanol and a glycol ether solvent, in a concentration of 7.5% $\pm$ 1.5% by weight each and ammonium hydroxide in a concentration of 3% $\pm$ 1%, simulating a commercial windshield cleaner. Alternatively, a commercial glass cleaner meeting these requirements may be used.

5.15.2 Procedure. Two 25 mm x 178 mm (1 in x 7 in) substantially flat specimens shall be tested with each of the chemicals prescribed in 5.15.1 using a new specimen for each test with each chemical. Prior to testing, any protective masking material shall be removed and the specimen shall be cleaned by a practice recommended by the manufacturer. Specimens shall be conditioned prior to testing for a minimum time of 48 hours at 22 ^{o}C to 24 ^{o}C (71 ^{o}F to 75 ^{o}F) and 50% $\pm$ 2% relative humidity. The tests shall be conducted in an atmosphere maintained at 22 ^{o}C to 24 ^{o}C (71 ^{o}F to 75 ^{o}F) and 50% $\pm$ 2% relative humidity.

The specimens shall be set up as a Class I lever with the fulcrum 51 mm (2 in) from the stationary end and a load suspended at a 102 mm (4 in) overhang from the fulcrum. This load in grams (pounds) shall be equal to $28.7t^2$ ($41.7t^2$) where t = thickness in millimeters (inches) that will produce an outer fiber stress of 6.9 Mpa (1000 psi) in the plastic at the fulcrum point. While the specimen is stressed, one of the prescribed chemicals shall be applied to the top surface of the specimen above the fulcrum point. The chemical shall be applied with a soft, 13 mm (1/2 in) wide brush, wet before each stroke. Ten individual strokes at one second intervals across the width of the specimen shall be wiped dry with clean absorbent cotton and immediately examined for any evidence of surface defects, cracks, or crazing while the specimen is maintained in the loaded state.

5.15.3 Interpretation of Results. There shall be no tackiness, crazing, or visible loss of transparency in the specimens as a result of chemical application.

5.16 Dimensional Stability, Test 16 (Warpage)

5.16.1 Purpose of Test. The purpose of this test is to determine whether excessive shape changes occur in rigid plastics under conditions of high atmospheric temperature and humidity.

5.16.2 Procedure. Two 152 mm x 152 mm x 6.35 mm (6 in x 6 in x 1/4 in) flat specimens, edge-finished, shall be tested. Prior to testing, any protective masking material shall be removed and the specimens cleaned by a practice recommended by the manufacturer.

Before testing, the specimens shall be conditioned on a plane glass-plate surface for a minimum time of 48 hours at 22 ^{o}C to 24 ^{o}C (71 ^{o}F to 75 ^{o}F) and 50% $\pm$ 2% relative humidity.

The conditioned specimens shall be measured for initial "off-flatness" by determining the greatest distance from a straight edge connecting diagonally opposite corners to the near surface of the plastic. This distance may be measured by means of a dial micrometer, thickness gauge, or any other device having an accuracy of 0.03 mm (0.001 in).

The conditioned and measured specimens, placed on the plane glass-plate surfaces in the same orientation in which they were conditioned, shall be exposed for 24 hours at 71 ^{o}C (160 ^{o}F) and 70% to 75% relative humidity. Following this the specimen shall be immediately transferred, while on the plane glass-plate surface, to another container maintained at 70% to 75% relative humidity and 22 ^{o}C to 24 ^{o}C (71 ^{o}F to 75 ^{o}F) and held for 2 hours. The specimen shall be removed to a 22 ^{o}C to 24 ^{o}C (71 ^{o}F to 75 ^{o}F) and 50 %$\pm$ 2% relative humidity atmosphere, wiped dry, and immediately re-measured for warpage by determining the greatest distance of the surface of the plastic from a straight edge connecting diagonally opposite comers. Warpage shall be reported as the greatest increase in deviation from flatness in any of the specimens tested.

