Designation: D6540 – 17

Standard Test Method for Accelerated Soiling of Pile Yarn Floor Covering[1]

This standard is issued under the fixed designation D6540; 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 test method describes the equipment, and the test method for assessing the propensity of pile yarn floor coverings to soiling in the absence of abrasive wear and texture changes, using a standard synthetic soil composition.

1.2 This test method is applicable for use in testing unused pile yarn floor covering of all types. It is not applicable for use in testing used pile yarn floor covering.

1.3 This test method can be used to compare the soiling propensity of two or more carpets; or it can be used to soil carpets as a preliminary step to other test procedures.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

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]
D123 Terminology Relating to Textiles
D1776 Practice for Conditioning and Testing Textiles
D5684 Terminology Relating to Pile Floor Coverings

2.2 *ASTM Adjunct:*
TEX-PAC[3]
2.3 *AATCC Test Method:*
Evaluation Procedure 1 – Gray Scale for Color Change[4]

3. Terminology

3.1 For definitions of terms relating to Pile Floor Coverings, D13.21, refer to Terminology D5684.

3.1.1 The following terms are relevant to this standard: carpet, finished, finished pile yarn floor covering, floor covering, pile, pile lay, pile yarn floor covering, soiling, textile floor covering, tufted fabric, use-surface.

3.2 For all other terminology related to textiles, refer to Terminology D123.

4. Summary of Test Method

4.1 The carpet test specimens are secured to a backing sheet that is mounted inside the drum with the pile surface exposed, and are subjected to an accelerated soiling process. The degree of soiling is measured or assessed by comparing the change in color between soiled and original pile yarn floor covering, using a measurement device or visually matching the differences on the light-dark axis of Gray Scales.

NOTE 1—Differentiation between test samples is significantly reduced when Gray Scales are used.

5. Significance and Use

5.1 This test method may be used to soil test specimens in the absence of abrasive wear and texture changes under controlled conditions using a standard synthetic soil, or as a preliminary step to other procedures.

5.2 This test method will provide a uniformly soiled test specimen to evaluate, is reproducible (see section 11), and is economical for Testing Laboratories.

5.3 This test method has been found to give results similar to the actual floor service soiling, but its use is recommended only as a screening test method and not as a replacement for floor testing.

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.21 on Pile Floor Coverings.

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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 PC program on floppy disks for analyzing Committee D13 interlaboratory data are available from ASTM. Request ADJ:D2904.

[4] Available from American Association of Textile Chemists and Colorists, PO Box 12215, Research Triangle Park, NC 27709.

5.4 The acceptance criteria of this test method shall be set by mutual agreement between the purchaser and supplier.

6. Apparatus and Materials

6.1 *Hexapod Tumble Tester*

6.1.1 *Drum*—Constructed of molded PVC and is capped by a lid that is secured. The drum base and lid have a locating groove to hold the specimen backing sheet flat to the inner wall of the drum. The drum dimensions are:

Internal Diameter	12.00 ± 0.04 in.	(305 ± 1 mm)
Wall Thickness	0.03 in. approx.	(8 mm approx.)
Internal Depth	7.90 ± 0.04 in.	(200 ± 1 mm)

6.1.2 *Driving System*—Cradles the drum on rollers and keeps the axis of the drum level, rotates at 0.60 ± 0.03 r/s (35 ± 2 rpm). The driving system reverses every 15 min with approximately one minute stationary time.

6.2 *Specimen Backing Sheet*—is a polyethylene sheet 37.40 × 8.50 × 0.08 in. (950 × 215 × 2 mm).

6.3 *Tape*—double sided pressure sensitive adhesive, 2.0 in. (50 mm) width.

6.4 *Cleaning Frame*—A rectangular frame 39.4 × 11.8 in. (1000 × 300 mm) with a central rectangular aperture 37.0 × 7.9 in. (940 × 200 mm) to receive the test specimen, of material similar in construction to the test specimen and mounted on a backing sheet.

6.5 *Vacuum Cleaner*—upright type, with a rotating brush and beater bar, unless this type of apparatus is not recommended by the manufacturer of the pile floor covering under test, in that case the appropriate recommended device should be used.

