Designation: ~~D543 – 14~~ D543 – 20

Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents[1]

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 ~~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.~~ 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, ~~and strength~~ color, strength, and other mechanical properties. Standard reagents are specified to establish results on a comparable ~~basis.~~ 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) depends upon the end-use of the material. If the material is used as a container or transfer line, ~~immerse the specimens.~~ 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, ~~use~~ the wet patch method of applying ~~reagent.~~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 ~~other~~ 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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.* Specific hazards statements are given in Section 7.

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

[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.

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

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
~~D1898~~D2244 Practice for ~~Sampling of Plastics~~Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates ~~(Withdrawn 1998)~~
D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
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-D-50030 Decontaminating Agent, DS2~~
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-83283~~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 Testing[6]

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 ~~typical~~ 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.

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

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*—~~A~~ 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 ± 2°C (73.4 ± 3.6°F) and 50 ± 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 corrosive effects of the reagents being used. Provide venting when using volatile reagents at elevated temperatures. Tightly sealed containers are preferred for room temperature testing to minimize loss.

5.5 *Strain Jigs*—Jigs are to be capable of supplying known amounts of strain to test specimens. These jigs are three point flexural strain devices and are to be made of stainless steel with stainless steel tabs at each end capable of affixing the test specimen to the fixtures in such a way that intimate contact is maintained between the test specimen and the fixture along the entire length of the test specimen. The clamping system should allow for thermal expansion of the material when exposure to elevated temperature is specified. Fig. 1 is a side view drawing of a typical strain jig used to obtain 1.0 % strain in a 3.2 mm (0.125 in.) thick test specimen. Shown in Fig. 1 is an equation that can be used to calculate strain from known dimensions or back-calculate jig dimensions for a desired specimen strain.

5.6 *Oven or Constant Temperature Bath,* capable of maintaining temperatures within ±2°C of the specified test temperatures.

5.7 *Testing ~~Devices—~~Devices,* ~~Testing devices~~ for determining specific ~~strength~~ properties of specimens before and after ~~submersion or strain, or both,~~submersion, such as color coordinates, strength, strain, and impact, conforming to the requirements prescribed in the ASTM test methods for the specific properties being determined.

5.8 *Laboratory ~~Hood,~~Hood* or other system adequate for vapor ventilation.

6. Reagents and Materials

6.1 The following list of standard reagents is intended to be representative of the main categories of pure chemical compounds, solutions, and common industrial products. Chemicals used in these practices shall be of technical grade or greater purity. All solutions shall be made with freshly prepared distilled water. Specific concentrations are on a weight percent or specific gravity basis. ~~Mixing instructions are based on amounts of ingredients calculated to produce 1000 mL of solution of the specified concentration.~~

6.2 The following list of standard reagents is not intended to preclude the use of other reagents pertinent to particular chemical resistance requirements. It is intended to standardize typical reagents, solution concentrations, and industrial products for general testing of the resistance of plastics to chemical reagents. Material specifications in which chemical resistance is indicated shall preferably be based upon reagents and conditions selected from those listed herein except by mutual agreement between the seller and the ~~purchaser.~~purchaser and/or where other reagents are more appropriate for the end use application.

6.3 *Standard Reagents:*

6.3.1 *Acetic Acid (sp gr 1.05)*—Glacial acetic acid.

6.3.2 *Acetic Acid ~~(5 %)—~~(5 %).* ~~Add 48 mL (50.5 g) of glacial acetic acid (sp gr 1.05) to 955 mL of water.~~

6.3.3 *Acetone.*

6.3.4 *Ammonium Hydroxide (sp gr 0.90)*—Concentrated ammonium hydroxide (NH_4OH).

6.3.5 *Ammonium Hydroxide ~~(10 %)—~~(10 %).* ~~Add 375 mL (336 g) of (NH_4OH) (sp gr 0.90) to 622 mL of water.~~

6.3.6 *Aniline.*

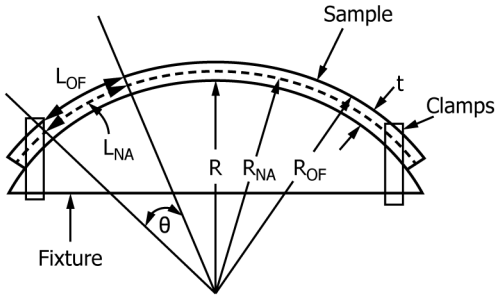
6.3.7 *Benzene.*

6.3.8 *Carbon Tetrachloride.*

6.3.9 *Chromic Acid ~~(40 %)—~~(40 %).* ~~Dissolve 549 g of chromic anhydride (C_rO_2) in 822 mL of water.~~

6.3.10 *Citric Acid ~~(1 %)—~~(1 %).* ~~Dissolve 104 g of citric acid crystals in 935 mL of water.~~