5.16.3 Interpretation of Results. The maximum warpage shown by any of the specimens shall not exceed 1.27 mm (0.050 in).

5.17 Flexibility, Test 17

5.17.1 Purpose of Test. The purpose of this test is to determine whether plastics have satisfactory flexibility.

5.17.2 Procedure. Two 254 mm x 64 mm (10 in x 2 1/2 in) flat specimens shall be tested. Before testing, any protective masking material shall be removed and the specimens cleaned by a practice recommended by the manufacturer. Before testing, the specimens shall be conditioned for a minimum time of 48 hours at 22 ^{o}C to 24 ^{o}C (71 ^{o}F to 75 ^{o}F) and 50% $\pm$ 2% relative humidity. After conditioning, the specimens shall be immediately bent over a mandrel so that the entire length of the specimen shall conform to the surface of the mandrel, or it shall be bent 180 degrees over the mandrel, with the longitudinal axis of the specimen normal to the axis of the mandrel. The diameter of the

mandrel shall be equal to 80 times the thickness of the plastic material being tested.

5.17.3 Interpretation of Results. The safety glazing plastic shall show no cracks, wrinkles, or surface impairment during or after bending.

5.18 Flammability, Test 18 (1.27 mm [0.050 in] or Less in Thickness)

5.18.1 Purpose of Test. The purpose of this test is to determine the rate of burning of plastics, 1.27 mm (0.050 in) or less in thickness.

5.18.2 Procedure. Six 318 mm x 25 mm (121/2 in x 1 in) flat specimens shall be tested. The specimen shall be marked into squares 13 mm (1/2 in) on a side before the test is started. This marking may be done by any convenient means, provided the markings are still visible on the unburned portion of the specimen after the test is completed.

The apparatus for the test shall consist of a shield constructed from sheet metal or other fire-resistant material, 305 mm (12 in) in width, 305 mm (12 in) in depth, and 762 mm (30 in) in height, and open at the top. The shield shall be so constructed as to provide a ventilating opening approximately 25 mm (1 in) in height around the bottom and shall have a viewing window in one side, of sufficient size and in such a position that the entire length of the specimen under test may be observed. Because of danger due to breaking glass, it may be necessary to use heat-resistant glass for the viewing window. One side of the shield shall be hinged (or some other suitable form of construction used) so that the shield may be readily opened and closed to facilitate the mounting and ignition of the specimen. A spring type of paper clamp shall be used for holding the specimen in a vertical position with 305 mm (12 in) of the specimen exposed below the clamp. The holding clamp shall be attached rigidly to the shield in such a manner that when the specimen is clamped therein it is centered within the shield facing the viewing window.

Ordinary laboratory grade toluene (C_7H_8) shall be used for ignition. A drop of toluene shall be placed on the specimen approximately 6.35 mm (1/4 in) above the lower edge of the specimen, and allowed to run down to form a large drop on the blunt end without dripping off. Within 7 seconds after application to the specimen, this drop shall be ignited by either a spark or flame. After ignition, the door of the shield shall be closed immediately. The time required from the start of ignition for the flame either to cease or to completely burn the specimen shall be measured. The area of the specimen that is burned or charred shall be measured to the nearest 161 mm^2 (1/4 in^2). The markings on the specimen may be used for estimating the amount of material burned. If material melts and drops from the specimen, the area melted shall be included in the burned area. The charred portion that drops off in handling shall also be included in the burned area.

5.18.3 Interpretation of Results. The vertical burning rate shall not exceed the limits indicated in Table 3. If the specimen does not continue burning after the toluene is ignited, it shall be reported as non-sustaining.

TABLE 3
VERTICAL BURNING RATES

Thickness		Vertical Burning Rate	
mm	in	mm^2/s	In^2/s
0.13 to 0.25	0.005 to 0.010	645	1.00
0.28 to 0.38	0.011 to 0.015	323	0.50
0.41 to 1.27	0.016 to 0.050	161	0.25

5.19 Flammability, Test 19 (Greater Than 1.27 mm [0.050 in] in Thickness).

5.19.1 Purpose of Test. The purpose of this test is to determine the rate of burning of plastics or glass-plastic glazing materials greater than 1.27 mm (0.050 in) in thickness.

