

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

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ANSI/SAE Z26.1-1996**

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Foreword

(This foreword is not part of American National Safety Standard Z26.1-1996.)

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 is 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 so far advanced 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, plastic materials.

Early in its deliberations, the Z26 Committee recognized the fact that no one set of specifications or methods of test could well 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 whether they may be broken or unbroken.

It is the fundamental 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 does not state that safety glazing materials shall be used or to what extent they shall be used in glazing motor vehicles and motor vehicle equipment. Such requirements rest with either the legislative or administrative authority. When by law or regulation escape or emergency egress openings are required and when such requirement is met by use of glazed openings, Test 25 (see 5.25) is provided as a means of measuring and establishing the escape value of the safety glazing material.

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. All seven types are commercially feasible today. Each of them possesses its own distinctive safety characteristics. The seven types are listed below and are described in Section 1.

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

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. It is felt, however, that uniform requirements are very much needed, that the standard in its present form permits the use of the more desirable types of safety glazing materials now commercially available, and that it distinguishes between the better and the poorer grades of those types, as well as prescribing and, in some cases, limiting the places at which certain types may be used.

Definitions are provided in Section 1.

Footnotes to this standard are included for purposes of clarification.

Suggestions for improvement of this standard will be welcome. They should be sent to the Secretariat at the Society of Automotive Engineers, Inc., 3001 W. Big Beaver Road, Suite 320, Troy, Michigan 48084.

This standard was processed and approved for submittal to ANSI by the Society of Automotive Engineers/American National Standards Committee on Specifications and Methods of Test for Safety Glazing Material, Z26. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the Z26 Committee had the following members:

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1. Definitions

1.1 Bullet-Resistant Glazing

The term "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 27, Ballistics).

Bullet-resistant glazing for motor vehicles operating on land highways is available in four types:

- (1) Type MP glazing, ballistically resistant to 9 mm full metal copper jacket with lead core medium-power small arms ammunition; muzzle velocity 358 m/s (1175 ft/s).
- (2) Type HP glazing, ballistically resistant to .357 Magnum jacketed lead soft point high-power small arms ammunition; muzzle velocity 381 m/s (1250 ft/s).
- (3) Type SP glazing, ballistically resistant to .44 Magnum lead semi-wadcutter gas checked super-power small arms ammunition; muzzle velocity 411 m/s (1350 ft/s).
- (4) Type RR glazing, ballistically resistant to high-power rifle ammunition; .30 caliber rifle lead core soft point; muzzle velocity 774 m/s (2540 ft/s). 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 types provided that they satisfactorily meet the requirements of 1.1 through 3.1 and 13.1 through 13.3 of UL 752 1995, Standard for Bullet-Resistant Equipment.

1.2 Bullet-Resistant Shield

The term "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

The term "bus" means a motor vehicle with motive power (except a trailer) designed to carry more than ten persons¹.

1.4 Camper

The term "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 persons.

1.5 Glass-Plastic Glazing Material

The term "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.

1.6 Laminated Glass

The term "laminated glass" means two or more pieces of sheet, plate, or 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 hole is produced, the edges are likely to be less jagged than would be the case with ordinary annealed glass.

1.7 Manufacturer

The term "manufacturer" means a person who fabricates, laminates, or tempers safety glazing material.

1.8 Model Number

The term "model number" means a designation assigned by a glazing manufacturer to a specific safety glazing material and related by that manufacturer to a detailed description of that safety glazing material.

1.9 Motorhome

The term "motorhome" means a multipurpose passenger vehicle that provides living accommodations for persons.

1.10 Motor Vehicle

The term "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.

1.11 Multiple Glazed Unit

The term "multiple glazed unit" means two or more sheets 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 appropriate 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 appropriate requirements of this standard.

¹ "Persons" are every natural person, firm, co-partnership, association or corporation.

1.12 Multipurpose Passenger Vehicle (MPV)

The term "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.

1.13 Passenger Car

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

1.14 Pickup Cover

The term "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.

1.15 Plastic

The term "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.

1.16 Readily Removable Windows

The term "readily removable windows" means windows that can be quickly and completely removed from the motor vehicle without tools. Readily removable windows in buses having a GVWR of more than 4540 kg (10 000 lbs), which are required to include push-out 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.

1.17 Safety Glass

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

1.18 Safety Glazing Materials

A product consisting of organic and/or inorganic materials so constructed or treated to reduce, in comparison with annealed sheet, plate, or float glass, the likelihood of injury to persons as a result of contact with these safety glazing materials when used in a vehicle, whether they may be broken or unbroken, and for which special requirements regarding visibility, strength and abrasion resistance are set forth.

1.19 Safety Glazing Plastics

The term "safety glazing plastics" includes any safety glazing material, predominantly synthetic organic in character, that meets the appropriate requirements of this standard,

including single-ply and laminated products whether rigid or flexible.

1.20 Slide-in Camper

The term "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.

1.21 Tempered Glass

The term "tempered glass" means a single piece of specially treated sheet, plate, or float glass possessing mechanical strength substantially higher than annealed glass. 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.

(Other terms such as "heat treated glass," "toughened glass," "case hardened glass," and "chemically tempered glass" are used also).

1.22 Trailer

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

1.23 Truck

The term "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 sheet glass, plate glass, or 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 "bullet-proof," 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 obtainable qualities for its acceptance under this standard. Many of the tests are of such severity that even a satisfactory product will 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 362-84, Standard Specification for Industrial Grade Toluene²

ASTM D 618-95, Methods of Conditioning Plastics and Electrical Insulating Materials for Testing²

ASTM D 1003-92, Method of Test for Haze and Luminous Transmittance of Transparent Plastics²

ASTM D 1044-94, Method of Test for Haze and Luminous Transmittance of Transparent Plastics²

ASTM D 2240-91, Standard Method of Test for Durometer Hardness of Rubber Property²

ASTM D 3699-92, Specification for Kerosene²

ASTM D 4329-92 Standard Practice for Operating Light and Water Apparatus (Fluorescent UV and Condensation Type) for Exposure of Plastics²

ASTM G 53-88 Standard Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV and Condensation Type) for Exposure of Nonmetallic Materials²

1985 Annual Book of ASTM Standards²

SAE J673 APR93, Automotive Safety Glazing³

SAE J2020 JUN89 Accelerated Exposure of Automotive Exterior Materials Using a Fluorescent UV and Condensation Apparatus³

ISO 3536/1-92 Road vehicles - Safety glazing materials - Vocabulary - Part 1⁴

ISO 3537-93 Road vehicles - Safety glazing materials - Test methods for mechanical properties⁴

ISO 3538-78 Road vehicles - Safety glazing materials - Test methods for optical properties⁴

ISO 3917-92 Road vehicles - Safety glazing materials - Test methods for resistance to radiation, High temperature, humidity, fire, and simulated weathering⁴

ISO 4892-1 Plastics—Methods of exposure to laboratory light sources—Part 1: General guidance⁴

ISO 4892-2 Plastics—Methods of exposure to laboratory light sources—Part 2: Xenon-arc sources⁴

ISO 4893-3 Plastics—Methods of exposure to laboratory light sources—Part 3: Fluorescent UV lamps⁴

ISO 4892-4:1994 Methods of exposure to laboratory light sources—Part 4: Open-flame carbon-arc lamps⁴

FMVSS 210, 49 CFR 571.210 Seat Belt Assembly Anchorages⁵

OSHA Standard 29 CFR 1910.106 - "Handling Storage and Use of Flammable Combustible Liquids"⁶

UL 752-1995, Safety Standard for Bullet Resistant Equipment⁷

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 3.2 to 3.9.

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.

3.2 Tempered Glass

3.2.1 The following specimens shall be submitted in the case of tempered glass:

- (1) Twenty 305 mm x 305 mm (12 in x 12 in), substantially flat specimens or, optionally, seventeen 305 mm x 305 mm (12 in x 12 in) and three 76 mm x 305 mm (3 in x 12 in), substantially flat specimens.

² Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

³ Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

⁴ Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

⁵ Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

⁶ Available from OSHA Publication Office, Room S-4203, 200 Constitution Avenue, NW, Washington, DC 20210.

⁷ Available from Underwriters Laboratories Inc., Publications, 333 Pfingsten Road, Northbrook, IL 60062.

- (2) Three 102 mm x 102 mm (4 in x 4 in), flat specimens⁸ having both surfaces substantially plane and parallel, with a 6.35 mm (¼ in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (¼ in) hole is not necessary.
- (3) Six production parts representing each model number construction for Fracture, Test 7.

3.3 Laminated Glass

3.3.1 The following specimens shall be submitted in the case of laminated glass for windshield use:

- (1) Thirty-six 305 mm x 305 mm (12 in x 12 in), substantially flat specimens or, optionally, thirty-three 305 mm x 305 mm (12 in x 12 in) and three 76 mm x 305 mm (3 in x 12 in), substantially flat specimens.
- (2) Three 102 mm x 102 mm (4 in x 4 in), flat specimens having both surfaces substantially plane and parallel, with a 6.35 mm (¼ in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (¼ in) hole is not necessary.
- (3) Where curved laminated safety glass is proposed for use in windshields, three additional specimens shall be submitted. These specimens shall be approximately 305 mm x 305 mm (12 in x 12 in) in size and shall be cut from the windshield at the section of greatest curvature (minimum radius).

3.3.2 The following specimens shall be submitted in the case of laminated glass for glazing applications other than windshields:

- (1) Twenty-six 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, or, optionally, twenty-three 305 mm x 305 mm (12 in x 12 in) and three 76 mm x 305 mm (3 in x 12 in), substantially flat specimens.
- (2) Three 102 mm x 102 mm (4 in x 4 in), flat specimens having both surfaces substantially plane and parallel, with a 6.35 mm (¼ in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (¼ in) hole is not necessary.

3.4 Glass-Plastic Glazing Materials⁹

3.4.1 The following specimens shall be submitted in the case of glass-plastic glazing materials for windshield use:

- (1) Thirty-eight 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, or optionally, thirty-five

305mm x 305 mm (12 in x 12 in) and three 76 mm x 305mm (3 in x 12 in), substantially flat specimens.

- (2) Six 102 mm x 102 mm (4 in x 4 in), flat specimens having both surfaces substantially plane and parallel, with a 6.35 mm (¼ in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (¼ in) hole is not necessary.
- (3) Three 102 mm x 102 mm (4 in x 4 in), flat specimens representing the face that would be mounted to the exterior of the vehicle.
- (4) Ten 25 mm x 178 mm (1 in x 7 in), substantially flat specimens.
- (5) Three 13 mm x 152 mm (1/2 in x 6 in), substantially flat specimens.
- (6) Where curved glass-plastic glazing material is proposed for use in windshields, three additional specimens shall be submitted. These specimens shall be approximately 305 mm x 305 mm (12 in x 12 in) in size and shall be cut from the windshield at the section of greatest curvature (minimum radius).

3.4.2 The following specimens shall be submitted in the case of glass-plastic materials for glazing applications other than windshields:

3.4.2.1 In the case of glass-plastic glazing materials for use in areas requisite for driving visibility.

- (1) Twenty-eight 305 mm x 305 mm (12 in x 12 in), substantially flat specimens or, optionally, twenty-five 305 mm x 305 mm (12 in x 12 in) and three 76 mm x 305 mm (3 in x 12 in), substantially flat specimens.
- (2) Six 102 mm x 102 mm (4 in x 4 in), flat specimens having both surfaces substantially plane and parallel, with a 6.35 mm (¼ in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (¼ in) hole is not necessary.
- (3) Three 102 mm x 102 mm (4 in x 4 in), flat specimens representing the face that would be mounted to the exterior of the vehicle.
- (4) Ten 25 mm x 178 mm (1 in x 7 in), substantially flat specimens.
- (5) Three 13 mm x 152 mm (1/2 in x 6 in), substantially flat specimens.
- (6) In addition, for tempered glass-plastic glazing materials, for Fracture, Test 7, six production parts representing each model construction shall be furnished for the test.

⁸ Not required for glazings used in areas not requisite for driving visibility.

⁹ The inward facing surface of each glass-plastic laminated glazing specimen as mounted in the vehicle, shall be identified.

3.4.2.2 In the case of glass-plastic glazing materials for use in areas not requisite for driving visibility.

- (1) Twenty-five 305 mm x 305 mm (12 in x 12 in), substantially flat specimens.
- (2) Three 102 mm x 102 mm (4 in x 4 in), flat specimens representing the face that would be mounted to the exterior of the vehicle.
- (3) Ten 25 mm x 178 mm (1 in x 7 in), substantially flat specimens.
- (4) Three 13 mm x 152 mm (1/2 in x 6 in), substantially flat specimens.
- (5) In addition, for tempered glass-plastic glazing materials, for Fracture, Test 7, six production parts representing each model construction shall be furnished for the test.

3.5 Multiple Glazed Units

In the case of multiple glazed units, which for the purposes of this standard are divided into two classes, the specimens described in 3.5.1 and 3.5.2 shall be furnished as unitary structures in accordance with the commercial practice of the manufacturer.

