



Designation: ~~D4213-96~~ (Reapproved 2003) Designation: D 4213 – 08

Standard Test Method for Scrub Resistance of Paints by Abrasion Weight Loss¹

This standard is issued under the fixed designation D 4213; 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 covers an accelerated procedure for determining the resistance of paints to erosion caused by scrubbing. (Note: The term *wet abrasion* is sometimes used for *scrubbing*, and *wet abrasion resistance* or *scrubbability* for *scrub resistance*.) Although scrub resistance tests are intended primarily for interior coatings, they are sometimes used with exterior coatings as an additional measure of film performance.

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

1.3 *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

D 562 Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer

D 1193 Specification for Reagent Water

D 1475 Test Method ~~for~~For Density of Liquid Coatings, Inks, and Related Products

D 2486 Test Methods for Scrub Resistance of Wall Paints

D 3450 Test Method for Washability Properties of Interior Architectural Coatings

D 3980 Practice for Interlaboratory Testing of Paint and Related Materials³

D 4828 Test Methods for Practical Washability of Organic Coatings

E 70 Test Method for pH of Aqueous Solutions ~~with~~With the Glass Electrode

E 180 Practice for Determining the Precision of ASTM Methods for Analysis and Testing of Industrial and Specialty Chemicals

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Summary of Test Method

3.1 The material under test is applied to a black plastic scrub test panel, and after drying one week, a section of the test panel is placed in a straight-line abrasion tester, adjacent to a similar section of a standard calibration panel. The two sections are scrubbed simultaneously to produce essentially identical abrasion experiences and the amount of erosion loss in each section determined from the panel weights before and after scrubbing.

3.2 The scrub resistance on a dry-film basis is calculated as the percent ratio of the weight loss of the calibration panel to that of the test panel. From that value, scrub resistance is calculated on the basis of both dry- and wet-film volume.

4. Significance and Use

4.1 Interior paint films often become soiled, especially near doorways, windows, and play areas, and frequently need to be cleaned by scrubbing. This test method covers the determination of the relative resistance of paints to erosion when scrubbed.

4.2 The precision of scrub resistance measurements in absolute physical values, such as Test Methods D 2486 cycles-to-failure or this test method, microlitres per 100 cycles, is poor due to the relatively large effect of subtle and difficult-to-control variables in test conditions. The test method described herein minimizes this problem by using a standard calibration panel as an integral part of each scrubbing operation and relating its weight loss to that of the paint film under test to establish the latter's scrub resistance.

¹ This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.42 on Architectural Coatings.

~~Current edition approved Dec. 1, 2003. Published December 2003. Originally approved in 1983. Last previous edition approved in 1996 as D4213-96¹.~~

Current edition approved Feb. 15, 2008. Published April 2008. Originally approved in 1983. Last previous edition approved in 2003 as D 4213 – 96 (2003).

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 Withdrawn.

NOTE 1—The numerical scrub resistance values obtained by this test method are of significance only in relation to the specific calibration panel types with which the value is obtained. Thus, for example, a scrub resistance value of 83 with a Type X calibration panel would be reported as 83X.

4.3 Results obtained by this test method do not necessarily represent the scrub resistance that might be determined if the test film is allowed to dry before testing appreciably longer than the seven-day period specified herein.

4.4 Results obtained by this test method do not necessarily relate to ease of soil or stain removal (also referred to as “cleanability” or “cleansability”). To test for those characteristics use Test Methods D 3450 and D 4828 and D 4828.

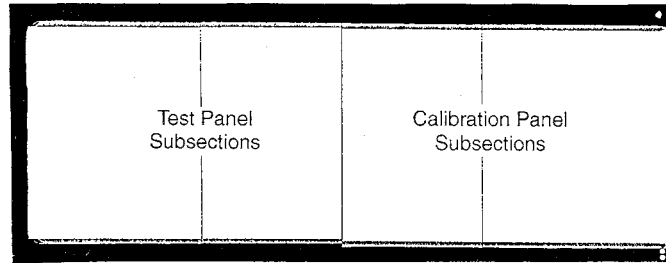


FIG. 1 Alignment of Panels for Scrubbing

5. Apparatus and Materials

5.1 *Straight-line Scrub Tester*, set for 37 ± 1 cycles per minute, having a minimum intrinsic stroke length of 255 mm (10 in.), counter for recording the number of scrub cycles, base pan, glass support plate, “Lilly” frame, and C-clamps to hold down the entire test assembly.

5.2 *Sponge Holder*, stainless steel construction, weight: 450 ± 10 g, approximate inside dimensions: 22 by 75 by 95 mm (7/8 by 3 by 3 3/4 in.).