5.19.2 Procedure. Three 152 mm x 13 mm, (6 in x 1/2 in) flat specimens shall be tested. The specimens shall be marked by scribing two lines 25 mm (1 in) and 102 mm (4 in) from one end of the specimen.

The test shall be conducted in a room or enclosure protected from air currents, but provided with means for venting the fumes from burning specimens. A hood may be used if its exhaust fan is turned off during the test and allowed to run periodically to clear out the fumes between tests. The specimen shall be clamped in a support, at the end farthest from the 25 mm (1 in) mark, with its inboard surface facing downward and with its longitudinal axis horizontal and its transverse axis inclined at 45 degrees to the horizontal. Under the specimen there shall be clamped a piece of 20 mesh per 25.4 mm Bunsen burner gauze about 127 mm (5 in) square, in a horizontal position 6.35 mm (1/4 in) below the edge of the specimen, and with about 13 mm (1/2 in) of the specimen extending beyond the edge of the gauze.

A Bunsen burner or an alcohol lamp with a flame 13 mm to 19 mm (1/2 in to 3/4 in) in height shall be placed under the free end of the specimen and adjusted so that the flame tip is just in contact with the specimen. At the end of 30 seconds the flame shall be removed and the specimen allowed to burn. A stopwatch shall be started when the flame reaches the first mark, 25 mm (1 in) from the end, and the time observed when the flame reaches the 102 mm (4 in) mark. In case the plastic or glass-plastic glazing material does not continue to burn after the first ignition, the burner shall be placed under the free end for a second period of 30 seconds immediately following extinction of the flame.

5.19.3 Interpretation of Results. The horizontal burning rate shall not exceed 88.9 mm/min (3.5 in/min). If the specimen does not continue burning to the 102 mm (4 in) mark after the second ignition, the specimen shall be reported as non-sustaining. For glass-plastic specimens only the plastic surface facing inward, whether coated or uncoated, is subject to test and evaluation.

5.20 Penetration Resistance, Test 20

5.20.1 Purpose of Test. The purpose of this test is to determine whether the safety glazing material has satisfactory penetration resistance.

5.20.2 Procedure. Ten 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 ^{O}C to 29 ^{O}C (70 ^{O}F to 85 ^{O}F) for at least 4 hours immediately preceding the test to ensure a uniform temperature throughout each specimen when tested. The specimen to be tested shall be supported in a steel frame made in accordance with Figure 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal. When necessary to retain the specimen in the frame, the specimen shall be clamped to ensure that the movement of the specimen during the test will not exceed 2 mm (0.079 in) at any point along the inside periphery of the frame.

A 2.254 kg to 2.282 kg (5 lb ± 0.5 oz) solid, smooth steel sphere shall be dropped from a height of 4 m (13.1 ft), once, freely and from rest, so as to strike the approximate center of the surface that would be mounted to the interior of the vehicle. The ball shall be allowed to make only one impact with each test specimen.

5.20.3 Interpretation of Results. The impact may produce a large number of cracks in the glass and may cause tears in reinforcing interlayer material. The impact furthermore may produce a substantial permanent deformation in the shape of the originally substantially flat specimen. However, with no more than two of the specimens shall the ball pass completely through the specimen within a 5 second interval after impact, either by what could be described as a puncture of the specimen or by means of the specimen fracturing into relatively large pieces that subsequently fold aside to permit passage of the ball.

When the specimen is clamped, any specimen that exhibits more than 2 mm (0.079 in) of movement at any point along the inside periphery of the frame shall be discarded and a new specimen substituted in its place.

5.21 Ballistics, Test 21

Bullet-resistant glazing and bullet-resistant shields of performance levels 1 through 8 and supplementary shotgun rating shall comply with the ballistics requirements specified by ANSI/UL 752-2005 (tested at high, room, and low temperature). Evidence of listing by Underwriters Laboratories, Inc., shall be considered proof of compliance.

5.22 Resistance to Temperature Change, Test 22

5.22.1 Purpose of Test. The purpose of this test is to determine whether or not the glazing material is capable of withstanding changes in temperature.