3.5.1 Class 1. If each of the individual components of the multiple glazed unit comply with this standard, the specimens described in 3.5.1.1 and 3.5.1.2 are required.

3.5.1.1 For Windshield Use:

- (1) Ten 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, or, optionally, seven 305 mm x 305 mm (12 in x 12 in) and three 76 mm x 305 mm (3 in x 12 in), substantially flat specimens shall be furnished.
- (2) Where curved multiple glazed units are proposed for use in windshields, three additional specimens shall be furnished. 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).

3.5.1.2 For glazing applications other than windshields, three 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, or, optionally, three 76 mm x 305 mm (3 in x 12 in), substantially flat specimens shall be furnished.

3.5.2 Class 2. If any of the individual components of the multiple glazed unit do not comply with this standard, the specimens described in 3.5.2.1 through 3.5.2.3 are required.

3.5.2.1 For Windshield Use:

- (1) Forty-five 305 mm x 305 mm (12 in x 12 in), substantially flat specimens shall be furnished. Where multiple glazed units are nonsymmetrical in construction rather than shape, twelve additional 305 mm x 305 mm (12 in x 12 in), substantially flat specimens are required.

- (2) Three 102 mm x 102 mm (4 in x 4 in), flat glazing specimens representing the exterior component, in relation to the vehicle, of the multiple glazed unit shall be furnished. These specimens shall have both surfaces substantially plane and parallel, with a 6.35 mm (1/4 in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (1/4 in) hole is not necessary.
- (3) Where curved multiple glazed units are proposed for use in windshields, three additional specimens shall be furnished. 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).

3.5.2.2 For Glazing Applications Other Than Windshields in the First Group Under Class 2:

- (1) Thirty-five 305 mm x 305 mm (12 in x 12 in), substantially flat specimens shall be furnished. Where multiple glazed units are nonsymmetrical in construction rather than shape, twelve additional 305 mm x 305 mm (12 in x 12 in), substantially flat specimens are required.
- (2) Three 102 mm x 102 mm (4 in x 4 in), flat glazing specimens representing the exterior component, in relation to the vehicle, of the multiple glazed unit shall be furnished. These specimens shall have both surfaces substantially plane and parallel, with a 6.35 mm (1/4 in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (1/4 in) hole is not necessary.

3.5.2.3 For Glazing Applications Other Than Windshields in the Second Group Under Class 2:

- (1) Thirty-five 305 mm x 305 mm (12 in x 12 in), substantially flat specimens shall be furnished. Where multiple glazed units are nonsymmetrical in construction rather than shape, twelve additional 305 mm x 305 mm (12 in x 12 in), substantially flat specimens are required.
- (2) Three 102 mm x 102 mm (4 in x 4 in), flat glazing specimens representing the exterior component, in relation to the vehicle, of the multiple glazed unit shall be furnished. These specimens shall have both surfaces substantially plane and parallel, with a 6.35 mm (1/4 in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (1/4 in) hole is not necessary.
- (3) Six production parts representing each model number construction for Fracture, Test 7.

3.6 Plastics More Than 1.27 mm (0.050 in) in Thickness

For plastics more than 1.27 mm (0.050 in) in thickness, the following specimens are required:

- (1) Seventeen 305 mm x 305 mm (12 in x 12 in), substantially flat specimens.
- (2) Six (nine for Item 4A) 102 mm x 102 mm (4 in x 4 in), flat specimens having both surfaces substantially plane and parallel, with a 6.35 mm (¼ in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (¼ in) hole is not necessary.
- (3) Eighteen 25 mm x 178 mm (1 in x 7 in), substantially flat specimens.
- (4) Two 152 mm x 152 mm x 6.35 mm (6 in x 6 in x ¼ in), substantially flat specimens.
- (5) Three 13 mm x 152 mm (1/2 in x 6 in), substantially flat specimens.
- (6) Three 102 mm x 102 mm (4 in x 4 in), flat specimens representing the face that would be mounted to the exterior of the vehicle.

3.7 Plastics 1.27 mm (0.050 in) in Thickness or Less

For plastics 1.27 mm (0.050 in) in thickness or less, the following specimens are required:

- (1) Three 102 mm x 102 mm (4 in x 4 in), flat specimens representing the face that would be mounted to the exterior of the vehicle.
- (2) Eighteen 25 mm x 178 mm (1 in x 7 in), substantially flat specimens.
- (3) Two 64 mm x 254 mm (2½ in x 10 in), substantially flat specimens.
- (4) Six 318 mm x 25 mm (12½ in x 1 in), substantially flat specimens.

3.8 Bullet-Resistant Glazing**3.8.1 For Laminated Glass:**

- (1) Twelve 305 mm x 305 mm (12 in x 12 in), substantially flat specimens shall be furnished.
- (2) Where curved bullet-resistant glazings are proposed for use in windshields, three additional specimens shall be furnished. 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.
- (3) Three 102 mm x 102 mm x 6.35 mm (4 in x 4 in x ¼ in), flat specimens representing the face that would be mounted to the exterior of the vehicle shall be furnished. These specimens shall have both surfaces substantially plane and parallel, with a 6.35 mm (¼ in) diameter hole

centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (¼ in) hole is not necessary.

3.8.2 For Plastic:

- (1) Ten 305 mm x 305 mm (12 in x 12 in), substantially flat specimens shall be furnished. Where bullet-resistant plastic glazing (see Item 11b) is of a monolithic configuration, only five 305 mm x 305 mm (12 in x 12 in), specimens are required.
- (2) Three 102 mm x 102 mm (4 in x 4 in), flat glazing specimens of 6.35 mm (¼ in), flat specimens representing the face that would be mounted to the exterior of the vehicle shall be furnished. These specimens shall have both surfaces substantially plane and parallel, with a 6.35 mm (¼ in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (¼ in) hole is not necessary.
- (3) Three 102 mm x 102 mm (4 in x 4 in), flat specimens representing the face that would be mounted to the exterior of the vehicle.
- (4) Eighteen 25 mm x 178 mm (1 in x 7 in), substantially flat representative specimens of 6.35 mm (¼ in) thickness shall be furnished.
- (5) Two 152 mm x 152 mm (6 in x 6 in), substantially flat specimens shall be furnished. Where the bullet-resistant glazing is of monolithic configuration, these specimens shall be of 6.35 mm (1/4 in) thickness.
- (6) Three 152 mm x 152 mm x 6.35 mm (6 in x 6 in x ¼ in), substantially flat specimens shall be furnished. Where the bullet-resistant glazing is of monolithic configuration, these specimens shall be of 6.35 mm (¼ in) thickness.

3.8.3 For Bullet-Resistant Shields:

- (1) Ten 305 mm x 305 mm (12 in x 12 in), substantially flat specimens shall be furnished. Where bullet-resistant shields (see Item 11c) are of a monolithic configuration only, five 305 mm x 305 mm (12 in x 12 in), specimens are required.
- (2) Where curved bullet-resistant shields are proposed for use in conjunction with windshields, three additional specimens shall be furnished. These specimens shall be complete bullet-resistant shields 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 bullet-resistant shields.
- (3) Three 102 mm x 102 mm (4 in x 4 in), flat glazing specimens of 6.35 mm (¼ in), flat specimens representing the face that would be glazed to the outside of the vehicle shall be furnished. These specimens shall have both surfaces substantially plane and parallel, with a

6.35 mm (¼ in) diameter hole centrally drilled therethrough. Where fixturing for mounting specimens on a Taber Abraser is available, the 6.35 mm (¼ in) hole is not necessary.

- (4) Three 102 mm x 102 mm (4 in x 4 in), flat specimens representing the face that would be mounted to the exterior of the vehicle.
- (5) Twenty 25 mm x 178 mm (1 in x 7 in), substantially flat representative specimens of 6.35 mm (¼ in) thickness shall be furnished.
- (6) Two 152 mm x 152 mm (6 in x 6 in), substantially flat specimens shall be furnished. Where the bullet-resistant shield glazing is of monolithic configuration, these specimens shall be of 6.35 mm (¼ in) thickness.
- (7) Three 13 mm x 152 mm (1/2 in x 6 in), substantially flat specimens shall be furnished.

3.9 Specimens for Egress Test 25

When safety glazing material is to be tested for compliance with Test 25 (see 5.25), five specimens of the safety glazing material to be tested and five specimens of laminated safety glass of identical size and shape and meeting the requirements given in 5.25.2 are required. In addition, the vehicle body, a section of vehicle body including the opening for which the specimens are designed, or an equivalent framing, rigidly supported, shall be provided.

4. Application of Tests

4.1 Condition of Specimens

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

4.2 Grouping of Tests

The groups of tests listed in this subsection and shown in Table 1, item by item, are deemed adequate for determining the locations in the motor vehicle for which the various safety glazing materials that qualify under this standard may be suitable. The different characteristics of the various safety glazing materials that qualify under this standard make specific groupings of tests necessary, and individual tests in one group may not be substituted for individual tests in another group.

Safety glazing materials in motor vehicles shall comply with the applicable requirements listed in this subsection and shown in Table 1, item by item, in definite groupings of tests that are appropriate for the safety glazing material in question, and the location in the motor vehicle in which it is intended to be used. Additionally, safety glazing materials shall comply with the marking and labeling requirements appropriate for the given safety glazing material as shown in Section 7, Marking of Safety Glazing Materials.

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) Tests 1, 2¹⁰, 3, 4, 9, 12, 15, 18, and 26; or
- (b) Multiple glazed units, Class 1¹¹, that comply with the sets of tests designated in (a), and the assembled unit of which complies with Tests 1, 2¹⁰, and 15; or
- (c) Multiple glazed units, Class 2¹¹, that comply with Tests 1, 2¹⁰, 3, 5, 9, 12, 14, 15, 18, and 26.

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) Tests 1, 2¹⁰, 3, 4, 9, 12, and 18; or
- (b) Tests 1, 2¹⁰, 6, 7, 8, and 18; or
- (c) Multiple glazed units, Class 1¹¹, the individual component units of which comply with one or another of the sets of tests immediately above designated; and the assembled unit of which complies with Tests 1 and 2¹⁰; or
- (d) Multiple glazed units, Class 2¹¹, that comply with Tests 1, 2¹⁰, 3, 5, 9, 12, 14, and 18; or Tests 1, 2¹⁰, 3, 5, 6, 7, 8, 14, and 18.

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), or (d) 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) Tests 1, 3, 4, 9, and 12; or
 - (b) Tests 6, 7, and 8; or
 - (c) Multiple glazed units, Class 1¹², the individual component units of which comply with one or

¹⁰ Glazing materials that in a single sheet have some areas with a light transmittance of less than 70 % and are intended for use at levels requisite for driving visibility are to be permanently marked at the edge of the sheet to show what portion of the material may be used at levels requisite for driving visibility. The portion of the glazing materials intended for use at levels requisite for driving visibility must comply with Test 2.

¹¹ Multiple glazed units are classified only for convenience in designating test procedures. See 1.11 for multiple glazed unit classification.

another of the sets of tests designated in (a) and (b), and the assembled unit of which complies with Test 1; or

- (d) Multiple glazed units, Class 2¹², that comply with Tests 1, 3, 5, 9, 12 and 14; or Tests 1, 3, 5, 6, 7, 8, and 14.

Item 4. Safety Glazing Materials for Use in Motor Vehicles Only in the Following Specific Locations. Safety glazing materials that comply with Tests 2, 10, 13, 16, 17, 19, 20, 21, and 24 may be used in a motor vehicle only in the following specific locations:

- (a) Interior partitions and auxiliary wind deflectors.
- (b) Folding doors.
- (c) Standee windows in buses.
- (d) Flexible curtains or readily removable windows or in ventilators used in conjunction with readily removable windows.
- (e) Openings in the roof not requisite for driving visibility.
- (f) Trailers.
- (g) Glazing to the rear of the driver in trucks or truck tractor cabs where other means of affording visibility of the highway to the side and rear of the vehicle are provided.
- (h) The rear windows of convertible passenger car tops.
- (i) The rear doors of taxicabs.
- (j) Readily removable windows of buses having a GVWR of more than 4540 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, 10, 13, 16, 17, (on the interior side only), 17 as modified in 5.17.4 (exterior side only), 19, 20, 21, and 24 may be used in the following specific locations:

- (a) In all areas in which Item 4 safety glazing may be used.
- (b) In a vehicle whose rearmost designated seating position is forward-facing and cannot be adjusted so that it is side or rear-facing and, the forwardmost point on the visible interior surface of the glazing, 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 10, 13, 16, 19, 20, 21, and 24 may be used in a motor vehicle only in the following specific locations at levels not requisite for driving visibility:

- (a) Interior partitions and auxiliary wind deflectors.
- (b) Folding doors.
- (c) Standee windows in buses.
- (d) Flexible curtains or readily removable windows or in ventilators used in conjunction with readily removable windows.
- (e) Openings in the roof not requisite for driving visibility.
- (f) Trailers.
- (g) Glazing to the rear of the driver in trucks or truck tractor cabs where other means of affording visibility of the highway to the side and rear of the vehicle are provided.
- (h) The rear windows of convertible passenger car tops.
- (i) Rear doors of taxicabs.
- (j) Readily removable windows of buses having a GVWR of more than 4540 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) For Item 5: Motorcycle windscreens below the intersection of a horizontal plane 381 mm (15 in) vertically above the lowest seating position.