5.3 *Polyurethane Sponges*,⁴ skin free, open-cell formation, density 0.032 to 0.040 g/cm³ (2 to 2.5 lb/ft³), compression (25 % deflection) 4.8 kPa (0.7 psi), width and length 0.08 in. (2 mm) larger than the sponge holder with which it is to be used, thickness such that when inserted into the sponge holder it protrudes about 5 to 6 mm (0.25 in.) beyond the skirt (see Fig. 1).

5.4 *Abrasive Pad*,⁵ 6-mm (1/4-in.) thick, cut to same size as the sponge with which it is to be used.

5.5 *Film Caster*, with horseshoe frame, clearance 175 μm (7 mils), film width approximately 135 mm (5 1/4 in.).

5.6 *Black Plastic Panels*,⁶ dimensions: $0.25 \pm 10\%$ by 165 by 430 mm ($0.01 \pm 10\%$ by 6.5 by 17 in.). Level and uniform dull black surface, impervious to and unaffected by water or aliphatic solvents, plasticizer-free, density 1.33 ± 0.05 g/cm³.

NOTE 2—With dark colored paints use white panels. These should be the same as the black except for color, and density: 1.41 ± 0.05 g/cm³.

5.7 *Drawdown Plate*, 6-mm (1/4-in.) thick, clear float glass, size adequate to be used as a base for drawdowns on the specified scrub test panels.

5.8 *Non-Abrasive Scrub Medium*,⁷ standard wetting liquid. Formula and preparation instructions are as follows:;^{8, 9, 10}

	Formula—Parts by Weight	
Water, reagent, Specification D 1193, Type IV		89.6 ^A
Hydroxyethyl cellulose ^Z		-2.0
Hydroxyethyl cellulose ^B		2.0
Detergent ^A		-4.0
Detergent ^C		4.0

⁴ Abrasive pad—Scotch-Brite #7448 manufactured by 3M Company, 3M Center Bldg., St. Paul, MN 55144-1000 has been found satisfactory. Pads cut to the correct size are available from suppliers of scrub testers.

⁴ Sponges, available from suppliers of scrub testers, cut to precise size for their respective holders.

⁵ Scrub Test Panels—Black: Form P121-10N and White: Form P122-10N, available from The Leneta Co., 15 Whitney Rd., Mahwah, NJ 07430, have been found satisfactory and are in compliance with requirements stated in 5.6.

⁵ Abrasive pad—Scotch-Brite #7448 manufactured by 3M Company, 3M Center Bldg., St. Paul, MN 55144-1000 has been found satisfactory. Pads cut to the correct size are available from suppliers of scrub testers.

⁶ Non-Abrasive Scrub Medium—Catalog Item SC-1 available from The Leneta Company is made in accordance with these requirements.

⁶ Scrub Test Panels—Black: Form P121-10N and White: Form P122-10N, available from The Leneta Co., 15 Whitney Rd., Mahwah, NJ 07430, were used in the round-robin for this method. Other charts that are in compliance with requirements stated in 5.6 may be used also.

⁷ Hydroxyethyl cellulose having a molar substitution (MS) value from 1.8 to 2.5 and a 2% solution viscosity in the range of 4400 to 6500 cps.

⁷ Non-Abrasive Scrub Medium—Catalog Item SC-1 available from The Leneta Company is made in accordance with these requirements.

⁸ Iso-octylphenoxy polyethoxyethanol detergent, such as Triton X-100 has been found satisfactory for this purpose.

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⁹ 1,3,5-triethyl hexahydro-sym-triazine (Vancide TH), obtainable from R. T. Vanderbilt Co., 30 Winfield St., Norwalk, CT 06855, has been found satisfactory.

⁹ Iso-octylphenoxy polyethoxyethanol detergent, such as Triton X-100 has been found satisfactory for this purpose.

¹⁰ Calibration panels may be prepared by individual laboratories for internal use and for relating their results to those of associated laboratories. Suitably aged and standardized calibration panels, having “poor,” “good,” and “very good” scrub resistance are available commercially from the Leneta Company. These are identified as Type A, C, and D respectively. The scrub resistance of Type A has been found to be approximately 35% of Type C, and Type C approximately 50% of Type D.

¹⁰ 1,3,5-triethyl hexahydro-sym-triazine (Vancide TH), obtainable from R. T. Vanderbilt Co., 30 Winfield St., Norwalk, CT 06855, has been found satisfactory.

Trisodium phosphate, anhydrous	4.0
Acetic acid glacial	0.3 ^B
Preservative ^A	0.1
Preservative ¹⁰	0.1
	100.0

^A Vary to achieve a final consistency of 165 to 220 g (75 to 85 Krebs Units) with a Stormer viscometer in accordance with Test Method D 562.

^B Vary to achieve a final pH from 9.5 to 10.0 in accordance with Test Method E 70.

