



Standard Guide for Testing Materials for Aerospace Plastic Transparent Enclosures¹

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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:²

- [C117 Test Method for Materials Finer than 75- \$\mu\$ m \(No. 200\) Sieve in Mineral Aggregates by Washing](#)
- [D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies](#)
- [D150 Test Methods for AC Loss Characteristics and Permittivity \(Dielectric Constant\) of Solid Electrical Insulation](#)
- [D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics](#)

- [D257 Test Methods for DC Resistance or Conductance of Insulating Materials](#)
- [D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension](#)
- [D542 Test Method for Index of Refraction of Transparent Organic Plastics](#)
- [D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents](#)
- [D570 Test Method for Water Absorption of Plastics](#)
- [D624 Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers](#)
- [D638 Test Method for Tensile Properties of Plastics](#)
- [D695 Test Method for Compressive Properties of Rigid Plastics](#)
- [D696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between \$-30^{\circ}\text{C}\$ and \$30^{\circ}\text{C}\$ with a Vitreous Silica Dilatometer](#)
- [D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact](#)
- [D785 Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials](#)
- [D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials](#)
- [D792 Test Methods for Density and Specific Gravity \(Relative Density\) of Plastics by Displacement](#)
- [D953 Test Method for Bearing Strength of Plastics](#)
- [D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics](#)
- [D1004 Test Method for Tear Resistance \(Graves Tear\) of Plastic Film and Sheet](#)
- [D1044 Test Method for Resistance of Transparent Plastics to Surface Abrasion](#)
- [D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer](#)
- [D1499 Practice for Filtered Open-Flame Carbon-Arc Exposures of Plastics](#)
- [D1525 Test Method for Vicat Softening Temperature of Plastics](#)
- [D2240 Test Method for Rubber Property—Durometer Hardness](#)

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

**TABLE 1 Property or Aspects of Aerospace Plastic Transparent Enclosures**

Property or Aspect	Test Method
Abrasion Resistance	D1044
Abrasion Resistance—Oscillating Sand	F735
Abrasion Testing—Sizing Sand for	C117
Bearing Strength	D953
Bird Impact Resistance	F330
Bond Integrity	F521
Brittleness Temperature—By Impact	D746
Chemical Resistance	D543
Coefficient of Linear Thermal Expansion	D696
Compressive Properties	D695
Electrical Insulating Material—DC Resistance or Conductance	D257
Electrical Insulating Material—Dielectric Breakdown Voltage	D149
Electrical Insulating Material—Dielectric Constant	D150
Electrical Insulating Material—Flexural Properties	D790
Electrical Insulating Material—Impact Resistance	D256
Electrical Insulating Material—Rockwell Hardness	D785
Environmental Resistance	F520
Exposure Apparatus Operation—Carbon ARC Type	D1499
Exposure Apparatus Operation—Fluorescent UV Type	G154
Exposure Apparatus Operation—Xenon ARC Type	D2565
Flow Rate	D1238
Glass Transition Temperature	E1640
Hail Impact Resistance	F320
Hardness—Barcol	D2583
Hardness—Durometer	D2240
Heating Elements—Detection of Flaws	F319
Ignition Loss	D2584
Impact Resistance—Falling Weight	D5420
Impact Resistance—Falling Weight (Polycarbonate)	F736
Index of Refraction	D542
Interlayer Material Selection	F942
Light Transmissivity	F1316
Luminous Transmittance and Haze	D1003
Optical Angular Deviation	F801
Optical Angular Displacement—Multiple Images	F1165
Optical Binocular Disparity	F1181
Optical Distortion and Deviation—Double Exposure	F733
Optical Reflectivity	F1252
Peel Resistance—Floating Roller	D3167
Rubber Properties in Tension	D412
Scratches—Intensity of	F548
Shear Strength—Fusion Bonded Polycarbonate	F734
Shear Strength and Modulus—Interlayer Materials	F1362
Softening Temperature	D1525
Specific Gravity and Density	D792
Specific Heat	D2766
Stress Crazeing	F791
Stress Crazeing	F484
Tear Resistance	D624
Tear Resistance—Initial	D1004
Tensile Properties	D638
Water Absorption	D570

[D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications](#)

[D2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor](#)

[D2584 Test Method for Ignition Loss of Cured Reinforced Resins](#)

[D2766 Test Method for Specific Heat of Liquids and Solids](#)

[D3167 Test Method for Floating Roller Peel Resistance of Adhesives](#)

[D5420 Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight \(Gardner Impact\)](#)

[E1640 Test Method for Assignment of the Glass Transition Temperature By Dynamic Mechanical Analysis](#)

[F319 Practice for Polarized Light Detection of Flaws in Aerospace Transparency Heating Elements](#)

[F320 Test Method for Hail Impact Resistance of Aerospace Transparent Enclosures](#)

[F330 Test Method for Bird Impact Testing of Aerospace Transparent Enclosures](#)

[F484 Test Method for Stress Crazeing of Acrylic Plastics in Contact with Liquid or Semi-Liquid Compounds](#)

[F520 Test Method for Environmental Resistance of Aerospace Transparencies to Artificially Induced Exposures](#)

[F521 Test Methods for Bond Integrity of Transparent Laminates](#)

[F548 Test Method for Intensity of Scratches on Aerospace Transparent Plastics](#)

[F733 Practice for Optical Distortion and Deviation of Transparent Parts Using the Double-Exposure Method](#)

[F734 Test Method for Shear Strength of Fusion Bonded Polycarbonate Aerospace Glazing Material](#)

[F735 Test Method for Abrasion Resistance of Transparent Plastics and Coatings Using the Oscillating Sand Method](#)

[F736 Test Method for Impact Resistance of Monolithic Polycarbonate Sheet by Means of a Falling Weight](#)

[F791 Test Method for Stress Crazeing of Transparent Plastics](#)

[F801 Test Method for Measuring Optical Angular Deviation of Transparent Parts](#)

[F942 Guide for Selection of Test Methods for Interlayer Materials for Aerospace Transparent Enclosures](#)

[F1165 Test Method for Measuring Angular Displacement of Multiple Images in Transparent Parts](#)

[F1181 Test Method for Measuring Binocular Disparity in Transparent Parts](#)

[F1252 Test Method for Measuring Optical Reflectivity of Transparent Materials](#)

[F1316 Test Method for Measuring the Transmissivity of Transparent Parts](#)

[F1362 Test Method for Shear Strength and Shear Modulus of Aerospace Glazing Interlayer Materials](#)

[G154 Practice for Operating Fluorescent Ultraviolet \(UV\) Lamp Apparatus for Exposure of Nonmetallic Materials](#)

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, 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 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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