¹² Multiple glazed units are classified only for convenience in designating test procedures. See 1.11 for multiple glazed unit classification.

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 Windcreens for Motorcycles, in Flexible Curtains or Readily Removable Windows, or in Ventilators Used in Conjunction with Readily Removable Windows. Safety glazing materials that comply with Tests 2, 16, 19, 20, 22, and either 23 or 24 may be used in a motor vehicle only in the following specific locations:

- (a) Trailers.
- (b) The rear windows of convertible passenger car tops.
- (c) Windcreens 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 Windcreens for Motorcycles, in Flexible Curtains or Readily Removable Windows, or in Ventilators Used in Conjunction with Readily Removable Windows. Safety glazing materials that comply with Tests 16, 19, 20, 22, and either 23 or 24 may be used in a motor vehicle only in house- or property-carrying trailers and at levels not requisite for driving visibility in the following specific locations:

- (a) The rear windows of convertible passenger car tops.
- (b) Windcreens 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, 5, 11, 14, and 18 may be used in a motor vehicle only in the following specific locations:

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

Item 9. Safety Glazing Material for Use Only in Trailers, Multipurpose Passenger Vehicles, Slide-in Campers, Pickup Covers Designed to Carry Persons While in Motion, Motorhomes, Standee Windows in Buses, and at Levels Not Requisite for Driving Visibility in Folding Doors, Rear of Driver in Trucks or Truck Tractors, and Rearmost Windows in Buses. Safety glazing materials in multiple glazed units that comply with Tests 1, 3, 5, 11, and 14, may be used in a motor vehicle only in trailers, standee windows in buses, and at levels not requisite for driving visibility in the following specific locations:

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

Item 10. Safety Glazing Material for Use Where Bullet Resistance is Required Anywhere in Motor Vehicle. Bullet-resistant glazings that comply with Tests 18¹³, 27, 28, 29, 30, 31, and 32 may be used anywhere in a motor vehicle.

Item 11A. Safety Glazing Material for Use Where Bullet Resistance is Required in Motor Vehicle Except Windshields. Bullet-resistant glazings that comply with Tests 18¹³, 27, 28, 29, 30, and 31 may be used anywhere in a motor vehicle except windshields.

Item 11B. Safety Glazing Material for Use Where Bullet Resistance is Required in 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 19¹³, 20¹³, 21¹⁴, 24¹⁴, 27, 28¹⁵, and 29¹⁵, may be used anywhere in a motor vehicle except windshields, glazing of windows to the immediate right or left of the driver, and in rearmost window if the latter is requisite for driving visibility.

Item 11C. Safety Glazing Material for Use in Bullet-Resistant Shields. Bullet-resistant glazing material that complies with Tests 2, 17, 19, 20, 21, 24, 27, 28, 29, 30, and 32 and the labeling requirements of Section 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 10, 13, 16, 19, 20, 21, and 24, with the exception of the test for resistance to undiluted denatured alcohol Formula SD No. 30, 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 16, 19, 20, 22, and 23 or 24, with the exception of the test for resistance to undiluted denatured alcohol Formula SD No. 30, 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, 12, 15, 16, 17, 18, 19, 24, 26, and 28, may be used anywhere in a motor vehicle except that they may not be used in the windshields of the following vehicles: convertibles, vehicles that have no roof or vehicles whose roofs are completely removable.

Item 15A. Annealed Glass-Plastic for Use in All Positions in a Vehicle Except the Windshield. Glass-plastic glazing materials that comply with Tests 1, 2, 3, 4, 9, 12, 16, 17, 18, 19, 24, and 28 may be used anywhere in a motor vehicle except the windshield.

Item 15B. Tempered Glass-Plastic for Use in All Positions in a Vehicle Except the Windshield. Glass-plastic glazing materials that comply with Tests 1, 2, 3, 4, 6, 7, 8, 16, 17, 18, 19, 24, and 28 may be used anywhere in a motor vehicle except the windshield.

¹³ Flat representative specimens of 6.35 mm (¼ in) thickness are to be used.

¹⁴ Except for monolithic configurations, where specimens of 6.35 mm (¼ in) thickness are to be used, the specimen thickness is to correspond to that used in Test 27.

¹⁵ Test not required for monolithic configurations.

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, 12, 16, 19, 24, and 28 may be used in a motor vehicle in all locations not requisite for driving visibility.

Item 16B. Tempered Glass-Plastic For Use in All Positions in a Vehicle Not Requisite For Driving Visibility. Glass-plastic glazing materials that comply with Tests 3, 4, 6, 7, 8, 16, 19, 24, and 28 may be used in a motor vehicle in all locations not requisite for driving visibility.

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 the only ones 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.

Unless otherwise specified, interpretation of results should be made at the time the test is performed. This is necessary because in the case of some of these tests the condition of the specimen is subject to further change over a period of time.

Multiple glazed units shall be tested on both sides using separate specimens for each side in Test 14.

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, thereby indicating the suitability of the safety glazing material and 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 as submitted shall be tested for regular (parallel) luminous

transmittance at normal incidence calculated to International Commission on Illumination "Illuminant A."¹⁶

5.1.2.2 After the regular (parallel) luminous transmittance has been determined, the same three specimens shall be subjected to ultraviolet radiation.¹⁷ About ½ of each specimen shall be protected from the radiation. The operating exposure conditions^{18 19 20} shall be:

- (a) Continuous ultraviolet radiation only (no moisture cycle)
- (b) Operating temperature at 44 °C ± 2 °C (110 °F ± 3 °F)
- (c) Duration 100 hours
- (d) UV lamp(s) facing the specimen surface corresponding to the vehicle exterior
- (e) Average irradiance at specimen(s) throughout the test shall be 0.83 W/m²/nm ± 7 % measured at 340 nm²¹
- (f) If any irradiance deviates more than ± 15 % from 0.83 W/m²/nm at 340 nm, terminate the test until the cause of the deviation has been determined, corrected, and documented.
- (g) Maintain and calibrate the apparatus to the manufacturer's specifications

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

¹⁶ International Commission on Illumination "Illuminant A" consists of a tungsten lamp operated at a correlated color temperature of 2856° K. Suitable lamps properly aged and calibrated are obtainable from the Intertek Testing Services, 3933 Route 11, Cortland, NY 13045-0950.

¹⁷ This irradiance can be achieved with (1) a Uviarc 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 Scientific Instruments Company) or (4) a UVCON (Atlas Electric Devices Company) Accelerated Weathering Tester.

¹⁸ Ref. SAE J2020 Accelerated Exposure of Automotive Exterior Materials using a Fluorescent UV and Condensation Apparatus - Appendix B: Measurement of Irradiance.

¹⁹ Ref. ASTM G 53 Standard Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV and Condensation Type) for Exposure of Nonmetallic Materials.

²⁰ Ref. ASTM D 4329 Standard Practice for Operating Light and Water Apparatus (Fluorescent UV and Condensation Type) for Exposure of Plastics.

²¹ 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. A (1) CR10 (Q Panel Lab Products Company) or (2) IL1350 (International Light Company or equivalent meets this requirement.

5.1.3 Interpretation of Results. The regular (parallel) luminous transmittance of the exposed specimens shall be reduced no more than 5 %. An increase in regular (parallel) luminous transmittance is acceptable. A very slight discoloration, noticeable only when specimens are placed on a white background, may develop, but defects other than this discoloration shall not develop.

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 °C (150 °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 material intended for use at levels in motor vehicles requisite for driving vision.

5.2.2 Procedure. If safety glass is being tested, the data obtained from Test 1 through 5.1.3 shall be used. If plastic is being tested, the data obtained in Test 16 shall be used. No additional samples other than those tested in Test 1 or 16 are required in this test.

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.²² For Item 11C - safety glazing material for use in bullet-resistant shields, the combined regular (parallel) luminous transmittance at normal incidence through both the shield and the permanent vehicle glazing must 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 successfully 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), substantially flat specimens, as submitted, shall be kept 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 °C and 54 °C (120 °F and 130 °F). (These conditions give a relative humidity of about 100 %).

5.3.3 Interpretation of Results. No separation of materials shall develop, except for occasional small spots, no one of which shall extend inward from the adjacent edge of the specimen to a depth of more than 6.35 mm (¼ in).

5.4 Boil, Test 4 (This test is not applicable to multiple glazed units)

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

5.4.2 Procedure. Three 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, as submitted, shall be immersed, vertically on edge, in water at 66 °C (150 °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 2 hours and then removed. The first immersion is intended to reduce the possibility of thermal shock breakage and is optional.

5.4.3 Interpretation of Results. The glass itself may crack in this test, but no bubbles or other defects shall develop more than 13 mm (½ in) from the outer edge of the specimen or from any cracks that may develop. Any specimen in which the glass cracks to an extent confusing the result shall be discarded without prejudice, and another specimen shall be tested in its stead.

5.5 Bake, Test 5 (Multiple Glazed Unit Only)

5.5.1 Purpose of Test. The purpose of this test is to determine whether the multiple glazed structure will successfully withstand exposure to tropical temperatures over an extended period of time.

5.5.2 Procedure. The 305 mm x 305 mm (12 in x 12 in), substantially flat specimens of multiple glazed unit after irradiation as specified in Test 1 through 5.1.2 shall be heated to 100 °C (212 °F) in an oven for 2 hours. If the structure having an air or gas layer between layers of glass is hermetically sealed, the seal shall be vented.

5.5.3 Interpretation of Results. The glass itself may crack in this test, but no bubbles or other defects shall develop more than 13 mm (½ in) from the outer edge of the specimen or from any cracks that may develop. Any specimen in which the glass cracks to an extent confusing the result shall be discarded without prejudice, and another specimen shall be tested in its stead.

²² See Section 4 and Table 1 for locations in vehicles where glazing material complying with this test is required.

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
		<u>Multiple Glazed Unit</u>			<u>Multiple Glazed Unit</u>				<u>Multiple Glazed Unit</u>					
Test No.	Test Name	Laminated Glass	Class 1	Class 2	Laminated Glass	Tempered Glass	Class 1	Class 2 Any Group	Laminated Glass	Tempered Glass	Class 1	Class 2 Any Group	Rigid Plastics	Rigid Plastics
1	Light Stability	1	1	1	1	1	1	1	1					
2	Luminous transmittance	2	2	2	2	2	2	2					2	2
3	Humidity test	3		3	3			3	3			3		
4	Boil test	4			4				4					
5	Bake test			5				5				5		
6	Impact, Ball, 3.05 m (10 ft.)					6		6		6				
7	Fracture test					7		7		7				
8	Impact, Shot bag, 2.44 m (8 ft.)					8		8		8				
9	Impact, Dart, 9.14 m (30 ft.)	9		9	9			9	9			9	10	10(x)
10	Impact, Dart													
11	Impact, Dart, 3.05 m (10 ft.)													
12	Impact, Ball, 9.14 m (30 ft.)	12		12	12			12	12			12		
13	Impact, Ball												13	13(x)
14	Impact, Ball			14				14	14			14	14	
15	Deviation and distortion	15	15	15										
16	Weathering test												16	16(x)
17	Abrasion resistance												17	17*(i)(x)
18	Abrasion resistance	18		18	18	18		18	18					
19	Chemical resistance												19	19
20	Chemical resistance												20	20
21	Dimensional stability												21	21
22	Flexibility test													
23	Flammability test													
24	Flammability test												24	24
25	Egress test**													
26	Penetration resistance	26		26										
27	Ballistics test													
28	Temperature change													
29	Impact, Ball 6.1 m (20 ft.)													
30	Light Stability													
31	Luminous transmittance													
32	Deviation and distortion													

Note: 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.

Table 1 (Con't)
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, Windcreens 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, Windcreens 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 of Immediate Right or Left of Driver and in Rearmost Window if Lateral is requisite for Driving Visibility.
Rigid Plastics	Flexible Plastics	Flexible Plastics	Multiple Glazed Unit Class 2	Multiple Glazed Unit Class 2		Laminated Glass	Plastics
10	2		1 2 3 5	1 3 5			
13			11	11			
16	16	16	14	14			
19	19	19	18		18*	18*	19*
20	20	20					20*
21	22	22					21†
24	23 or 24	23 or 24					24†
					27 28 29 30 31 32	27 28 29 30 31	27 28† 29†

- * Flat representative specimens of 6.35 mm (1/4-in) thickness shall be used.
 ** Test 25 need not be performed on glazing that is to be used in a pushout window or in windows not designed or intended for use as a means of egress.
 † Except for monolithic configurations, where specimens of 6.35 mm (1/4-in) thickness shall be used, specimen thickness shall correspond to that used in Test 27.
 ‡ Test not required for monolithic configurations.

