



Designation: D543 – 21

Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents¹

This standard is issued under the fixed designation D543; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 These practices cover the evaluation of all plastic materials including cast, hot-molded, cold-molded, laminated resinous products, and sheet materials for resistance to chemical reagents.

1.2 Three procedures are presented, two under practice A (Immersion Test), and one under practice B (Mechanical Stress and Reagent Exposure under Standardized Conditions of Applied Strain). These practices include provisions for reporting changes in weight, dimensions, appearance, color, strength, and other mechanical properties. Standard reagents are specified to establish results on a comparable basis without precluding the use of other chemical reagents pertinent to specific chemical resistance requirements. Provisions are made for various exposure times, stress conditions, and exposure to reagents at elevated temperatures. The type of conditioning (immersion or wet patch/wipe method) depends upon the end-use of the material. If the material is used as a container or transfer line, immersion of the specimens is used. If the material will only see short exposures or will be used in proximity and reagent will splash or spill on the material, the wet patch or wipe method of applying reagent to the material is used.

NOTE 1—Practice B for evaluating environmental stress cracking resistance differs from Practice D7474, which seeks to measure residual stresses in molded sulfone plastic parts with the use of calibrated chemical reagents. Practice B differs from Test Method D1693, which seeks to quantify the susceptibility of ethylene plastics to environmental stress-cracking subjected to specific conditions, by measuring the proportion of specimens that crack in a given time.

1.3 The effect of chemical reagents on properties shall be determined by making measurements on standard specimens for such tests before and after immersion or stress, or both, if so tested.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific hazards statements are given in Section 7.

NOTE 2—ISO 175 and ISO 22088 Part 3 address the same subject matter as Practices A and B of this standard, but differ in technical content and the results cannot be directly compared.

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- D13 Specification for Spirits of Turpentine
- D396 Specification for Fuel Oils
- D618 Practice for Conditioning Plastics for Testing
- D883 Terminology Relating to Plastics
- D1040 Specification for Uninhibited Mineral Insulating Oil for Use in Transformers and in Oil Circuit Breakers (Withdrawn 1980)³
- D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
- D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
- D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens

¹ These practices are under the jurisdiction of ASTM Committee D20 on Plastics and are the direct responsibility of Subcommittee D20.50 on Durability of Plastics.

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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.

³ The last approved version of this historical standard is referenced on www.astm.org.

*A Summary of Changes section appears at the end of this standard

D7474 Practice for Determining Residual Stresses in Extruded or Molded Sulfone Plastic (SP) Parts by Immersion in Various Chemical Reagents

2.2 Military Specifications:⁴

MIL-A-11755 Antifreeze, Arctic-Type

MIL-A-46153 Antifreeze, Ethylene Glycol, Inhibited, Heavy Duty, Single Package

MIL-C-372 Cleaning Compound, Solvent (For Bore of Small Arms and Automatic Aircraft Weapons)

MIL-D-12468 Decontaminating Agent, STB

MIL-F-46162 Fuel, Diesel, Referee Grade

MIL-G-5572 Gasoline, Aviation, Grades 80/87, 100/130, 115/145

MIL-H-5606 Hydraulic Fluid, Petroleum Base, Aircraft, Missiles, and Ordinance

MIL-H-6083 Hydraulic Fluid, Petroleum Base, for Preservation and Operation

MIL-H-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft

MIL-L-7808 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number 0-148

MIL-L-14107 Lubricating Oil, Weapons, Low Temperature

MIL-L-23699 Lubricating Oil, Aircraft Turbine Engines, Synthetic Base

MIL-L-46000 Lubricant, Semi-Fluid (Automatic Weapons)

MIL-T-5624 Turbine Fuel, Aviation, Grades JP-4 and JP-5

MIL-T-83133 Turbine Fuel, Aviation, Kerosene Type, Grade JP-8

2.3 U.S. Army Regulation:⁴

AR 70-71 Nuclear, Biological, and Chemical Contamination Survivability of Army Material

2.4 ISO Standards:⁵

ISO 175 Plastics—Determination of Resistance to Liquid Chemicals

ISO 22088 Part 3 Plastics—Determination of Resistance to Environmental Stress Cracking (ESC)—Bent Strip Method

2.5 SAE Standards:

SAE J1681 Gasoline, Alcohol and Diesel Fuel Surrogates for Materials Testing⁶

3. Terminology

3.1 Definitions—Definitions of terms applying to these practices appear in Terminology **D883**.

4. Significance and Use

4.1 There are limitations of the results obtained from these practices. The choice of types and concentrations of reagents, duration of immersion or stress, or both, level of stress, temperature of the test, and properties to be reported are necessarily arbitrary. The specification of these conditions

provides a basis for standardization and serves as a guide to investigators wishing to compare the relative resistance of various plastics to chemical reagents.

4.2 Correlation of test results with the actual performance or serviceability of plastics is necessarily dependent upon the similarity between the testing and the end-use conditions. For applications involving continuous immersion, the data obtained in short-time tests are of interest only in eliminating the most unsuitable materials or indicating a probable relative order of resistance to chemical reagents.

4.3 Evaluation of plastics for special applications involving corrosive conditions shall be based upon the particular reagents and concentrations to be encountered. Base the selection of test conditions on the manner and duration of contact with reagents, the temperature of the system, applied stress, and other performance factors involved in the particular application.

4.4 The practices present general guidelines without covering specifics on all the varied applications of plastics, such as use in automobiles and exposure to various automotive fluids, or use in hospital environments with exposure to disinfectants and cleaning fluids. These practices can be extended to such applications with specifics on the study conducted noted in the report.

4.5 The use of appropriate controls is critical to evaluate the utility of the information generated by these practices. Particular attention should be given to the variability in the data generated, especially for the baseline controls, and issues in data generation reported to mitigate misuse of information.

5. Apparatus

5.1 Balance—Use a balance capable of weighing accurately to 0.05 % for a test specimen weighing 100 g or less, and to 0.1 % for a test specimen weighing over 100 g. Assurance that the balance meets the performance requirements is provided by frequent checks on adjustments of zero points and sensitivity and by periodic calibration for absolute accuracy, using standard masses.

5.2 Micrometers—Use a suitable micrometer for measuring the dimensions of test specimens similar to that described in Test Method **D5947**. The micrometer should have an incremental discrimination of at least 0.025 mm (0.001 in.). For specimens 0.100 in. thick or less, the micrometer used shall have an incremental discrimination of at least 0.0025 mm (0.0001 in.). The micrometer must be verified using gauge blocks traceable to the international system of units (SI) through a national metrology institute (NMI)⁷.

5.3 Room, or enclosed space capable of being maintained at the standard laboratory atmosphere of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and $50 \pm 10\%$ relative humidity in accordance with Practice **D618**, Procedure A.

5.4 Containers—Suitable containers for submerging specimens in chemical reagents. They must be resistant to the

⁴ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁶ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

⁷ NMI includes such organizations as the National Institute of Standards and Technology (NIST).