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



R = radius of jig
R_{NA} = radius of neutral axis
R_{OF} = radius of outer fiber
t = thickness of specimen

θ = arbitrary angle
L_{OF} = length of outer fiber
L_{NA} = length of neutral axis

considering a portion of test bar determined by angle θ

$$L_{NA} = R_{NA}\,\theta = (R + \tfrac{1}{2}t)\,\theta \qquad R_{NA} = R + \tfrac{1}{2}t$$

$$L_{OF} = R_{OF}\,\theta = (R + t)\,\theta \qquad R_{OF} = R + t$$

$$\Delta L = L_{OF} - L_{NA} = (R + t)\,\theta - (R + \tfrac{1}{2}t)\,\theta$$

$$\varepsilon = \frac{\Delta L}{L} = \frac{(R + t)\,\theta - (R + \tfrac{1}{2}t)\,\theta}{(R + \tfrac{1}{2}t)\,\theta}$$

$$\varepsilon = \frac{(R + t) - R + \tfrac{1}{2}t}{R + \tfrac{1}{2}t} = \frac{\tfrac{1}{2}t}{R + \tfrac{1}{2}t}$$

$$\boxed{\varepsilon = \frac{1}{\frac{2R}{t} + 1}} \qquad \boxed{R = \frac{\left(\frac{1}{\varepsilon} - 1\right)t}{2}}$$

FIG. 1 Determination of Strain Level of ~~ESCR Fixtures~~Environmental Stress Crack Resistance (ESCR) Fixtures (Practice B)

6.3.11 *Cottonseed Oil,* edible grade.

6.3.12 *Detergent Solution, Heavy Duty (0.025 %)*—Dissolve 0.05 g of alkyl aryl sulfonate and 0.20 g of trisodium phosphate in 1000 mL of water.

6.3.13 *Diethyl Ether.*

6.3.14 *Dimethyl Formamide.*

6.3.15 *Distilled Water,* freshly prepared.

6.3.16 *Ethyl Acetate.*

6.3.17 *Ethyl Alcohol (95 %)*—Undenatured ethyl alcohol.

6.3.18 *Ethyl Alcohol ~~(50 %)—~~(50 %).* ~~Add 598 mL (482 g) of 95 % undenatured ethyl alcohol to 435 mL of water.~~

6.3.19 *Ethylene Dichloride.*

6.3.20 *2-Ethylhexyl Sebacate.*

6.3.21 *Heptane,* commercial grade, boiling range from 90 to 100°C.

6.3.22 *Hydrochloric Acid (sp gr 1.19)*—Concentrated hydrochloric acid (HCl).

6.3.23 *Hydrochloric Acid ~~(10 %)—~~(10 %).* ~~Add 239 mL (283 g) of HCl (sp gr 1.19) to 764 mL of water.~~

6.3.24 *Hydrofluoric Acid ~~(40 %)—~~(40 %).* ~~Slowly add 748 mL (866 g) of hydrofluoric acid (52 to 55 % HF) to 293 mL of water.~~

6.3.25 *Hydrogen Peroxide Solution,* 28 % or USP 100 volume.

6.3.26 *Hydrogen Peroxide Solution (3 % or USP 10 ~~volume)—~~volume).* ~~Add 98 mL (108 g) of commercial grade (100 volume or 28 %) hydrogen peroxide (H_2O_2) to 901 mL of water.~~

6.3.27 *Isooctane,* 2,2,4-trimethyl pentane.

6.3.28 *Kerosine*—No. 2 fuel oil, Specification D396.

6.3.29 *Methyl Alcohol.*

6.3.30 *Mineral Oil, White, USP,* sp gr 0.830 to 0.860; Saybolt at 100°F: 125 to 135 s.

6.3.31 *Nitric Acid (sp gr 1.42)*—Concentrated nitric acid (HNO_3).

6.3.32 *Nitric Acid ~~(40 %)—(40 %).~~* ~~Add 500 mL (710 g) of HNO_3 (sp gr 1.42) to 535 mL of water.~~

6.3.33 *Nitric Acid ~~(10 %)—(10 %).~~* ~~Add 108 mL (153 g) of HNO_3 (sp gr 1.42) to 901 mL of water.~~

6.3.34 *Oleic Acid, cP.*

6.3.35 *Olive Oil,* edible grade.

6.3.36 *Phenol Solution ~~(5 %)—(5 %).~~* ~~Dissolve 47 g of carbonic acid crystals, USP, in 950 mL of water.~~

6.3.37 *Soap Solution (1 %)*—Dissolve dehydrated pure white soap flakes (dried 1 h at 105°C) in water.