Table 1 (Con't)
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, Reclining 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 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 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 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
2			1 2 3 4	1 2 3 4	1 2 3 4	3 4	3 4
	10		9 (x)	9 (x)	6 (x) 7 (x) 8 (x)	9	6 (x) 7 (x) 8 (x)
	13		12 (x)	12 (x)		12	
	16	16	15 16 (x) 17 (i) 18 (x) 19 (i)	16 (x) 17 (i) 18 (x) 19 (i)	16 (x) 17 (i) 18 (x) 19 (i)	16	16 (x)
17	19	19				19	19 (i)
20	20	20					
21	21	22 23 or 24					
24	24		24 (i) 26 (i)	24 (i)	24 (i)	24 (i)	24 (i)
27			28	28	28	28	28
28							
29							
30							
32							

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

5.6 Impact, Test 6 (Ball Drop, 3.05m [10 ft])

5.6.1 Purpose of Test. The purpose of this test is to determine whether the safety glazing material has a certain minimum strength to resist impact from exterior projectiles such as stones.

5.6.2 Procedure. Twelve 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, as submitted, shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 °C to 29 °C (70 °F to 85 °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 Fig. 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact. A 224 g to 230 g (0.5 lb $\pm$ 0.1 oz) smooth, steel sphere shall be dropped 3.05 m (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 face mounted to the exterior of the vehicle.

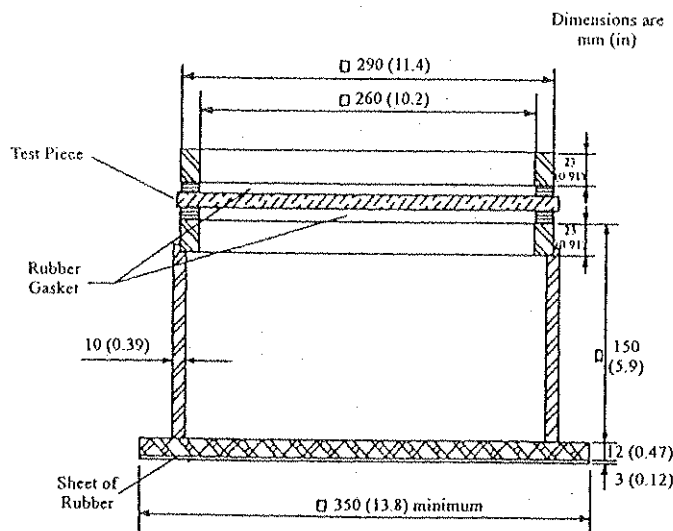


FIGURE 1

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).

5.6.3 Interpretation of Results. Not more than two specimens shall crack or break as a result of this test. (See Test 7)

5.7 Fracture, Test 7

5.7.1 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.

5.7.2 Specimens to be Tested. Specimens shall be selected from the range of glazing that a manufacturer produces or plans to produce and shall represent the model number considering the following:

- (1) Thickness
- (2) Color
- (3) Conductors

The number of specimens selected from each model number of glazing shall be six (6) and shall all be of the most difficult part or pattern designation within the model number.

5.7.3 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 break-point shall be 25 mm (1 in) inboard of the edge at the mid-point of the longest edge of the specimen. In the event that the specimen has two long edges of equal length, the edge nearer the manufacturer's trademark shall be chosen.

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 $\pm$ 0.05 mm (0.008 in $\pm$ 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 ($\frac{3}{4}$ 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.

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

5.8 Impact, Test 8 (Shot Bag)

5.8.1 Purpose of Test. The purpose of this test is to determine whether the safety glazing material has a certain minimum strength under impact by a large yielding object representing parts of the body of an occupant of a vehicle.

5.8.2 Procedure. Five 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, as submitted, shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 °C to 29 °C (70 °F to 85 °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 Fig. 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact.

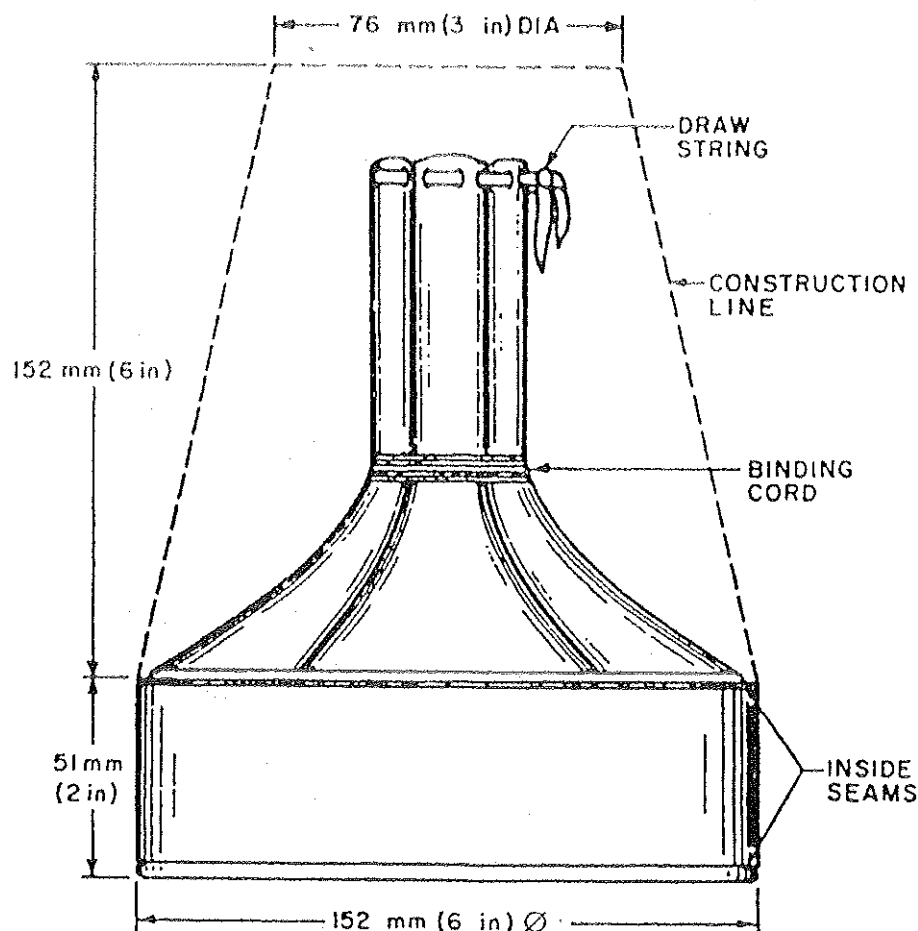
A 4.99 kg (11 lb) shot bag, made in accordance with Fig. 2, shall be dropped 2.44 m (8 ft), once, freely and from rest, the center of the bottom of the bag striking the specimen within 25 mm (1 in) of its center. The shot bag shall strike the face of the specimen representing the face mounted to the interior of the vehicle.

5.8.3 Interpretation of Results. Not more than one specimen shall crack or break as a result of this test.

5.9 Impact, Test 9 (Dart Drop, 9.14 m [30 ft])

5.9.1 Purpose of Test. The purpose of this test is to determine the behavior of the safety glazing material under impact from a small, hard object.

5.9.2 Procedure. Five 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, as submitted, shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 °C to 29 °C (70 °F to 85 °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 Fig. 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact.



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

Figure 2

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

A 196 g to 201 g (7 oz $\pm$ 0.1 oz) steel dart, made in accordance with Fig. 3, shall be dropped 9.14 m (30 ft), once, freely and from rest, the nose of the dart striking the specimen within 25 mm (1 in) of its center on that face of the specimen representing the face mounted to the exterior of the vehicle.

5.9.3 Interpretation of Results. The dart may crack the safety glazing material and may puncture the specimen. However, the hole so produced in the specimen shall not be sufficiently large to permit passage of the body of the dart completely through the specimen. Small particles may disengage themselves from both sides of the specimen at and immediately around the point of impact, but no loose or detached pieces shall leave any area of the specimen exclusive of the area punctured by the dart. Furthermore, the glass on adjacent sides of each crack extending from the area punctured by the dart shall be held in place by the reinforcing or strengthening material, and no glass shall be freed from reinforcing or strengthening material for a distance greater than 38 mm (1½ in) from a crack. Spalling of the outer glass surface opposite the point of impact and adjacent to the area of impact is not to be considered a failure.

Not more than one specimen shall break into separate large pieces.

5.10 Impact, Test 10 (Dart Drop, Table 2 Heights)

5.10.1 Purpose of Test. The purpose of this test is to determine the behavior of the plastic under impact from a small, hard object.

5.10.2 Procedure. Five 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, as submitted, shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 °C to 29 °C (70 °F to 85 °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 Fig. 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact.

A 196 g to 201 g (6.9 oz to 7.1 oz) steel dart, made in accordance with Fig. 3, shall be dropped from a height in accordance with Table 2, once, freely and from rest, the nose of the dart striking the specimen within 25 mm (1 in) of its center.

5.10.3 Interpretation of Results. The dart may crack or puncture the specimen, but not more than one specimen shall break into separate large pieces. At the point immediately opposite the point of impact, small fragments of plastic may leave the specimen if laminated, the small area thus affected shall expose less than 645 mm² (1 in²) of reinforcing or strengthening material, the surface of which shall always be well covered with particles of tightly adhering plastic. Total

separation of plastic from the reinforcing or strengthening material shall not exceed 1935 mm² (3 in²) on either side.

5.11 Impact, Test 11 (Dart Drop, 3.05 m [10 ft])

5.11.1 Purpose of Test. The purpose of this test is to determine the behavior of multiple glazed units under impact from a small, hard object.

5.11.2 Procedure. Five 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, as submitted, shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 °C to 29 °C (70 °F to 85 °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 Fig. 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact.

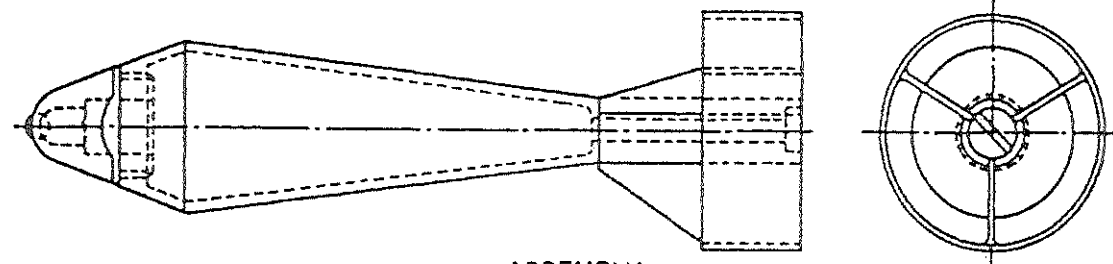
A 196 g to 201 g (6.9 oz to 7.1 oz) steel dart, made in accordance with Fig. 3, shall be dropped 3.05 m (10 ft), once, freely and from rest, the nose of the dart striking the specimen within 25 mm (1 in) of its center.

5.11.3 Interpretation of Results. The dart may crack the glass and may puncture the specimen, and small particles may disengage themselves from both sides of the specimen at and immediately around the point of impact, but no loose or detached pieces shall leave any area of the specimen exclusive of the area punctured by the dart. Furthermore, the glass on adjacent sides of each crack extending from the area punctured by the dart shall be held in place by the reinforcing or strengthening material, and no glass shall be freed from reinforcing or strengthening material for a distance greater than 38 mm (1½ in) from a crack.

