



Standard Guide for Testing Materials for Aerospace Plastic Transparent Enclosures¹

This standard is issued under the fixed designation F 790; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide is intended to summarize the standard test methods available on individual and composite materials utilized in fabrication of aerospace plastic transparent enclosures. As such, it is intended to specifically include transparent thermoplastics, transparent elastomers, and reinforced plastics, whether thermoplastic or thermosetting.

1.2 This guide is intended as an aid in the search for test methods pertinent to Aerospace Plastic Transparent Enclosures. It should be understood that all methods listed may not apply to all enclosures.

1.3 The standards included refer to the properties or aspects listed in Table 1. The properties or aspects are listed in alphabetical order and the descriptions used are intended to facilitate the search.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- C 117 Test Method for Material Finer Than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing²
- D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies³
- D 150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation³
- D 256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics⁴
- D 257 Test Methods for DC Resistance or Conductance of Insulating Materials³

TABLE 1 Property or Aspects of Aerospace Plastic Transparent Enclosures

Property or Aspect	Test Method
Abrasion Resistance	D 1044
Abrasion Resistance—Oscillating Sand	F 735
Abrasion Testing—Sizing Sand for	C 117
Bearing Strength	D 953
Bird Impact Resistance	F 330
Bond Integrity	F 521
Brittleness Temperature—By Impact	D 746
Chemical Resistance	D 543
Coefficient of Linear Thermal Expansion	D 696
Compressive Properties	D 695
Electrical Insulating Material—DC Resistance or Conductance	D 257
Electrical Insulating Material—Dielectric Breakdown Voltage	D 149
Electrical Insulating Material—Dielectric Constant	D 150
Electrical Insulating Material—Flexural Properties	D 790
Electrical Insulating Material—Impact Resistance	D 256
Electrical Insulating Material—Rockwell Hardness	D 785
Environmental Resistance	F 520
Exposure Apparatus Operation—Carbon ARC Type	D 1499
Exposure Apparatus Operation—Fluorescent UV Type	G 154
Exposure Apparatus Operation—Xenon ARC Type	D 2565
Flow Rate	D 1238
Glass Transition Temperature	E 1640
Hail Impact Resistance	F 320
Hardness—Barcol	D 2583
Hardness—Durometer	D 2240
Heating Elements—Detection of Flaws	F 319
Ignition Loss	D 2584
Impact Resistance—Falling Weight	D 5420
Impact Resistance—Falling Weight (Polycarbonate)	F 736
Index of Refraction	D 542
Interlayer Material Selection	F 942
Light Transmissivity	F 1316
Luminous Transmittance and Haze	D 1003
Optical Angular Deviation	F 801
Optical Angular Displacement—Multiple Images	F 1165
Optical Binocular Disparity	F 1181
Optical Distortion and Deviation—Double Exposure	F 733
Optical Reflectivity	F 1252
Peel Resistance—Floating Roller	D 3167
Rubber Properties in Tension	D 412
Scratches—Intensity of	F 548
Shear Strength—Fusion Bonded Polycarbonate	F 734
Shear Strength and Modulus—Interlayer Materials	F 1362
Softening Temperature	D 1525
Specific Gravity and Density	D 792
Specific Heat	D 2766
Stress Cracking	F 791
Stress Cracking	F 484
Tear Resistance	D 624
Tear Resistance—Initial	D 1004
Tensile Properties	D 638
Water Absorption	D 570

¹ This guide is under the jurisdiction of ASTM Committee F07 on Aerospace and Aircraft and is the direct responsibility of F07.08 on Transparent Enclosures and Materials.

Current edition approved May 10, 2002. Published June 2002. Originally published as F 790 – 88. Last previous edition F 790 – 94.

² Annual Book of ASTM Standards, Vol 04.02.

³ Annual Book of ASTM Standards, Vol 10.01.

⁴ Annual Book of ASTM Standards, Vol 08.01.