6.3.38 *Sodium Carbonate Solution ~~(20 %)—(20 %).~~* ~~Add 660 g of sodium carbonate ($Na_2CO_3 \cdot 10H_2O$) to 555 mL of water.~~

6.3.39 *Sodium Carbonate Solution ~~(2 %)—(2 %).~~* ~~Add 55 g of $Na_2CO_3 \cdot 10H_2O$ to 964 mL of water.~~

6.3.40 *Sodium Chloride Solution ~~(10 %)—(10 %).~~* ~~Add 107 g of sodium chloride (NaCl) to 964 mL of water.~~

6.3.41 *Sodium Hydroxide Solution ~~(60 %)—(60 %).~~* ~~Slowly dissolve 971 g of sodium hydroxide (NaOH) in 649 mL of water.~~

6.3.42 *Sodium Hydroxide Solution ~~(10 %)—(10 %).~~* ~~Dissolve 111 g of NaOH in 988 mL of water.~~

6.3.43 *Sodium Hydroxide Solution ~~(1 %)—(1 %).~~* ~~Dissolve 10.1 g of NaOH in 999 mL of water.~~

6.3.44 *Sodium Hypochlorite Solution, National Formulary, (4 to ~~6 %)—6 %).~~* ~~The concentration of this solution can be determined as follows: Weigh accurately in a glass-stoppered flask about 3 mL of the solution and dilute with 50 mL of water. Add 2 g of potassium iodide (KI) and 10 mL of acetic acid, and titrate the liberated iodine with 0.1 N sodium thiosulfate ($Na_2S_2O_3$), adding starch solution as the indicator. Each millilitre of 0.1 N $Na_2S_2O_3$ solution is equivalent to 3.7222 mg of sodium hypochlorite.~~

6.3.45 *Sulfuric Acid ~~(sp gr 1.84)—(30 %).~~* ~~Concentrated sulfuric acid (H_2SO_4).~~

6.3.46 *Sulfuric Acid ~~(30 %)—(3 %).~~* ~~Slowly add 199 mL (366 g) of H_2SO_4 (sp gr 1.84) to 853 mL of water.~~

~~6.3.47 *Sulfuric Acid (3 %)*—Slowly add 16.6 mL (30.6 g) of H_2SO_4 (sp gr 1.84) to 988 mL of water.~~

6.3.47 *Toluene.*

6.3.48 *Transformer Oil,* in accordance with the requirements of Specification D1040.

6.3.49 *Turpentine*—Gum spirits or steam distilled wood turpentine in accordance with Specification D13.

NOTE 3—Prior versions of this standard, D543-14 and earlier, listed recipes for preparing several of the standard reagents listed above, which were not accurate. The use of commercially available mixed reagents is encouraged; the recipes in the prior versions of this standard may be evaluated as an information source when appropriate.

6.4 Table 1 contains a list of military specifications for various liquids intended to be representative of the main types of liquids that are sometimes encountered in a military service environment. Plastics that are intended for use in such environments shall be tested for chemical resistance to the liquids in Table 1 as applicable.

6.4.1 Army Regulation 70-71 establishes the requirement for chemical contamination survivability of Army material intended to withstand the hazards of a chemical warfare (CW) environment. Decontaminating agents STB ~~and DS2 are~~ is included in Table 1. In addition, selected CW agents (or suitable simulants) are liquids against which it is appropriate to test the resistance of certain plastics.

TABLE 1 Military Specifications for Liquids Encountered in Military Service Environments

Specification	Title
MIL-C-372	Cleaning Compound, Solvent (for Bore of Small Arms and Automatic Aircraft Weapons)
MIL-G-5572	Gasoline, Aviation, Grades 80/87, 100/130, 115/145
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missiles, and Ordinance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-H-6083	Hydraulic Fluid, Petroleum Base, for Preservation and Operation
~~MIL-L-7808~~	~~Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, Nato Code Number 0-148~~
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-A-11755	Antifreeze, Artic-Type
MIL-D-12468	Decontaminating Agent, STB
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-A-46153	Antifreeze, Ethylene Glycol, Inhibited, Heavy Duty, Single Package
MIL-F-46162	Fuel, Diesel, Referee Grade
~~MIL-D-50030~~	~~Decontaminating Agent, DS2~~
MIL-T-83133	Turbine Fuel, Aviation, Kerosene Type, Grade JP-8
~~MIL-H-83283~~	~~Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft~~
MIL-H-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft

6.5 SAE J1681 contains a list of gasoline, alcohol and diesel fuel surrogates intended to be representative of the fuels that are encountered in internal combustion engines in automobile applications. Plastics that are intended for use in such environments shall be tested for chemical resistance to these fuel surrogates as applicable.