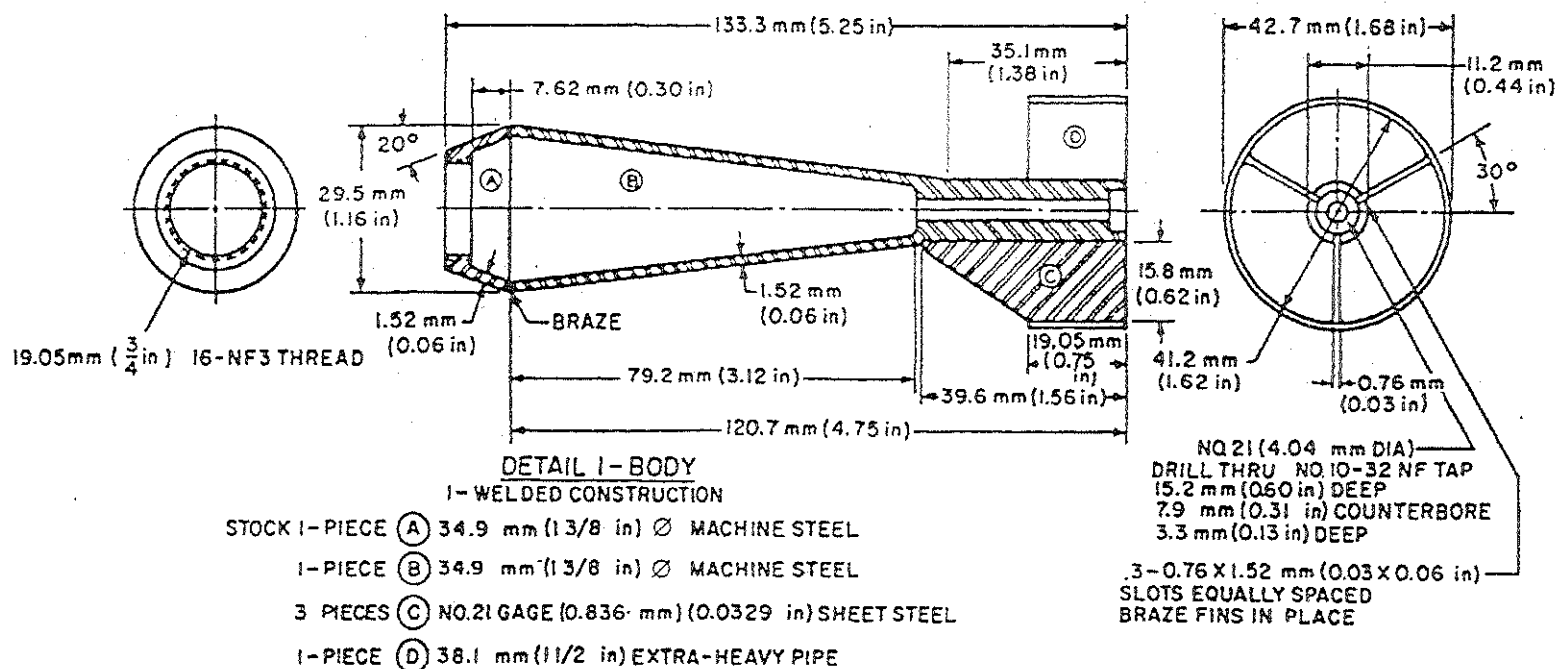
TABLE 2
HEIGHT OF DROP FOR BALL AND DART IMPACT
TESTS OF PLASTIC SPECIMENS*

Nominal Thickness of Plastic Specimen		Height of Drop	
Millimeters	Inches	Meters	Feet
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

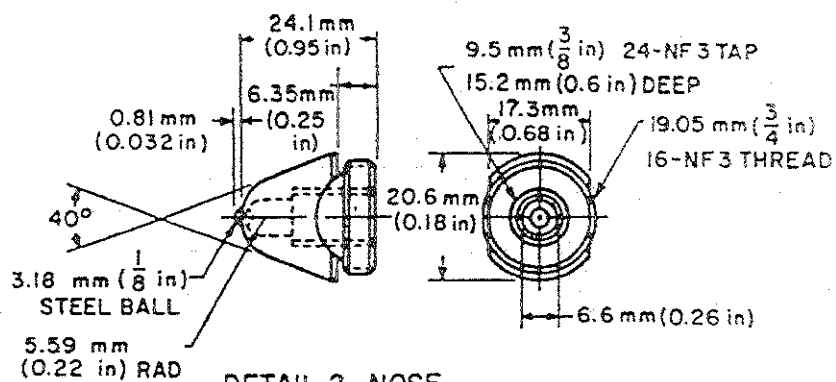
*For the purpose of determining the height of drop to be used, thickness of the plastic specimen measured 25 mm (1 in) from the edge at any point shall not differ from the nominal thicknesses given in the table. The height of drop for materials of nominal thicknesses between those listed in the table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



ASSEMBLY

WEIGHT: 196 TO 201 g (7 oz $\pm$ 0.1 oz) (ADJUST WITH LEAD SHOT)

(Continued on next page)

**DETAIL 2-NOSE**

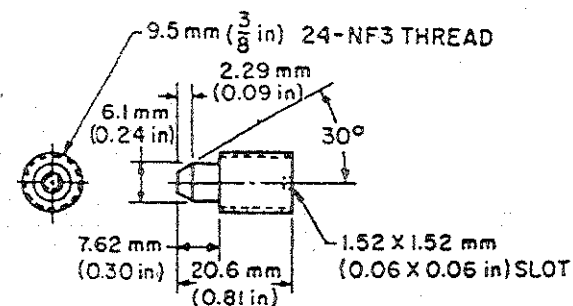
AISI TYPE A-6 STEEL

STOCK 25.4 mm (1.0 in) Ø

HEAT TREATMENT: AUSTENIZE

AIR COOL, TEMPER TO ROCKWELL 52-56C

NOTE: Not to scale.

**DETAIL 3-SCREW**

AISI TYPE A-6 STEEL

STOCK 12.7 mm (1/2 in) Ø

HEAT TREATMENT: AUSTENIZE

AIR COOL, TEMPER TO ROCKWELL 58-62C

FIGURE 3

DART FOR SAFETY GLAZING MATERIAL TESTS (CONTINUED)

5.12 Impact, Test 12 (Ball Drop, 9.14 m [30 ft])

5.12.1 Purpose of Test. The purpose of this test is to determine whether the safety glazing material has a certain minimum strength and whether it is properly made.

5.12.2 Procedure. Twelve 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, as submitted, shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 °C to 29 °C (70 °F to 85 °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 Fig. 1. The frame shall be so supported that the plane of the specimen will be substantially horizontal at the time of impact.

A 224 g to 230 g (0.5 lb ± 0.1 oz) solid, smooth steel sphere shall be dropped 9.14 m (30 ft), 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.

5.12.3 Interpretation of Results. The impact may produce a large number of cracks in the glass; not more than two of the specimens shall break into separate large pieces. Furthermore, with no more than two of the remaining specimens shall the ball produce a hole or fracture at any location in the specimen through which the ball will pass.

At the point immediately opposite the point of impact, small fragments of glass may leave the specimen, but the small area thus affected shall expose less than 645 mm² (1 in²) of reinforcing or strengthening material, the surface of which shall always be well covered with tiny particles of tightly adhering glass. Total separation of glass from the reinforcing or strengthening material shall not exceed 1935 mm² (3 in²) on either side.

Spalling of the outer glass surface opposite the point of impact and adjacent to the area of impact is not to be considered a failure.

5.13 Impact, Test 13 (Ball Drop, Table 2 Heights)

5.13.1 Purpose of Test. The purpose of this test is to determine whether the plastic has a certain minimum strength and whether it is properly made.

5.13.2 Procedure. Twelve 305 mm x 305 mm, (12 in x 12 in) substantially flat specimens, as submitted, shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 °C to 29 °C (70 °F to 85 °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 Fig. 1. The frame shall be so supported that

the plane of the specimen will be substantially horizontal at the time of impact.

A 224 g to 230 g (0.5 lb ± 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.

5.13.3 Interpretation of Results. The impact may produce cracks in the plastic; not more than two of the specimens shall break into separate large pieces, nor shall more than two of the remaining specimens develop a fracture that can be described as a hole through the body of the specimen.

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 mm² (1 in²) 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 mm² (3 in²) on either side.

5.14 Impact, Test 14 (Ball Drop, Variable) (Multiple Glazed Unit, Class 2 Only)

5.14.1 Purpose of Test. The purpose of this test is to determine whether multiple glazed units have a certain minimum strength and whether they are properly made.

5.14.2 Procedure. Twelve 305 mm x 305 mm (12 in x 12 in), substantially flat specimens of multiple glazed units of Class 2, as submitted, symmetrical in construction rather than in shape, shall be tested in accordance with the technique of Test 12 and the test shall be continued to fracture of all component layers other than reinforcing or strengthening material in an interlayer. 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.

Twenty-four 305 mm x 305 mm (12 in x 12 in), substantially flat specimens of multiple glazed units of Class 2, as submitted, nonsymmetrical in construction rather than in shape, shall be tested on both sides, using a separate specimen for impacting opposite sides.

5.14.3 Interpretation of Results. No single fragment of glazing material free from cracks or separated from reinforcing or strengthening material shall exceed 1290 mm² (2 in²) in area.

5.15 Optical Deviation and Visibility Distortion, Test 15

5.15.1 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 (5.15.2.1) and Visibility Distortion (5.15.2.2).

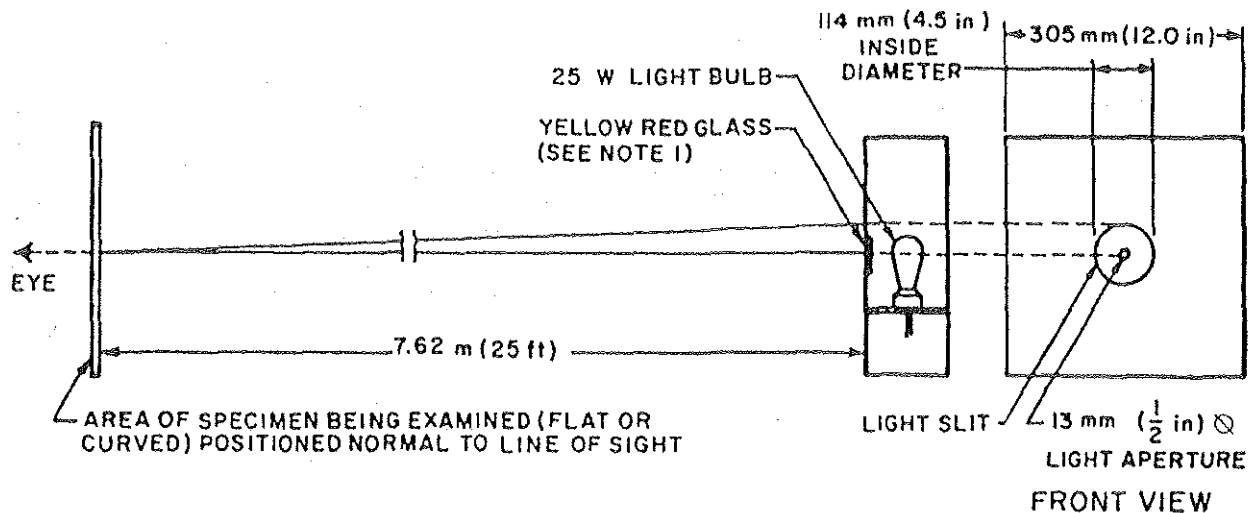
5.15.2 Procedure. Ten 305 mm x 305 mm (12 in x 12 in), substantially flat specimens of the safety glazing material and in the case of curved glazings, three approximately 305 mm x 305 mm (12 in x 12 in) additional curved specimens as described in Section 3, Specimens to Be Tested, curved to the minimum radius, shall be tested for optical deviation (see 5.15.2.1) and visibility distortion (see 5.15.2.2) 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.

5.15.2.1 Optical Deviation. The equipment for this test consists of the illuminated box as shown in Fig. 4. The illuminated box shall be placed in a dark or semidark 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 unsymmetrical glazing materials, such as glass-plastic laminates, the exterior surface of the specimens shall face the illuminated box.

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

- (1) A good quality, 500 W, lantern 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 shall be not less than 500 W rating.
- (2) A square, clean, matte, white projection screen that lies substantially in one plane, measuring approximately 1.62 m (5 ft) on a side.
- (3) A darkroom of sufficient length to accommodate the setup.

The projection lantern shall be focused on the screen 7.62 m (25 ft) distant. The specimen shall be placed between the lantern and the screen, close to and as nearly parallel with the screen as may be possible. The specimen shall be positioned so that the exterior surface faces the screen. The specimen shall be moved toward the lantern in steps of 127 mm (5 in), always as nearly parallel to the screen as may be 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.



NOTES:

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

FIGURE 4

OPTICAL DEVIATION METHOD

5.15.3 Interpretation of Results. Throughout the area surveyed under 5.15.2.1 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 5.15.2.2, no light and dark patches, existent over the entire area, shall appear in the shadow of the unmarked area of the specimen before the specimen shall have been moved a distance of at least 635 mm (25 in) from the screen.

Specimens shall comply with both 5.15.2.1 and 5.15.2.2 to meet the requirements of this test.

5.16 Weathering, Test 16

5.16.1 Purpose of Test. The purpose of this test is to determine whether the plastic or glass-plastic material glazing will successfully withstand exposure to simulated weathering conditions over an extended period of time.

5.16.2 Procedure

5.16.2.1 Apparatus. The exposure apparatus²³ shall use a long arc xenon lamp as the source of the radiation, which shall comply with ISO 4892 Part 2.2, Section 4. The long arc xenon lamp can, when correctly filtered and maintained, yield a spectrum closely approximating that of natural sunlight. To this end, the quartz xenon burner tube shall be fitted with suitable borosilicate glass optical filter(s).²⁴ 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 Part 2.2, Section 4.1.2, 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 which 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 radiant²⁵ exposure, in joules per square meter, shall be measured or computed and shall be considered the primary measure of specimen exposure.