6.6 *Mixing Container*—a wide mouth container such as a Standard Mill jar.

6.7 *Polymer Pellets*—polyamide polymer pellets having a maximum size of 0.27 ± 0.08 in. (7 ± 2 mm)

6.8 *Chrome Alloy Steel Balls (Ball Bearings)*—with a 0.37 ± 0.01 in. (9.50 ± 0.02 mm) diameter.

6.9 *Standard Soiling Compound*—A soiling compound, such as AATCC synthetic soil formula, which is compatible with the equipment.

6.10 *Control Pile Yarn Floor Covering*—an internal standard light colored carpet of known specifications used as a reference for each test evaluation.

6.11 *Color Measurement Equipment*—A color measurement device with a 2.0 ± 0.2 in. (50 ± 0.5 mm) aperture, capable of measuring the color of pile yarn floor covering and expressing the results in Delta E (dE) or Delta L (dL).

6.12 *Gray Scales*—standard gray scales used to visibly assess change in color of pile yarn floor covering as per AATCC Procedure 1.

6.13 *Template*—to be the same size as the test specimen with 3 holes of the same dimensions as the measuring head of the color measuring device. See Fig. 1.

6.14 *Magnet*—capable of attracting and holding several chrome alloy steel balls at one time.

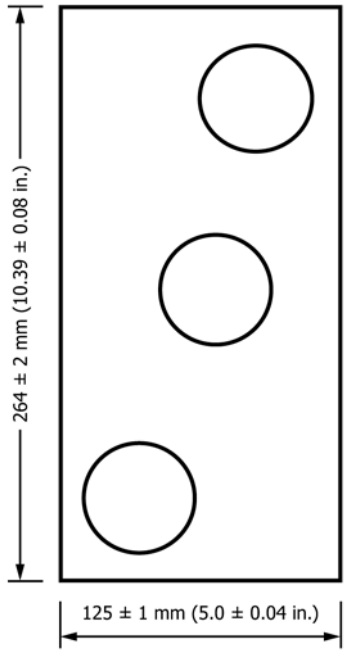

FIG. 1 Example of a Suitable Template for Color Measurement

7. Sampling, and Preparation of Soiled Pellets, Sampling, and Test Specimens

7.1 *Preparation of Soiled Polyamide Polymer Pellets*

7.1.1 Place 0.1058 ± 0.0017 oz (3.00 ± 0.05 g) of the standard soiling compound (see 6.9) and 2.205 ± 0.002 lb (1000 ± 1 g) of polyamide polymer pellets (see 6.7) in the mixing container. Secure the lid and place the mixing container on the driving system for 10 minutes, reverse direction and continue for an additional 10 min, for a total of 20 min to ensure a homogeneous mixture of the soil and polyamide polymer pellets.

NOTE 2—To simulate particular use areas, it may be necessary to adjust the type or quantity, or both, of soiling compound and document the change in the written report.

NOTE 3—If large quantities of soiled pellets are prepared, that is more than 4.409 lb (2000 g), they shall be kept in an airtight container to ensure no loss of moisture from the mixture occurs, and the supply shall not be allowed to dwindle below 25 % of the original quantity.

NOTE 4—This Test Method was developed using AATCC synthetic soiling compound and if another soiling compound is used the amount of soil used to prepare the soiled polymer pellets must be adjusted.

7.2 Ensure the inside of the drum and chrome alloy steel balls are clean.

7.3 *Size of Test Specimens*

7.3.1 Cut a minimum of two test specimens per pile yarn floor covering, measuring a minimum of 5.00 ± 0.04 in. (125 ± 1 mm) in the direction of manufacture by 8.00 ± 0.08 in. (205 ± 2 mm) wide. Mark an arrow in the direction of the pile lay on the back of the test specimen. All test specimens shall be conditioned (clause 8.1), flat singly, and with use-surface uppermost, for a minimum of 24 h.