5.22.2 Procedure. Two 305 mm x 305 mm (12 in x 12 in) specimens shall be placed in air at a temperature of -45 ^{O}C to -35 ^{O}C (-49 ^{O}F to -31 ^{O}F) for a period of 6 hours, then placed in air at 22 ^{O}C to 24 ^{O}C (71 ^{O}F to 75 ^{O}F) for 1 hour or until temperature equilibrium has been attained in the specimens. The specimens shall then be placed in air at 70 ^{O}C to 74 ^{O}C (158 ^{O}F to 166 ^{O}F) for 3 hours. After removal to air at 21 ^{O}C to 27 ^{O}C (70 ^{O}F to 81 ^{O}F) and cooling to this temperature, the specimens shall be examined.

5.22.3 Interpretation of Results. The glazing specimens shall show no evidence of cracking, clouding, delaminating, or other visible deterioration.

5.23 Impact, Test 23 (Ball Drop, 6.10 m [20 ft])

5.23.1 Purpose of Test. The purpose of this test is to determine whether the plies of bullet-resistant glazing are satisfactorily bonded together.

5.23.2 Procedure. Two specimens 305 mm x 305 mm (12 in x 12 in) shall be tested. The specimen shall be supported at its edges in a horizontal position employing a steel frame made in accordance with Figure 1. The temperature of the specimen shall be -23 ^{O}C to -12 ^{O}C (-10 ^{O}F to +10 ^{O}F). The ball impact test shall consist of the dropping of a 2.254 kg to 2.282 kg (5 lb $\pm$ 0.5 oz) steel ball from a height of 6.10 m (20 ft) onto the test specimen within 25 mm (1 in) of the center. If all glass plies are not broken on the first ball impact, the specimen shall be reversed and the same test repeated on the opposite glass surface. In the case of asymmetric laminates with only one exterior glass surface, the specimen shall be impacted once on each surface, starting on the glass side. In the case of laminates with no exterior glass surfaces, the specimen shall be impacted once on each surface. Any impact not occurring within 25 mm (1 in) of the center of the assembly shall be disregarded and another assembly tested.

5.23.3 Interpretation of Results. A specimen shall be considered to fail the ball impact test when delamination occurs between any adjacent plies along any crack or fracture line that extends more than 3 mm (1/8 in) normal to such crack or fracture line. Any delamination exceeding 6.35 mm (1/4 in) in its largest dimension shall also constitute failure. Delamination is a visible parting of separate layers as observable by reflected light. Glass

spall in the area of impact on the impacted side or the spalling off of a cone-shaped mass in the area opposite the point of impact shall be disregarded.

5.24 Light Stability, Test 24

5.24.1 Purpose of Test. The purpose of this test is to determine the regular (parallel) luminous transmittance of the bullet-resistant glazing before and after irradiation, to determine whether or not it is adversely affected by exposure to simulated sunlight over an extended period of time.

5.24.2 Procedure. If laminated safety glazing material is being tested, two 305 mm x 305 mm (12 in x 12 in) specimens shall be tested by the procedure outlined in Test 1 through 5.1.2. If plastic or glass-plastic glazing materials are being tested, two 102 mm x 102 mm (4 in x 4 in) specimens shall be tested by the procedure outlined in Test 11 through 5.11.2.

5.24.3 Interpretation of Results. The irradiated specimens shall retain at least 70% of the original transmittance as determined on the specimens as submitted. A very slight discoloration visible only when specimens are placed on a white background may develop, but defects other than this discoloration shall not develop.

5.25 Luminous Transmittance, Test 25

5.25.1 Purpose of Test. The purpose of this test is to determine the regular (parallel) luminous transmittance of the bullet-resistant glazing employed in motor vehicles.

5.25.2 Procedure. The data obtained in Test 24 through 5.24.2 on the regular (parallel) luminous transmittance at normal incidence calculated to International Commission on Illumination "Illuminant A" shall be used. No additional specimens other than those tested in Test 22 or 24 are required in this test.