5.16.2.2 Method of Test. Three 102 mm x 102 mm (4 in x 4 in) flat specimens, as submitted, 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 their exterior surfaces facing the light source for a total ultraviolet irradiance of 306 MJ/m² 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 °C to 73 °C (152 °F to 163 °F) as indicated by a Black Standard Thermometer²⁶ 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.
- (4) The relative humidity within the exposure apparatus shall be controlled at $50\% \pm 5\%$ 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.

²³ Such as Atlas Ci or Xenotest Series or Suga WEL-X Series. These are tradenames. This information is given for the convenience of users of this standard and does not constitute an endorsement of the product named. Equivalent products may be used if they can be shown to lead to the same results.

²⁴ Borosilicate glass filters such as Corning 7740 and Atlas Type S and Atlas Suprax have been found satisfactory. (See Footnote 23 on tradenames).

²⁵ Total ultraviolet is considered to be all radiation of wavelength less than 400 nm.

²⁶ The Black Standard Thermometer (BST) is defined by ISO 4892 Part 1, Section 4.1.5.

- (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 °C to 24 °C (71 °F to 75 °F) and 50 % $\pm$ 2 % relative humidity. The irradiated specimens shall again be tested for regular (parallel) luminous transmittance (International Commission on Illumination "Illuminant A") at normal incidence. Following this, the plastic surfaces, whether coated or uncoated, of the irradiated specimens shall be abraded according to Test 17.

5.16.3 Interpretation of Results. The regular (parallel) luminous transmittance of the exposed specimens shall be reduced no more than 5 %. Any increase in regular (parallel) luminous transmittance is acceptable. Some discoloration may develop, but defects other than this discoloration shall not develop. No bubbles or other noticeable decomposition shall develop in the irradiated specimens.

The arithmetic mean of the percentages of light scattered by the three specimens as a result of abrasion shall conform to the requirements of 5.17.3 or 5.17.5, Test 17, whichever is appropriate.

5.17 Abrasion Resistance, Test 17 (Plastics)

5.17.1 Purpose of Test. The purpose of this test is to determine whether the plastic has a certain minimum resistance to abrasion.

5.17.2 Procedure

5.17.2.1 Apparatus

- (1) The apparatus for the abrasion shall be the Taber Abraser²⁷ or its equivalent. A load of 500 g shall be employed on each wheel.
- (2) The fine side of a Taber ST-11 refacing stone or disk and a refacing disk holder shall be used for resurfacing the abrasive wheels. It is important that the holder runs true on the abraser and that the refacing stone or disk lies flat on the holder.
- (3) An abrasive wheel²⁸ 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) The durometer hardness²⁹ of the wheel shall be measured on at least four points equally spaced on the center of the abrading surface. The test shall be made with the pressure applied vertically along a diameter of the wheel, and reading taken 10 seconds after full application of the pressure. Each wheel shall have a durometer hardness of 72 ± 5 .
 - (c) New wheels shall be broken in by 100 revolutions on the ST-11 refacing stone or disk followed by 500 revolutions on the material to be tested, followed by 25 revolutions on the ST-11 refacing stone or disk before starting the test on the specimen.
- (4) The turntable of the abraser shall rotate substantially in a plane with a deviation at the distance of 1.59 mm ($1/16$ in) from its periphery of not greater than ± 0.05 mm (± 0.002 in).
- (5) An integrating sphere, photoelectric photometer³⁰ constructed essentially as shown in Fig. 5 or 6 and conforming to the requirements shown below shall be used to measure the light scattered by the abraded track. A diaphragm shall be centrally inserted in the haze-measuring apparatus to center the light beam on the abraded track and limit it to a diameter of $7 \text{ mm} \pm 1 \text{ mm}$ ($0.28 \text{ in} \pm 0.04 \text{ in}$) at the specimen. If haze measurements are made with other devices or by other

²⁷ According to ASTM D 1044-94.

²⁸ Such as a Calibrase CS-10F-81 wheel or the equivalent.

²⁹ According to ASTM D 2240-91.

³⁰ According to ASTM D 1003-92.

methods, a correlation shall be established with the results obtained with the apparatus and method described as follows:

- (a) An integrating sphere shall be used to collect transmitted flux; the sphere may be of any diameter so long as the total port area does not exceed 4.0 % of the internal reflecting area of the sphere.
- (b) Figs. 5 and 6 indicate possible arrangements of the apparatus. The entrance and exit ports shall be centered on the same great circle of the sphere and there shall be at least 170 degrees of arc between centers. The exit port shall subtend an angle of 8 degrees at the center of the entrance port. The axis of the irradiating beam shall pass through the centers of the entrance and exit ports. The photocells shall be positioned on the sphere 90 degrees $\pm$ 10 degrees from the entrance port. In the pivotable modification of this type (Fig. 6) designed to use the interior sphere wall adjacent to the exit port as the reflectance standard, the angle of rotation shall not exceed 10 degrees.
- (c) The specimen shall be illuminated by a substantially unidirectional beam; the maximum angle that any ray of this beam makes with the direction of its axis shall not exceed 3 degrees. This beam shall not be vignetted at either port of the sphere.
- (d) When the specimen is placed immediately against the integrating sphere at the entrance port, the angle between the normal to its surface and the axis of the beam shall not exceed 8 degrees.
- (e) When the beam is unobstructed by a specimen, its cross-section at the exit port shall be approximately circular, sharply defined and concentric within the exit port leaving an annulus of 1.3 degrees $\pm$ 0.1 degrees subtended at the exit port.
- (f) The surfaces of the interior of the integrating sphere, baffles, and reflectance standard shall be of substantially equal reflectance, matte, and highly reflecting throughout the visible wavelengths. Freshly smoked magnesium oxide is excellent for this purpose, but highly reflecting matte paints are more durable.
- (g) For some measurements the standard at the exit port is replaced by a light trap by actual removal of the reflectance standard or by pivoting the sphere

(Fig. 6). The light trap shall absorb the beam completely when no specimen is present.

- (h) The radiant flux within the sphere shall be measured by a photoelectric cell, the output measurements of which shall be proportional within 1 % to the incident flux over the range of intensity used. Spectral conditions for source and receiver shall be constant throughout the test of each specimen. The design of the instrument shall be such that there shall be no galvanometer deflection when the sphere is dark.
- (i) Determine the four readings given in Table 3.
- (j) Repeat readings for T_1 , T_2 , T_3 , and T_4 with additional specified positions of the specimen to determine uniformity.
- (k) Calculate total transmittance T_t equal to T_2/T_1
- (l) Calculate diffuse transmittance T_d as follows:

$$T_d = \frac{T_4 - T_3 (T_2 / T_1)}{T_1 - T_3}$$

- (m) Calculate percentage haze, scattered light, or both as follows:

$$\text{percent} = \frac{T_d}{T_1} \times 100$$

TABLE 3
TRANSMITTANCE READINGS FOR ABRASION RESISTANCE TEST

Reading Designation	Specimen In Position	Light Trap In Position	Reflectance Standard In Position	Quantity Represented
T_1	No	No	Yes	Incident light
T_2	Yes	No	Yes	Total light transmitted by specimen
T_3	No	Yes	No	Light scattered by instrument
T_4	Yes	Yes	No	Light scattered by instrument and specimen

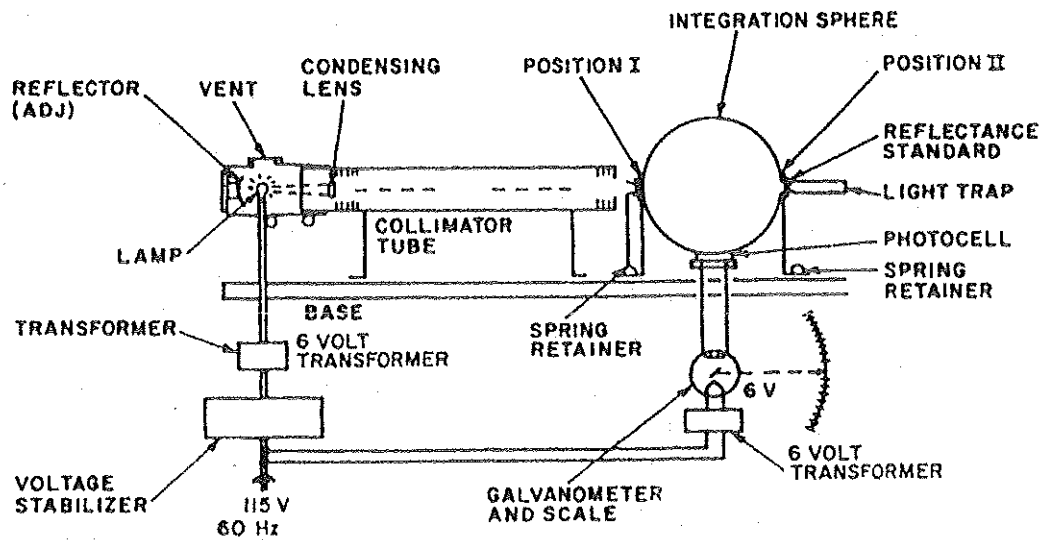


FIGURE 5
HAZEMETER

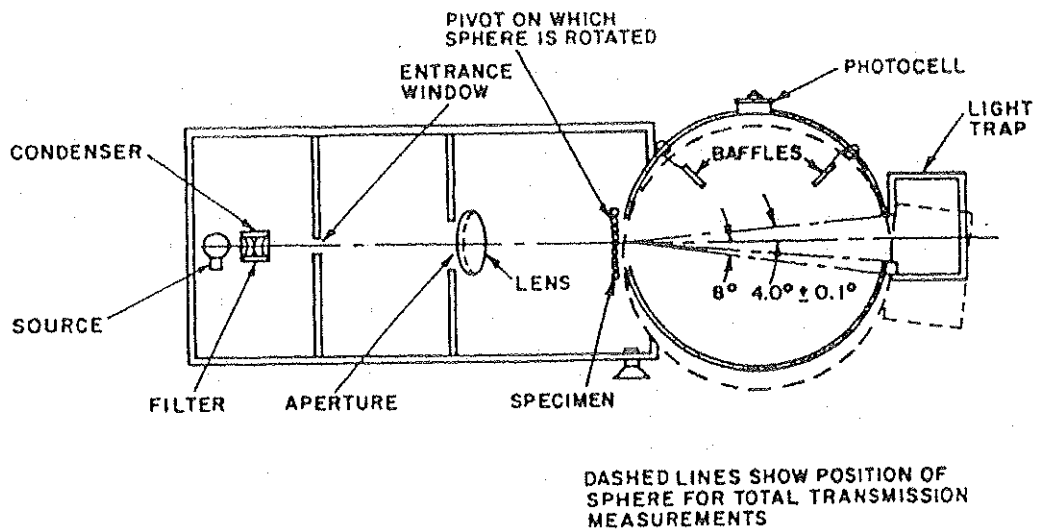


FIGURE 6
PIVOTABLE-SPHERE HAZEMETER

5.17.2.2 Specimens

- (1) Three 102 mm x 102 mm (4 in x 4 in), flat specimens, as submitted, having both surfaces substantially plane and parallel, shall be tested.
- (2) Before testing, any protective masking material shall be removed, and the specimens shall be cleaned by a practice recommended by the manufacturer.
- (3) 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.

5.17.2.3 Conditioning of Specimens. The specimens shall be conditioned prior to testing for a minimum time of 48 hours at 22 °C to 24 °C (71 °F to 75 °F) and 50 % $\pm$ 2 % relative humidity.³¹

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

- (1) Level the Taber Abraser.
- (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 refacing disk holder and the fine side of an ST-11 refacing stone, reface the wheel 25 cycles before abrading each specimen.
- (4) Measure the initial haze of the specimen at a minimum of four equally spaced points in the unabraded area in accordance with 5.17.2.1 (5) (m). The results shall be averaged for each specimen. In lieu of the four measurements, an average value may be obtained by rotating the specimen at three or more revolutions per second.
- (5) The specimen shall be mounted on the specimen holder so that it rotates substantially in a plane and subjected to abrasion for 100 cycles. Specimens shall be carefully wiped after abrasion with dry lens paper (or its equivalent).
- (6) Measure the light scattered by the abraded track at a minimum of four equally spaced points along the track in accordance with 5.17.2.1 (5) (m). The results shall be averaged for each specimen. In lieu of the four measurements, an average value may be obtained by rotating the specimen at three or more revolutions per second.

The average initial haze determined by 5.17.2.4 (4) shall be subtracted from the average total light scattered as measured by 5.17.2.4 (6), the difference representing the light scatter resulting from abrading the specimen.

5.17.3 Interpretation of Results. The arithmetic mean of the percentages of light scattered by the three specimens as a result of abrasion shall not exceed 15.0 %. For glass-plastic specimens, the arithmetic mean of the percentages of light scattered, on the plastic surface (whether coated or uncoated) facing inward, by the three specimens as a result of abrasion shall not exceed 4 %.