7.4 *Specimen Attachment*

7.4.1 To the specimen backing sheet (see 6.2) attach double sided pressure sensitive adhesive tape (see 6.3) at each edge,

across the ends and at each junction of the test specimen. Mount the test specimens and internal standard carpet with the use surface uppermost, allowing a 0.20 ± 0.04 in. (5 ± 1 mm) gap at each end and 0.31 ± 0.04 in. (8 ± 1 mm) between test specimens to allow for the test specimen to remain attached when the specimen backing sheet is curved to fit the internal circumference of the drum. Check to ensure that each test specimen is in the direction of manufacture, and in the case of cut pile, that the pile lay is in the same direction. All test specimens shall fit flat to the specimen backing sheet when it is curved to the inside drum diameter. If the test specimens are not secured properly adjust the test specimens accordingly. When test specimens of differing thickness are tested together, the difference in thickness of the adjacent test specimens shall not exceed 0.04 in. (1 mm).

7.4.2 Remove loose fiber from the test specimens with a vacuum cleaner (see 6.5), using a total of four strokes, two against and two with the direction of the pile at an approximate speed of 12 in./s (300 mm/s)

8. Conditioning

8.1 Condition the specimen in the standard atmosphere for testing textiles in accordance with Practice D1776.

9. Procedure

9.1 If using color measurement equipment for assessment, locate the measuring template (see section 6.13) on the test specimen and, using the color measuring device (see section 6.11) measure the color of the test specimen in three (3) places. Record these values.

9.2 Fit the mounted test specimens into the clean drum, ensuring that the backing sheet fits tightly and lies smoothly around the internal circumference.

9.3 Place 2.205 ± 0.004 lb (1000 ± 2 g) of clean chrome alloy steel balls (see 6.8), and 8.818 ± 0.007 oz (250.0 ± 0.2 g) of soiled polyamide polymer pellets (see 7.1.1) into the drum (see 6.1.1) and secure the lid.

9.4 Place the drum on the driving system (see section 6.1.2), start the machine and allow the drum to rotate for 30 min. When the test is completed remove the drum from the cradle and set it upright.

9.5 Remove the backing sheet with the test specimens and carefully clean the test specimens by suction using the vacuum cleaner to remove the loose surface soil and fiber at a speed of approximately 3 s per stroke, using a total of four strokes (two against the direction of the pile lay and two with). For a low level loop pile sample select a low vacuum cleaner height setting, for cut pile samples use a medium to high setting according to pile height. To ensure consistent vacuum cleaner height as intended, arrange two extra strips of carpet identical to the test specimen side by side to the sample as traction underlay. Allow the vacuum cleaner wheels to run over these strips with the sample in between when cleaning. Alternately, use a self-made template made of any suitable material to serve as traction underlay. In the case of cut pile carpets, ensure that the last stroke of the vacuum is against the lay of the pile.

9.6 Using the magnet (see section 6.14) remove the chrome alloy steel balls from the drum.

9.7 With a vacuum cleaner, remove the used soil polyamide polymer pellets from the inside of the drum. Clean the inside of the drum with a damp cloth.

9.8 Repeat steps 9.1 – 9.7 for the second test specimen.

10. Assessment

10.1 To achieve optimum and replicable results condition the test specimens in the standard atmosphere for testing textiles as directed in Practice D1776.

10.2 Using the measuring template and the color measuring equipment measure the color of the soiled test specimens in the same three (3) places on each test specimen. Calculate the mean color differences (dE) or mean light difference (dL) between the original and soiled test specimens according to the following formulae:

$$dE = \sqrt{(L_o - L_s)^2 + (a_o - a_s)^2 + (b_o - b_s)^2} \quad (1)$$

or $dL = L_o - L_s$

where L_o, a_o, and b_o are the mean co-ordinates of the original test specimen,

and L_s, a_s, and b_s are the mean color co-ordinates of the soiled test specimen.

10.3 To assess the level of soiling other than by the color measuring equipment (see 6.11) the Gray Scales (see 6.12) shall be used. Three operators shall visually assess the color difference between the soiled test specimen and the original test specimens in accordance with AATCC Procedure 1.