6.6 This standard does not list all the possible chemical reagents that plastics encounter in use. For example, one can foresee that a plastic used in a hospital environment would be subjected to disinfectants and cleaning agents encountered. Relevant chemical reagents used in the study to evaluate a plastic for an application should be reported.

7. Hazards

7.1 Take suitable safety precautions to avoid personal contact, to eliminate toxic vapors, and to guard against explosion hazards in accordance with the hazardous nature of the particular reagents being used.

8. Sampling

~~8.1 For Practices A and B, Procedure I, sample in accordance with the pertinent considerations outlined in Practice D1898.~~

8.1 ~~For Practices A and B, Procedure II, sample~~ Sample in accordance with the ASTM test methods for the specific properties to be determined.

9. Test Specimens

9.1 The type and dimensions of test specimens to be used depend upon the form of the material and the tests to be performed (see Note ~~2~~4). At least three specimens shall be used for each material being tested, for each reagent involved, for each length of conditioning, and for each strain level. The test specimens shall be as follows:

9.1.1 *Molding and Extrusion Materials*—Specimens shall be molded to shape or cut from molded slabs as required in 9.1.1.1 and 9.1.1.2. The cut edges of specimens shall be made smooth by sharp cutting, machining, or by finishing with No. 0 or finer sandpaper or emery cloth. Molding shall conform to conditions recommended by the manufacturer of the material (see Note ~~2~~5). The shape and dimensions of specimens shall depend upon the test to be performed and shall conform to the following:

9.1.1.1 *Weight and Dimension Changes*—Standard specimens shall be in the form of disks 50.80 mm (2 in.) in diameter and 3.175 mm (0.125 in.) in thickness molded or cut from molded slabs. The nominal surface area of this standard disk is 45.60 cm^2 (7.1 $in.^2$).

9.1.1.2 *Mechanical Property Changes*—Standard tensile specimens shall be used in accordance with the test method prescribed in the appropriate specification for the material being tested or by agreement among those concerned. Where the determination of other mechanical properties is agreed upon between the seller and the purchaser, standard specimens prescribed in the appropriate test methods shall be used.

9.1.1.3 *Color Changes*—The use of color chips 50.8 mm (2 in.) by 76.2 mm (3 in.) by 2 mm (0.080 in.) thick are recommended for color measurements, although specimens used for other properties may also be used as long as their dimensions are consistent with the requirements of the color measurement device used.

9.1.2 *Sheet Materials*—Specimens from sheet materials shall be cut from a representative sample of the material (see Note ~~3~~5) in a manner depending upon the tests to be performed and the thickness of the sheet, as follows (see 9.1.1 regarding preparation of cut edges):

9.1.2.1 *Weight and Dimension Changes*—Standard specimens shall be in the form of bars 76.20 mm (3 in.) in length by 25.40 mm (1 in.) in width by the thickness of the material. The nominal surface area of the standard bar, having a thickness of 3.175 mm (0.125 in.), is 45.16 cm^2 (7.0 $in.^2$). Circular disk specimens 50.80 mm (2 in.) in diameter by the thickness of the material are permissible under mutual agreement between the seller and the purchaser. Permissible variations in thickness of both types of specimens are ±0.18 mm (±0.007 in.) for hot molded and ±0.30 mm (±0.012 in.) for cold molded or cast materials.

9.1.2.2 *Mechanical Property Changes*—Standard machined, sheared, or cut tensile specimens shall be used in accordance with the test methods prescribed in the appropriate specifications of the material to be tested, or by agreement among those concerned (see 9.1.1.2).

~~NOTE 2—Specimen surface area greatly affects the weight change due to immersion in chemical reagents. Thickness influences percentage dimension change as well as percentage change in mechanical properties. In addition, results obtained on molded specimens may not agree with those from specimens cut from molded parts or extruded sheets of a given material. Consequently, comparison of materials should be made only on the basis of results obtained from specimens of identical dimensions and like methods of specimen preparation.~~

~~NOTE 3—Molding conditions can affect the resistance of plastics to chemical reagents. Compression moldings should be prepared in a manner that will disburse external lubricants and result in complete fusion of the particles. Injection molding of test specimens should be accomplished in a manner that results in a minimum of molecular orientation and thermal stress or a controlled level of both, depending upon the condition being simulated.~~

~~NOTE 4—For certain products, such as laminates, in which edge effects are pronounced, larger coupons may be exposed from which standard specimens can be cut after immersion for determining the effects of reagents on mechanical properties. This may be allowed in provisions of material specifications by mutual agreement between the seller and the purchaser and should be reported as such.~~

9.1.2.3 *Color Changes*—The use of color chips 50.8 mm (2 in.) by 76.2 mm (3 in.) by 2 mm (0.080 in.) thick are recommended for color measurements, although specimens used for other properties may also be used as long as their dimensions are consistent with the requirements of the color measurement device used.