5.25.3 Interpretation of Results. Bullet-resistant glazing used in the motor vehicle shall show regular (parallel) luminous transmittance of not less than 60% of the light at normal incidence both before and after irradiation.

5.26 Optical Deviation and Visibility Distortion, Test 26

5.26.1 Purpose of Test. The purpose of this test is to measure the optical deviation and visibility distortion effects of flat or curved bullet-resistant glazings, or both. To this end, the procedure is divided into two parts: Optical Deviation and Visibility Distortion.

5.26.2 Procedure. Six 305 mm x 305 mm (12 in x 12 in), substantially flat specimens of the bullet-resistant glass and, in the case of curved bullet-resistant glazing, three additional approximately 305 mm x 305 mm (12 in x 12 in) curved specimens shall be tested. These specimens shall be complete windshields with an area approximately 305 mm x 305 mm (12 in x 12 in) outlined at the section of greatest curvature (minimum radius), or the outlined area itself cut from the curved windshield. Each sample shall be tested by the procedure outlined in Test 10 for optical deviation (see 5.10.2.1) and visibility distortion (see 5.10.2.2) before being subjected to other tests. That area of the specimen within 25 mm (1 in) of any edge shall be covered with a suitable opaque mask.

5.26.3 Interpretation of Results. Described in 5.10.3

6. Edges

In vehicles except school buses, exposed edges shall be treated in accordance with SAE J673 "Automotive Safety Glazing". In school buses, exposed edges shall be banded.

7. Marking of Safety Glazing Materials

7.1 General Markings: In addition to any other markings required by law, ordinance, or regulation, all safety glazing materials manufactured for use in accordance with this standard shall be legibly and permanently marked in letters and numerals at least 1.78 mm (0.070 in) in height, with the words American National Standard or the characters AS and, in addition, with a model number that will identify the type of construction of the glazing material. They shall also be marked with the manufacturer's distinctive designation or trademark. In addition to the preceding markings and immediately adjacent to the words American National Standard or the characters AS, each piece of safety glazing material shall further be marked in numerals at least 1.78 mm (0.070 in) in height: if complying with the requirements of section 4. Application of Tests, Item 1 with numeral 1; if complying with the requirements of Section 4, Item 2, with the numeral 2; if complying with the requirements of Section 4, Item 3, with the numeral 3; if complying with the requirements of Section 4, Item 4, with the numeral 4; if complying with the requirements of Section 4, Item 4A, with the numeral and letter 4A; if complying with the requirements of Section 4, Item 5, with the numeral 5: if complying with the requirements of Section 4, Item 6, with the numeral 6; if complying with the requirements of Section 4, Item 7, with the numeral 7; if complying with the requirements of Section 4, Item 8, with the numeral 8; if complying with the requirements of Section 4, Item 9, with the numeral 9; if complying with the requirements of Section 4, Item 10, with the numeral 10; if complying with the requirements of Section 4, Item 11A, with the numeral and letter 11A; if complying with the requirements of Section 4, Item 11B, with the numeral and letter 11B; if complying with the requirements of Section 4, Item 11C, with the numeral and letter 11C; if complying with the requirements of Section 4, Item 12, with the numeral 12; if complying with the requirements of Section 4, Item 13, with the numeral 13; if complying with the requirements of Section 4, Item 14, with the

numeral 14; if complying with the requirements of Section 4, Item 15A, with the numeral and letter 15A; if complying with the requirements of Section 4, Item 15B, with the numeral and letter 15B; if complying with the requirements of Section 4, Item 16A, with the numeral and letter 16A, and; if complying with the requirements of Section 4, Item 16B, with the numeral and letter 16B.

The characters, or the words for which they stand, and the numerals as prescribed in the preceding paragraph, shall be outside of, and separate from the manufacturer's distinctive designation, trademark, and date code, but in close proximity thereto, preferably below.

The markings shall be located so as to be visible when the glass is fitted in the vehicle.

Each manufacturer or distributor who cuts a section of safety glazing material shall mark that section in accordance with the requirements of this standard.