5.8.1 Slowly add the hydroxyethyl cellulose to the water while stirring mechanically. Stir until uniform and then slowly add 2 to 3 drops of 28 % ammonium hydroxide solution while mixing, and continue mixing until the solution turns clear. In the order shown, add the other ingredients separately, stirring continuously. Be sure each item is uniformly dispersed before adding the next one. Finally, add the preservative and adjust the pH with glacial acetic acid.

NOTE 3—When a referee test is made the medium should be freshly prepared, or from a previously unopened container that is no more than 1-year old.

5.9 *Analytical Balance With Windshield Enclosure*, reading to 0.1 mg and accurate to 1 mg.

5.10 *Static Shield*, a thin gage metal plate, size 110 by 165 mm (4¼ by 6½ in.), to be placed on the balance pan when weighing. A satisfactory shield can be made from 0.175 to 0.300 mm (7 to 12 mil) thick aluminum or tinplate.

5.11 *Oven*, adjusted to 50 to 55°C (120 to 130°F).

5.12 *Calibration Panels*,¹¹ prepared in advance using paints of suitable scrub resistance.

NOTE 4—The procedure for preparing calibration panels is the same as described in 6.1 and 6.2 for regular test panels, except that the panels shall be aged sufficiently before use to ensure that the effect of additional ageing on their scrub resistance is negligible. A period of 6 months has been found adequate. Earlier use requires that in a given test series all calibration panels be the same age.

5.13 *Pycnometer*, for example, “weight-per-gallon” cup.

6. Procedure

6.1 Stir the test paint well by hand. (Do not shake). Strain if necessary to remove skins and large particles. Clean the surface of the glass drawdown plate carefully, then dust the scrub test panel making sure both sides are free of specks. Immediately after cleaning and dusting, place the panel on the drawdown plate (see 5.7) and tape or otherwise fasten it to the far end. Rub the panel against the plate with a lint-free cloth to develop static attraction.

6.2 Position the applicator at the fastened end of the panel, with its 7-mil (175-µm) clearance edge down, and evenly distribute approximately 12 mL of test paint across the front of the blade. Draw the paint down at a uniform rate of speed. The rate of application should be fairly slow (3 to 4 s from beginning to end) to prevent formation of pinholes or holidays in the film. Air dry for one week in a horizontal position, in a well ventilated area kept at 23 ± 2°C (73 ± 3.5°F) and 50 ± 10 % relative humidity.

6.3 At the end of the specified drying time cut the panel accurately in half with a paper cutter across the short dimension, and set aside one of the half-sections for a second test. Take the other half-section and make two subsections by cutting again, parallel to and 75 mm (3 in.) from the previous cut.

6.4 Weigh the narrower subsection in grams to four decimal places. It is essential while weighing, for the static shield to rest on the weighing pan and the panel to rest fully and flatly on the static shield.

NOTE 5—Weighing to four places is needed to ensure accuracy in the third (viz., to the nearest mg).

6.5 Place the two subsections in the machine, on the glass support plate, with the first-cut edge across the exact center line of the scrub path, and the wider subsection positioned so that the two second-cut edges are adjacent.

6.6 Repeat procedures 6.3, 6.4 and 6.5 using the selected calibration panel (see Note 6 below), placing the first-cut edge of the calibration panel adjacent to that of the test panel. See Fig. 1 for the configuration of the panel subsections on the support plate at this point.

NOTE 6—Use a calibration panel type similar in scrub resistance to that of the test paint, unless a single standard is required for a widely varying group of paints. In the latter case use calibration panels that can be characterized as having “good” or intermediate scrub resistance.

6.7 Place the Lilly frame (see 5.1) on the panel assembly and clamp it down firmly to prevent any shift in the test assembly while scrubbing.

6.8 Soak the sponge in tapwater and squeeze to a weight of about 20 g, then place it in the sponge holder making sure the sponge protrudes approximately 5 to 6 mm (¼ in.) (see Fig. 2).

6.9 Dampen the abrasive pad with tap water. Fill the 30-mL syringe with scrub medium and distribute 15 mL evenly over its unprinted face.

6.10 Place the unprinted face downward on the panel assembly and attach the sponge holder with sponge to the scrubbing machine, with the sponge resting squarely on the pad.

^{††} Supporting data are available from ASTM International Headquarters. Request RR:D01-1098.

¹¹ Calibration panels may be prepared by individual laboratories for internal use and for relating their results to those of associated laboratories. Suitably aged and standardized calibration panels, having “poor,” “good,” and “very good” scrub resistance are available commercially from the Leneta Company. These are identified as Type A, C, and D respectively. The scrub resistance of Type A has been found to be approximately 35 % of Type C, and Type C approximately 50 % of Type D.