11. Precision and Bias

11.1 *Precision*

11.1.1 An inter-laboratory study of this Test Method was conducted using two Laboratories and five test items of various pile yarns. Each laboratory had two operators, each operator tested all test specimens provided on two separate days.

11.1.2 The results of the inter-laboratory study are shown in Table 1. The statistics were prepared using the TEX-PAC package.

TABLE 1 Components of Variance for Jumbo Gray Scale Expressed as Variances and Standard Deviations[A]

Variance Component	As Variance	As $\sqrt{V}$ Gray Scale
Material	0.0887	0.2978
Laboratory	0	0
Material-times-laboratory interaction	0.0038	0.0616
Operators within laboratory	0.0007	0.0265
Materials-times-operator interaction within laboratories	0	0
Specimens within materials, laboratories, and operators	0.0236	0.1536

[A]The square roots of the components of variance are being reported to express the variability in the appropriate units of measure rather than as the squares of those units of measure.

TABLE 2 Components of Variance for Electronic Device Expressed as Variances and Standard Deviations[A]

Variance Component	As Variance	As $\sqrt{V}$ Gray Scale
Material	18.2540	4.2725
Laboratory	0.5610	0.7490
Material-times-laboratory interaction	0.1062	0.3259
Operators within laboratory	0	0
Materials-times-operator interaction within laboratories	0	0
Specimens within materials, laboratories, and operators	0.2812	0.5303

[A]The square roots of the components of variance are being reported to express the variability in the appropriate units of measure rather than as the squares of those units of measure.

11.1.3 *Interlaboratory Test Data*—An interlaboratory study consisted of 5 test carpets of various pile fiber, and construction. Two laboratories participated with two operators conducting two tests, three readings per test specimen using the electronic device as well as the Gray Scales. The interlaboratory test was conducted on two separate days.

11.1.4 *Components of Variance*—The components of variance shown as variances and the square root of the variances (to show appropriate units of measure) are listed in Tables 1 and 2.

11.1.5 *Precision Parameters*—For the components of variance reported in Tables 1 and 2, two averages of observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in Tables 3 and 4.

NOTE 5—The tabulated values of the critical differences should be considered to be a general statement, particularly with respect to between-laboratory precision.

NOTE 6—Because the interlaboratory test included less than five laboratories, estimates of between-laboratory precision may be either underestimated or overestimated to a considerable extent and should be used with special caution.

11.2 *Bias*

11.2.1 The procedure in this test method for accelerated soiling of pile floor covering contains no known bias other than those noted.

TABLE 3 Critical Differences for the Conditions Noted 95 % Probability Level, Single Material Comparisons AATCC Jumbo Gray Scale

Number of Test Results in each Average	Single Operator Precision		Within-Laboratory Precision		Between-Laboratory Precision	
	SE	CD	SE	CD	SE	CD
1	0.154	0.43	0.156	0.44	0.156	0.44
2	0.109	0.30	0.112	0.31	0.112	0.31
4	0.077	0.22	0.081	0.23	0.081	0.23
5	0.069	0.19	0.074	0.21	0.074	0.21

TABLE 4 Critical Differences for the Conditions Noted 95 % Probability Level, Single Material Comparisons Electronic Device ΔE

Number of Test Results in each Average	Single Operator Precision		Within-Laboratory Precision		Between-Laboratory Precision	
	SE	CD	SE	CD	SE	CD
1	0.530	1.48	0.530	1.48	0.918	2.57
2	0.375	1.05	0.375	1.05	0.838	2.35
4	0.265	0.74	0.265	0.74	0.795	2.22
5	0.237	0.66	0.237	0.66	0.786	2.20

12. Test Report

12.1 State that the test was conducted as directed in Test Method D6540.

12.2 State all information necessary for complete identification of the test specimen.

12.3 Date of test.

12.4 The atmosphere conditions if other than standard.

12.5 The details of the soiling compound used.

12.6 Whether assessment was by color measuring device or by Gray Scales.

12.7 The average test results of each test specimen and the lot.

12.8 Any deviations from this Test Method.

13. Keywords

13.1 appearance; carpet; pile floor covering; soiling