7.2 Bullet-Resistant Markings: Bullet-resistant glazing shall be marked as required herein except that following the letters AS and the numeral, the level shall be designated, in letters at least 1.78 mm (0.070 in) in height as specified in 1.1.

7.3 Modified Glazing Markings: All modifications to the glazing materials made by someone other than the original glazing manufacturer shall be permanently marked on the glazing. Such modifications include but are not limited to a change in size, drilling, chemical treatment or repair. All such modifications, even when done with the expectation that compliance to this standard will be retained, shall be designated by subsequent permanent markings in characters at least 1.78mm (0.070") in height. The markings shall indicate the nature of the change, the date (month and year), the location in which the change occurred, and a unique code that designates the change agent (e.g., body shop code, etc). The following codes shall be used as the leading character:

S = Size change
R = Repair
H = Holes added
T = Treatment or other change

For example, modification code S 0811 AZ 234239 represents glazing that is installed by cutting down a larger piece of glazing during August, 2011 in Arizona by shop 234239.

7.4 Limit Markings: Glazing materials, which in a single sheet of material are intentionally made with an area having a luminous transmittance of not less than 70%, adjoining an area that has less than 70% luminous transmittance, shall be permanently marked at the edge of the sheet to show the limits of the area that is intended to comply with Test 2. The markings shall be $\overline{\mathbf{A} \downarrow \mathbf{S1}}$, $\underline{\mathbf{A} \uparrow \mathbf{S2}}$, $\overline{\mathbf{A} \downarrow \mathbf{S14}}$, and so forth, the direction of the arrow indicating the portion of the material that complies with Test 2 and the number indicating the item with which that portion of the sheet complies. This marking shall be in addition to the marking described in 7.1.

7.5 Manufacturer's Markings: Each manufacturer of glazing materials designed to meet the requirements of Item 4A, Item 11C, Item 12, Item 13, Item 14, Item 15A, Item 15B, Item 16A or Item 16B shall affix a label, removable by hand without tools, to each item of such glazing materials. The label shall identify the product involved, specify instructions and agents for cleaning the material that will minimize the loss of transparency, and instructions for removing frost and ice and, at the option of the manufacturer, refer owners to the vehicle's Owner's Manual for more specific cleaning and other instructions. Further, each manufacturer of glazing materials designed to meet the requirements of Item 14, Item 15A, Item 15B, Item 16A and Item 16B may permanently and indelibly mark the lower center of each item of such glazing material, in letters not less than 4.8 mm (3/16 in) nor more than 6.35 mm (1/4 in) high, with the following words, "GLASS PLASTIC MATERIAL - SEE OWNER'S MANUAL FOR CARE INSTRUCTIONS."

APPENDIX (This appendix is Section 4.2 of ANSI/SAE Z26.1-2007. It is a summary of Section 4.1. In the case of any inconsistency between Section 4.1 and Table A1, Section 4.1 shall take precedence.)