5.17.4 Modified Procedure for Item 4A, Rigid Plastics

- (1) The procedure for this test shall be as described in Test 17 through 5.17.2.4 (6) and as follows.
- (2) After the abrasion measurements have been completed in 5.17.2.4 (6), remount the specimen on the specimen holder so that it rotates substantially in a plane and is subjected to abrasion for an additional 400 cycles on the same track already abraded for 100 cycles. Specimens shall be carefully rinsed with distilled water following the abrasion procedure and wiped dry with lens paper (or its equivalent).
- (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 5.17.2.1 (5) (m). The results shall be averaged for each specimen. In lieu of the four measurements, an average value may be obtained by rotating the specimen at three or more revolutions per second.

5.17.5 Interpretation of Results (For Item 4A). The initial maximum haze level shall not exceed 1.0 %. The arithmetic mean of the percentages of light scattered by the three specimens shall not exceed 4.0 % after being subjected to abrasion for 100 cycles and 10.0 % after being subjected to abrasion for 500 cycles.

5.18 Abrasion Resistance, Test 18 (Safety Glazing Material)

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

5.18.2 Procedure. The procedure for this test shall be that described in Test 17 except that the specimens of safety glazing material 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.

³¹ According to ASTM D 618-95.

5.18.3 Interpretation of Results. The arithmetic mean of the percentages of light scattered by the three specimens as a result of abrasion shall not exceed 2.0 %.

5.19 Chemical Resistance, Test 19 (Nonstressed)

5.19.1 Purpose of Test. The purpose of the test is to determine whether nonstressed transparent plastic or glass-plastic glazing material have a certain minimum resistance to the following chemicals³², which are likely to be used for cleaning purposes in motor vehicle service:

- (1) One percent solution of nonabrasive soap in deionized water (i.e., potassium oleate or equivalent)
- (2) Kerosene No. K-1 or K-2³³
- (3) Undiluted denatured alcohol (Formula SD No. 30)³⁴
- (4) Gasoline³⁵
- (5) An aqueous solution of isopropanol and glycol ether solvents in concentration no greater than 10 % or less than 5 % by weight each and ammonium hydroxide no greater than 5 % or less than 1 % by weight each, simulating typical commercial windshield cleaner.

5.19.2 Procedure. Two 25 mm x 178 mm (1 in x 7 in), flat specimens, as submitted, shall be tested with each of the chemicals prescribed in 5.19.1 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 °C to 24 °C (71 °F to 75 °F) and 50 % $\pm$ 2 % relative humidity. The tests shall be conducted in an atmosphere maintained at 22 °C to 24 °C (71 °F to 75 °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.

³² Caution should be observed in the use of these materials, some of which are toxic.

³³ As defined by ASTM D 3699-92

³⁴ One part 100 % methyl alcohol in 10 parts 190-proof ethyl alcohol by volume.

³⁵ ASTM Reference Fuel C, which is composed of Isooctane 50 volume percentage and Toluene 50 volume percentage. Isooctane must conform to A2.7 in Annex 2 of the Motor Fuels Section of the 1985 *Annual Book of ASTM Standards*. Vol. 05.04, and Toluene must conform to ASTM D 362-84, *Standard Specification for Industrial Grade Toluene*. ASTM Reference Fuel C must be used as specified in:

- (1) Paragraph A2.3.2 and Annex 2 of Motor Fuels, Section 1 in the 1985 *Annual Book of ASTM Standards*; and
- (2) OSHA Standard 29 CFR 1910.106 - "Handling Storage and Use of Flammable Combustible Liquids."

5.19.3 Interpretation of Results. There shall be no tackiness, crazing, or apparent loss of transparency in the specimens. For glass-plastic specimens only the plastic surface (whether coated or uncoated) facing inward is subject to test and evaluation.

5.20 Chemical Resistance, Test 20 (Stressed)

5.20.1 Purpose of Test. The purpose of this test is to determine whether stressed plastic will have a certain minimum resistance to the following chemicals³², which are likely to be used for cleaning purposes in motor vehicle service:

- (1) A 1 % solution of a nonabrasive soap in deionized water (i.e., potassium oleate or equivalent)
- (2) Kerosene No. K-1 or K-2³³
- (3) Undiluted denatured alcohol (Formula SD No. 30)³⁴
- (4) Gasoline³⁵

5.20.2 Procedure. Two 25 mm x 178 mm (1 in x 7 in), substantially flat specimens, as submitted, shall be tested with each of the chemicals prescribed in 5.20.1 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 of 48 hours at 22 °C to 24 °C (71 °F to 75 °F) and 50 % $\pm$ 2 % relative humidity. The tests shall be conducted in an atmosphere maintained at 22 °C to 24 °C (71 °F to 75 °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 (½ in) wide brush, wet before each stroke. Ten individual strokes at one second intervals across the width of the specimen shall be required. One minute after the last stroke 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.

5.20.3 Interpretation of Results. There shall be no tackiness, crazing, or apparent loss of transparency in the specimens.

5.21 Dimensional Stability, Test 21 (Warpage)

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

5.21.2 Procedure. Two 152 mm x 152 mm x 6.35 mm (6 in x 6 in x ¼ in), flat specimens, as submitted, 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 °C to 24 °C (71 °F to 75 °F) and 50 % ± 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 °C (160 °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 °C to 24 °C (71 °F to 75 °F) and held for 2 hours. The specimen shall be removed to a 22 °C to 24 °C (71 °F to 75 °F) and 50 % ± 2 % relative humidity atmosphere, wiped dry, and immediately remeasured for warpage by determining the greatest distance of the surface of the plastic from a straight edge connecting diagonally opposite corners. Warpage shall be reported as the greatest increase in deviation from flatness in any of the specimens tested.

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

5.22 Flexibility, Test 22

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

5.22.2 Procedure. Two 254 mm x 64 mm (10 in x 2½ in), flat specimens, as submitted, 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 °C to 24 °C (71 °F to 75 °F) and 50 % ± 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.

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

5.23 Flammability, Test 23 (1.27 mm [0.050 in] or Less in Thickness)

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

5.23.2 Procedure. Six 318 mm x 25 mm (12½ in x 1 in), flat specimens, as submitted, shall be tested. The specimen shall be marked into squares 13 mm (½ 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 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 (C₇H₈) shall be used for ignition. A drop of toluene shall be placed on the specimen approximately 6.35 mm (¼ 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 of the following means: (1) a high-potential, low-energy spark such as that delivered by an automobile ignition coil; or (2) a safety match. After ignition, the door of the shield shall be closed immediately. The time required for the flame either to cease or to completely burn the specimen shall be determined by means of a stop watch or timer, started at the instant of ignition. The area of the specimen that is burned or charred shall be measured to the nearest 161 mm² (¼ in²). 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 which drops off when touched with the fingers or in handling shall also be included in the burned area.

5.23.3 Interpretation of Results. The vertical burning rate shall not exceed the limits indicated in Table 4.

TABLE 4
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

If the specimen does not continue burning, it shall be reported as non-sustaining.

5.24 Flammability, Test 24 (More Than 1.27 mm [0.050 in] in Thickness).

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

5.24.2 Procedure. Three 152 mm x 13 mm, (6 in x ½ in) flat specimens, as submitted, shall be tested. The specimen 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 (¼ in) below the edge of the specimen, and with about 13 mm (½ 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 (½ in to ¾ 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 stop watch 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 safety glazing 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.

5.24.3 Interpretation of Results. The horizontal burning rate shall not exceed 1.48 mm/s (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.

5.25 Egress, Test 25

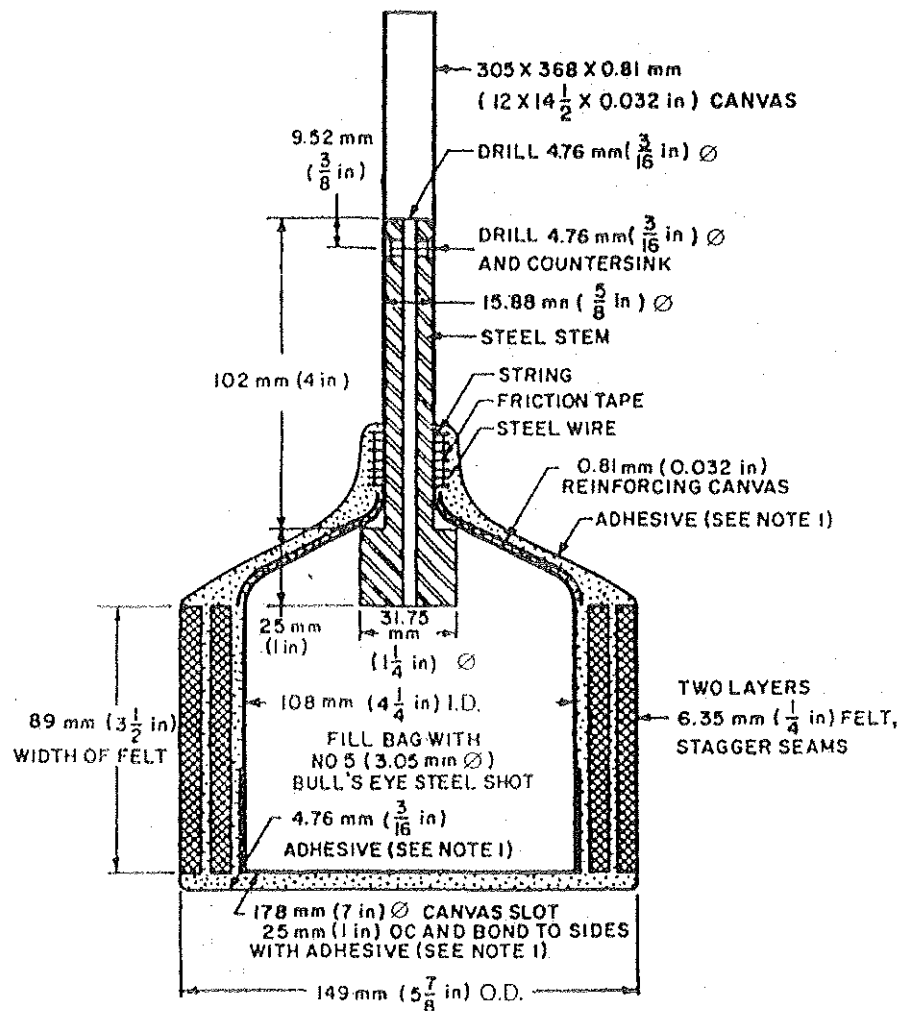
5.25.1 Purpose of Test. The purpose of this test is to determine whether or not the safety glazing material will provide an adequate means of egress from a motor vehicle without resort to "push-out" windows. This test need not be performed on glazing that is to be used in push-out windows or in windows not designed or intended for use as a means of egress.

5.25.2 Procedure. A vehicle body, a section of a vehicle body including the opening for which the specimens are designed, or equivalent framing rigidly supported shall be mounted so it is firmly held where a 6.974 kg (15 lb, 6 oz) shot bag (Fig. 7), forming the bob of a pendulum the length of which shall be not less than 3.05 m (10 ft) and that when freely swung will strike the test specimen at its approximate center. If the safety glazing material or multiple glazed unit is unsymmetrical in structure, the material shall be tested from both sides.

A specimen of 6.35 mm (¼ in) nominal thickness laminated safety glazing material³⁶ of the identical size and shape as the specimen to be tested shall be glazed in the opening by the means designed for the safety glazing material or opening, or both, and shall be impacted normal to surface or to the tangent of its surface in the case of curved safety glazing materials. The impact test shall be conducted by raising the approximate center of gravity of the shot bag on the pendulum in increasing increments of 152 mm (6 in) beginning at 305 mm (12 in) until the 6.35 mm (¼ in) nominal thickness laminated safety glazing material³⁶ is driven out of the frame or so broken as to be readily removable by hand. The test shall then be repeated with four similar specimens of 6.35 mm (¼ in) nominal thickness laminated safety glazing material.³⁶

Five specimens of the safety glazing material under test shall then be glazed by the same means and tested successively in the same manner, care being exercised to establish that the frame is in an undamaged condition at the beginning of each test. The shot bag shall then be dropped from the greatest height arrived at in breaking the 6.35 mm (¼ in) nominal thickness laminated safety glazing material.³⁶

³⁶ The term "6.35 mm (¼ in) nominal thickness laminated safety glazing material" means safety glazing material meeting the requirements of this standard and comprising two sheets of 3.18 mm (¼ in) nominal thickness, soft annealed glass laminated with a plasticized interlayer of polyvinyl butyral of 0.76 mm (0.030 in) nominal thickness.



NOTES:

- (1) Such as 3M Company EC-801 or the equivalent.
- (2) Weight: 6.974 kg (15 lb, 6 oz).
- (3) Not to scale.

FIGURE 7
PENDULUM SHOT BAG

5.25.3 Interpretation of Results. Any safety glazing materials shall be deemed to have failed this test if the average drop height of the shot bag for the series of five tests is higher than the average drop height of 6.35 mm (1/4 in) nominal thickness laminated safety glazing material.