- D 412 Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoelastic Elastomers Tension⁵
- D 542 Test Methods for Index of Refraction of Transparent Organic Plastics⁴
- D 543 Practice for Evaluating the Resistance of Plastics to Chemical Reagents⁴
- D 570 Test Method for Water Absorption of Plastics⁴
- D 624 Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers⁵
- D 638 Test Method for Tensile Properties of Plastics⁴
- D 695 Test Method for Compressive Properties of Rigid Plastics⁴
- D 696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30° and 30°C With a Vitreous Silica Dilatometer⁴
- D 746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact⁴
- D 785 Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials⁴
- D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials⁴
- D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement⁴
- D 953 Test Method for Bearing Strength of Plastics⁴
- D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics⁴
- D 1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting⁴
- D 1044 Test Method for Resistance of Transparent Plastics to Surface Abrasion⁴
- D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer⁴
- D 1499 Practice for Filtered Open-Flame Carbon-Arc Exposures of Plastics⁴
- D 1525 Test Method for Vicat Softening Temperature of Plastics⁴
- D 2240 Test Method for Rubber Property—Durometer Hardness⁵
- D 2565 Practice for Xenon Arc Exposure of Plastics Intended for Outdoor Operations⁶
- D 2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor⁶
- D 2584 Test Method for Ignition Loss of Cured Reinforced Resins⁶
- D 2766 Test Method for Specific Heat of Liquids and Solids⁷
- D 3167 Test Method for Floating Roller Peel Resistance of Adhesives⁸
- D 5420 Test Method for Impact Resistance of Flat, Rigid Plastic Specimens by Means of a Striker Impacted by a Falling Weight (Gardner Impact)⁹
- E 1640 Test Method for Assignment of the Glass Transition Temperature by Dynamic Mechanical Analysis¹⁰
- F 319 Practice for Polarized Light Detection of Flaws in Aerospace Transparency Heating Elements¹¹
- F 320 Test Method for Hail Impact Resistance of Aerospace Transparent Enclosures¹¹
- F 330 Test Method for Bird Impact Testing of Aerospace Transparent Enclosures¹¹
- F 484 Test Method for Stress Cracking of Acrylic Plastics in Contact with Liquid or Semi-Liquid Compounds¹¹
- F 520 Test Method for Environmental Resistance of Aerospace Transparencies¹¹
- F 521 Test Methods for Bond Integrity of Transparent Laminates¹¹
- F 548 Test Method for Intensity of Scratches on Aerospace Transparent Plastics¹¹
- F 733 Practice for Optical Distortion and Deviation of Transparent Parts Using the Double-Exposure Method¹¹
- F 734 Practice for Shear Strength of Fusion Bonded Polycarbonate Aerospace Glazing Material¹¹
- F 735 Test Method for Abrasion Resistance of Transparent Plastics and Coatings Using the Oscillating Sand Method¹¹
- F 736 Test Method for Impact Resistance of Monolithic Polycarbonate Sheet by Means of a Falling Weight¹¹
- F 790 Guide for Testing Materials for Aerospace Plastic Transparent Enclosures¹¹
- F 791 Practice for Stress Cracking of Transparent Plastics¹¹
- F 801 Test Method for Measuring Optical Angular Deviation of Transparent Parts¹¹
- F 942 Guide for Selection of Test Methods for Interlayer Materials for Aerospace Transparent Enclosures¹¹
- F 1164 Test Method for Evaluation of Transparent Plastics Exposed to Accelerated Weathering Combined with Biaxial Stress¹¹
- F 1165 Test Method for Measuring Angular Displacement of Multiple Images in Transparent Parts¹¹
- F 1181 Test Method for Measuring Binocular Disparity in Transparent Parts¹¹
- F 1252 Test Method for Measuring Optical Reflectivity of Transparent Materials¹¹
- F 1316 Test Method for Measuring the Transmissivity of Transparent Parts¹¹
- F 1362 Test Method for Shear Strength and Shear Modulus of Aerospace Glazing Interlayer Materials¹¹
- G 154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials¹²

3. Significance and Use

3.1 This guide is intended for use by material suppliers, aircraft transparent enclosure fabricators, air-frame manufacturers, government agencies, and others that may become involved in the testing of transparency components. These test methods provide data on both individual materials and material combinations commonly utilized in the fabrications of aerospace transparent enclosures comprised of monolithic plastic,

⁵ Annual Book of ASTM Standards, Vol 09.01.

⁶ Annual Book of ASTM Standards, Vol 08.02.

⁷ Annual Book of ASTM Standards, Vol 05.02.

⁸ Annual Book of ASTM Standards, Vol 15.06.

⁹ Annual Book of ASTM Standards, Vol 08.03.

¹⁰ Annual Book of ASTM Standards, Vol 14.02.

¹¹ Annual Book of ASTM Standards, Vol 15.03.

¹² Annual Book of ASTM Standards, Vol 14.04.

coated monolithic plastic or laminated constructions containing plastics.

3.2 Primary properties and their long term stability are critical to the performance of aerospace transparent enclosures. Property measurement tests define as-manufactured material properties of these materials. Aging procedures provide for exposure of parts or representative sections to environments that may induce changes in material properties as determined in property measurement tests. Property measurement tests performed before and after aging exposure provide a means of estimating the potential usable life span of a transparency or to compare the durability of one material with another.

3.3 When employing these test methods for comparison of materials for weathering effects the user should be aware that the many factors influencing degradation due to weathering vary from one location to another. For direct weathering comparisons, all various material(s) should undergo exposure conditions and property measurements testing at the same time.

3.4 The test methods listed include those considered critical to the performance of aircraft transparent enclosures. Other test methods to evaluate materials may also be performed. Additional test methods are in preparation and will be incorporated. The user is advised to employ the latest revision of any test method.

3.5 The dominant component of all transparent enclosures is one, or more, rigid transparent sheet(s). The sheet(s) must

permit the necessary visibility while providing structural integrity and protecting the aircraft interior from external environments as required by the specific aircraft design.

3.6 In its most simple form, the rigid transparent sheet may be the only component of a transparent enclosure.

3.7 When more than one rigid transparent sheet is employed, the sheets are laminated with a controlled thickness with either an air gap or with a transparent adhesive known as an interlayer.

3.8 Transparent enclosure designs may use multiple rigid transparent sheets to take advantage of specific properties of different materials. In this instance, there will be functions required of one of the sheets but not the other.

3.9 The test methods, practices and guides listed are a summary of the available test methods applicable to plastic transparent enclosures. They are presented in this format to simplify the search and to enable the user to determine if a method applicable to his requirements is available.

4. Keywords

4.1 abrasion; acrylic; adhesion; aerospace; bonding; electrical; enclosures; environmental; impact; interlayers; materials; mechanical; optical; physical; plastic; polycarbonate; properties; thermal; transparent

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