TABLE A1 - GLAZING MATERIAL APPLICABILITY IN MOTOR VEHICLES

Vehicle Type	Glazing Location in Vehicle	GLAZING MATERIAL APPLICABLE WHEN MARKED WITH "AS" DESIGNATION INDICATED BELOW	
		At Levels Requisite for Driving Visibility[1,2]	At Levels Not Requisite for Driving Visibility[1]
Passenger cars	Windshields	1, 10, 11C[3], 14[4]	—
	Interior partitions, auxiliary wind deflectors	1, 2, 4, 4A, 10, 11A, 11C[3], 14, 15A, 15B	—
	Flexible curtains, readily removable windows, ventilators used in conjunction with readily removable windows, rear windows in tops of convertible cars	1, 2, 4, 4A, 6, 10, 11A, 11C[3], 14, 15A, 15B	—
	Openings in roofs not required for driving visibility	—	1, 2, 3, 4, 4A, 5, 10, 11A, 11B, 11C, 12, 14, 15A, 15B, 16A, 16B
	Side windows between the "C" and "D" pillars in any station wagon and hatchback if not laterally adjacent to an outboard designated seating position	1, 2, 4A, 10, 11A, 11C[3], 14, 15A, 15B	—
	All other glazing except as listed above	1, 2, 10, 11A, 11C[3], 14, 15A, 15B	1, 2, 3, 10, 11A, 11B, 11C, 14, 15A, 15B, 16A, 16B
Taxicabs	Windshields	1, 10, 11C[3], 14[4]	—
	Interior partitions, auxiliary wind deflectors, windows in rear doors	1, 2, 4, 4A, 10, 11A, 11C[3], 14, 15A, 15B	—
	Openings in roofs not required for driving visibility	—	1, 2, 3, 4, 4A, 5, 10, 11A, 11B, 11C, 12, 14, 15A, 15B, 16A, 16B
	Flexible curtains, readily removable windows, ventilators used in conjunction with readily removable windows	1, 2, 4, 4A, 6, 10, 11A, 11C[3], 14, 15A, 15B	—
	All other glazing except as listed above	1, 2, 10, 11A, 11C[3], 14, 15A, 15B	1, 2, 3, 10, 11A, 11C, 14, 15A, 15B, 16A, 16B
Trucks and truck tractors	Windshields	1, 10, 11C[3], 14[4]	—
	Glazing to immediate right and left of driver	1, 2, 10, 11A, 11C[3], 14, 15A, 15B	—
	Rearmost window if used for driving visibility	1, 2, 8, 10, 11A, 11C[3], 14, 15A, 15B	—
	Openings in roofs not required for driving visibility	—	1, 2, 3, 4, 4A, 5, 10, 11A, 11B, 11C, 12, 13, 14, 15A, 15B, 16A, 16B
	Glazing to rear of driver where other means to afford visibility of the highways is provided	—	1, 2, 3, 4, 4A, 5, 8, 9, 10, 11A, 11B, 11C, 14, 15A, 15B, 16A, 16B
	Folding doors	1, 2, 4, 4A, 8, 10, 11A, 11C[3], 14, 15A, 15B	1, 2, 3, 4, 4A, 5, 8, 9, 10, 11A, 11B, 11C, 14, 15A, 15B, 16A, 16B
	All other glazing except as listed above	1, 2, 10, 11A,11C[3] , 14, 15A, 15B	1, 2, 3, 10, 11A, 11C, 14, 15A, 15B, 16A, 16B

[1] The numbers shown are item numbers as described in Section 4, Application of Tests, and as used in Table 1.

[2] Glazing material that is intentionally made so that only a portion of a single sheet has a luminous transmittance of not less than 70 % shall be marked at the edge of the sheet to show the limits of the area that may be used at levels requisite for driving visibility. The marks **A ↓ S1**, **A ↑ S2**, **A ↓ S14**, etc., shall be used, with the arrow pointing to the portion of the sheet having a luminous transmittance of not less than 70 %, and the number indicating the item with which that portion of the sheet complies.

[3] The combined parallel luminous transmittance with perpendicular incidence through both the shield and the permanent vehicle glazing is to be at least 60 %.

[4] May not be used in windshields of any of the following vehicles: convertibles, vehicles that have no roof, vehicles whose roofs are completely removable.

TABLE A1 (CONTINUED)