No provision of this test shall be so construed as to prohibit in a push-out window the use of a safety glazing material not meeting the requirements of this test.

5.26 Penetration Resistance, Test 26

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

5.26.2 Procedure. Ten 305 mm x 305 mm (12 in x 12 in), substantially flat specimens, as submitted, shall be tested. Specimens to be tested shall be separated and kept at a temperature of 21 °C to 29 °C (70 °F to 85 °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 Fig. 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 $\pm$ 0.5 oz) solid, smooth steel sphere shall be dropped from a height of 3.66 m (12 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.

5.26.3 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. For glass-plastic glazing material, only the plastic surface specimens, whether coated or uncoated, facing inward is subject to test and evaluation.

When the specimen is clamped, the specimens during the test exhibiting 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.

5.27 Ballistics, Test 27

Bullet-resistant glazing and bullet-resistant shields of Type MP, Type HP, Type SP, and Type RR shall comply with the ballistics requirements specified by UL 752-1995.³⁷ Evidence of listing by Underwriters Laboratories, Inc., shall be considered proof of compliance.

5.28 Resistance to Temperature Change, Test 28

5.28.1 Purpose of Test. The purpose of this test is to determine whether or not the glazing material is capable of withstanding changes in temperature without deterioration.

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

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

5.29 Impact, Test 29 (Ball Drop, 6.10 m [20 ft])

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

5.29.2 Procedure. The specimen shall be supported at its edges in a horizontal position employing a steel frame made in accordance with Fig. 1. The temperature of the specimen shall be -23°C to -12°C (-10°F to $+10^{\circ}\text{F}$). 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. Two specimens 305 mm x 305 mm (12 in x 12) shall be tested.

5.29.3 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.

³⁷ See Footnote 2.

5.30 Light Stability, Test 30

5.30.1 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, thereby indicating its suitability and whether or not it is adversely affected by exposure to simulated sunlight or simulated weathering conditions over an extended period of time.

5.30.2 Procedure. If laminated safety glazing material is being tested, two 305 mm x 305 mm (12 in x 12 in) specimens as submitted shall be tested by the procedure outlined in Test 1 through 5.1.2. If safety glazing 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 16 through 5.16.2, abrasion procedure of Test 17 is excluded.

5.30.3 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 noticeable only when specimens are placed on a white background may develop, but defects other than this discoloration shall not develop.

5.31 Luminous Transmittance, Test 31

5.31.1 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.

5.31.2 Procedure. The data obtained in Test 30 through 5.30.2 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 28 or 30 are required in this test.

5.31.3 Interpretation of Results. Bullet-resistant glazings 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.

5.32 Optical Deviation and Visibility Distortion, Test 32

5.32.1 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 (5.32.2.1) and Visibility Distortion (5.32.2.2).

5.32.2 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 (as described in Section 3, Specimens to Be Tested), curved to the minimum radius, shall be tested for optical

deviation (see 5.32.2.1) and visibility distortion (see 5.32.2.2) 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.

5.32.2.1 Optical Deviation. Described in 5.15.2.1.

5.32.2.2 Visibility Distortion. Described in 5.15.2.2.

5.32.3 Interpretation of Results. Described in 5.15.3

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

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 number³⁸ 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 the 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

³⁸ The model number shall be assigned by the manufacturer of the safety glazing material and shall be related by the manufacturer to a detailed description of a specific glazing material.

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; 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 this paragraph shall be outside of, and separate from the manufacturer's distinctive designation or trademark, but in close proximity thereto, preferably below.

If the manufacturer's standard or date markings are used outside the trademark, they shall be separated from any other letters or characters by a space or hyphen to avoid confusion. Any section of safety glazing material cut from a piece of safety glazing material marked by the manufacturer as indicated in the paragraph above shall be marked with the same words, designation, characters, and numerals as the piece from which it was cut.

Bullet-resistant glazing shall be marked as required herein except that following the letters AS and the numeral, the type shall be designated, in letters at least 1.78 mm (0.070 in) in height as specified in 1.1, subparagraph (4).

Glazing materials, which in a single sheet of material are intentionally made with an area having a luminous transmittance of not less than 70% (Test 2), 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 AS↓1, AS↓14 or AS↑2 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 previously described, which shall also include the item number appropriate for that area-of sheet having a luminous transmittance of not less than 70%.

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 ($\frac{3}{16}$ in) nor more than 6.35 mm ($\frac{1}{4}$ in) high, with the following words, "GLASS PLASTIC MATERIAL - SEE OWNER'S MANUAL FOR CARE INSTRUCTIONS."

Appendix

(This Appendix is not a part of American National Standard Safety Code for Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways, Z26.1-1996, but is included for information purposes only.)

TABLE A1

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 AS↓1, AS↑2, AS↓14, 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 (CON'T)			
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
	<i>All other glazing except as listed above</i>	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
	<i>All other glazing except as listed above</i>	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	
	<i>All other glazing except as listed above</i>	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 AS↓1, AS↑2, AS↓14, 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.

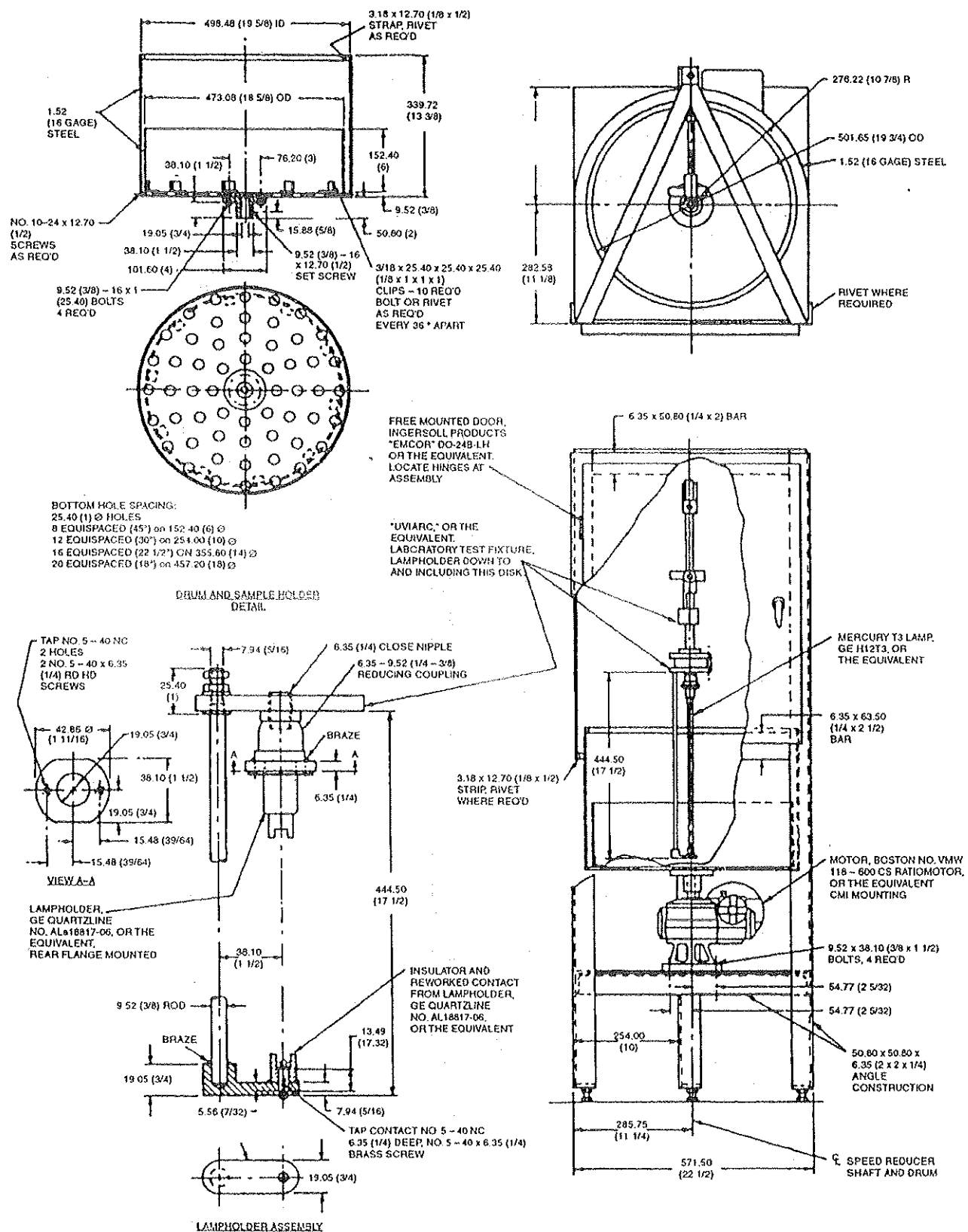
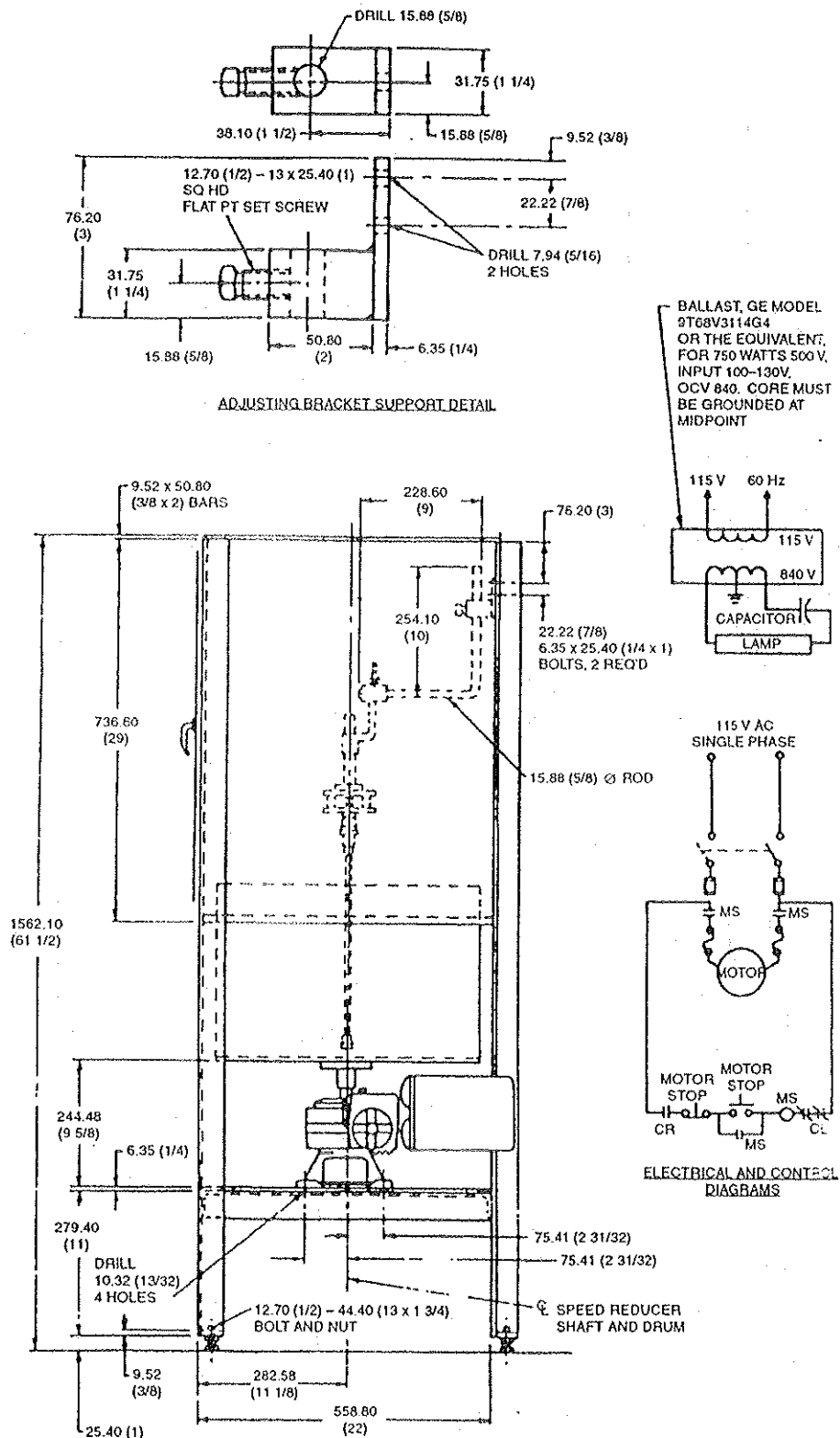


FIGURE A1

LIGHT STABILITY TEST EQUIPMENT



NOTE: All dimensions are in metric dimensions (millimeters), with customary units (inches) in parentheses.

SCALE: 1mm = 4 mm (3 inches = 1 foot)

FIGURE A1 (CONTINUED)