Vehicle Type	Glazing Location in Vehicle	GLAZING MATERIAL APPLICABLE WHEN MARKED WITH "AS" DESIGNATION INDICATED BELOW	
		At Levels Requisite for Driving Visibility[1,2]	At Levels Not Requisite for Driving Visibility[1]
Buses	Windshields	1, 10, 11C[3], 14[4]	—
	Glazing to immediate right and left of the driver	1, 2, 10, 11A, 11C[3], 14, 15A, 15B	—
	Rearmost window if used for driving visibility	1, 2, 8, 10, 11A, 11C[3], 14, 15A, 15B	—
	Rearmost window if not used for driving visibility	—	1, 2, 3, 5, 8, 10, 11A, 11B, 11C, 12, 14, 15A, 15B
	Interior partitions	1, 2, 4, 4A, 10, 11A, 11C[3], 14, 15A, 15B	1, 2, 3, 4, 4A, 5, 10, 11A, 11B, 11C, 12, 13, 14, 15A, 15B, 16A, 16B
	Auxiliary wind deflectors	1, 2, 4, 4A, 10, 11C[3] 11A, 14, 15A, 15B	1, 2, 3, 4, 4A, 5, 10, 11A, 11B, 11C, 12, 14, 15A, 15B, 16A, 16B
	Folding doors	1, 2, 4, 4A, 8, 10, 11A, 11C[3], 14, 15A, 15B	1, 2, 3, 4, 4A, 5, 8, 9, 10, 11A, 11B, 11C, 12, 14, 15A, 15B, 16A, 16B
	Standee windows	—	1, 2, 3, 4, 4A, 5, 8, 9, 10, 11A, 11B, 11C, 12, 13, 14, 15A, 15B, 16A, 16B
	Openings in roofs not required for driving visibility	—	1, 2, 3, 4, 4A, 5, 10, 11A, 11B, 11C, 12, 14, 15A, 15B, 16A, 16B
	Flexible curtains, readily removable windows, ventilators used in conjunction with readily removable windows	1, 2, 4, 4A, 6, 10, 11A, 11C[3], 14, 15A, 15B	1, 2, 3, 4, 4A, 5, 6, 7, 10, 11A, 11B, 11C, 12, 13, 14, 15A, 15B, 16A, 16B
	All other glazing except as listed above	1, 2, 10, 11A, 11C[3], 14, 15A, 15B	1, 2, 3, 10, 11A, 11B, 11C, 12, 14 15A, 15B, 16A, 16B
Motorhomes	Windshields	1, 10, 11C[3], 14[4]	—
	Glazing to immediate right and left of driver	1, 2, 10, 11A, 11C[3], 14, 15A, 15B	—
	Forward-facing windows	—	1, 2, 3, 4, 4A, 5, 10, 11A, 11B, 11C, 12, 14, 15A, 15B, 16A, 16B
	Windows and doors other than the windshield, forward-facing windows, and glazing to immediate right and left of the driver	—	1, 2, 3, 4, 4A, 5, 6, 7, 8, 9, 10, 11A, 11B, 11C, 12, 13, 14, 15A, 15B, 16A, 16B
	All other glazing except as listed above	1, 2, 10, 11A, 11C[3], 14, 15A, 15B	1, 2, 3, 10, 11A, 12, 13, 14, 15A, 15B, 16A, 16B
Trailers	All glazing	1, 2, 3, 4, 4A, 5, 6, 7, 8, 9, 10, 11A, 11B, 11C, 12, 13, 14, 15A, 15B, 16A, 16B	
Motorcycles	Windscreens	1, 6, 10, 11A, 11C[3]	1, 5, 6, 7, 10, 11C[3], 12, 13, 14
Slide-in Campers and Pickup Covers	Forward-facing windows	1, 2, 3, 4, 4A, 5, 8, 9, 10, 11A, 11B, 11C, 12, 14, 15A, 15B, 16A, 16B	
	All other glazing except as listed above	1, 2, 3, 4, 4A, 5, 6, 7, 8, 9, 10, 11A, 11B, 11C, 12, 13, 14, 15A, 15B, 16A, 16B	

[1] The numbers shown are item numbers as described in Section 4, Application of Tests, and as used in Table 1.

[2] Glazing material that is intentionally made so that only a portion of a single sheet has a luminous transmittance of not less than 70 % shall be marked at the edge of the sheet to show the limits of the area that may be used at levels requisite for driving visibility. The marks **A ↓ S1**, **A ↑ S2**, **A ↓ S14**, etc., shall be used, with the arrow pointing to the portion of the sheet having a luminous transmittance of not less than 70 %, and the number indicating the item with which that portion of the sheet complies.

[3] The combined parallel luminous transmittance with perpendicular incidence through both the shield and the permanent vehicle glazing is to be at least 60 %.

[4] May not be used in windshields of any of the following vehicles: convertibles, vehicles that have no roof, vehicles whose roofs are completely removable.