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Standard Guide for Testing Cleaning Performance of Products Intended for Use on Resilient Flooring and Washable Walls[1]

This standard is issued under the fixed designation D4488; 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.

ε[1] NOTE—A warning note was changed editorially in August 2001.

1. Scope

1.1 This guide covers the evaluation of the cleaning performance of products intended for use on resilient flooring or washable walls. Such evaluations specifically exclude windows, mirrors, carpets, ceramic tiles, and laminated counter tops. This guide provides techniques for soiling, cleaning, and evaluating performance of detergent systems under controlled, but practical, hard-surface cleaning conditions.

1.2 Such systems include any detergent intended for cleaning hard surfaces such as resilient flooring, washable wall surfaces, and other hard surfaces, but excluding glass, ceramic, or other glossy surfaces. They may consist of solutions of soluble powdered detergent, dilutions of concentrated liquid detergent, or products intended to be used full strength, for example, foams, sprays, liquid, or paste.

1.3 There is no universal soil/substrate combination that is representative of the many soil-removal tasks required of this type of cleaner in actual use conditions. Choice of soil/substrate and cleaning conditions should be by agreement between the testing laboratory and those using the data to evaluate cleaning performance relative to user experience.

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.* Material Safety Data Sheets are available for reagents. Review them for hazards prior to usage. Specific precautionary statements are given in A3.3.3 .

2. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *soil*—in hard surface cleaning, foreign matter on a hard surface.

2.1.2 *substrate*—the soiled surface that is being cleaned.

3. Summary of Guide

3.1 Soils are artificially applied in a standardized manner to specified floor or wall substrates. The soiled surfaces are cleaned using a straight-line washability apparatus, and the cleaned substrates are evaluated instrumentally or visually by a panel of judges.

4. Significance and Use

4.1 This guide suggests methodology for cleaning tests. Soil/substrate combinations are generally designed to be analogous to soiled surfaces commonly encountered. This methodology can be used with most soil/substrate combinations. Some example test methods that have worked well in other labs are provided in the annexes. There is no requirement for using the soils listed in the annexes. It is the responsibility of the user to select the appropriate battery of tests for the desired end results.

4.2 The results of tests based on this guide are regarded as diagnostic screening values useful in formulation studies, quality control, and ingredient raw material qualification. This guide is intended to allow a choice in test conditions and soil/substrate combinations appropriate to the evaluation at hand. For interlaboratory comparisons, exact test conditions must be established before test results are compared.

4.3 This guide is applicable to testing all types of multipurpose household cleaners, whether the detergent is prepared by dissolving a soluble powder, a dilutable liquid, or is a prediluted product. It may also be useful for evaluation of products or conditions normally associated with industrial or institutional cleaners.

5. Preparation of Soil/Substrate Combinations

5.1 Cleaning performance of a test product depends on the particular combination of test soil and substrate. Soils and substrates to be cleaned should be selected as pairs. The usual

[1] This guide is under the jurisdiction of ASTM Committee D12 on Soaps and Other Detergents and is the direct responsibility of Subcommittee D12.16 on Hard Surface Cleaning.

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criteria for appropriate soil/substrate combinations are: relative ease of discriminability among cleaners to be tested; reproducibility of the test performed; and correlation of test results with consumer experience.

5.1.1 While it may be reasonable to assume that lab tests using soil/substrate combinations found in normal practice should correlate with actual cleaning experience, no particular soil/substrate combination is sufficiently representative by itself to provide a reliable index of cleaning performance for all cleaning tasks. Also, lab screening systems are usually much more heavily soiled than those found under real-use conditions, in order to optimize discriminability. It is possible, however, that soil/substrate combinations not actually found in normal usage may provide a test system that correlates well with some actual cleaning conditions.

5.1.2 Preparation of the substrate, such as abrading finished floor tiles, may be necessary.

5.1.3 Natural or accelerated aging of soil, such as baked-on greasy soil, may be desirable for the purposes of enhanced discrimination or better correlation of actual home-use conditions.

5.2 For reliable test results, and to obtain the most information from lab testing, details of soiling and substrate preparation should be documented for appropriate reporting of final results.

6. Experimental Cleaning Test Procedure

6.1 Replication is essential for generation of reliable hard-surface cleaning test results. The number of replicate runs required depends on the soil/substrate combination selected, as well as the intended use of the results.

6.2 Experimental design may range from a simple paired comparison with three replicate runs using three tiles to multiple comparisons extending over days of testing.

6.3 A complete cleaning evaluation will usually require analysis of an appropriate composite result, taking into account several different soil/substrate combinations, and possibly more than one set of test conditions, for example, use-dilution, water hardness, etc.

6.4 Appropriate controls should be considered when testing. For example, a test control could be a commercial liquid detergent for which the test lab has established some index of cleaning performance prior to the test at hand. Another control could be water without detergent.

6.5 Test conditions that should normally be reported in all tests include the following:

6.5.1 Conditions pertinent to scrubbing apparatus, for example, weights (if any), cycles per test, brushes, sponges, or other scrubbing substrate used (specify).

6.5.2 Water used for dilution, if any, including temperature and hardness.

6.5.3 Use-dilution of detergent with water.

7. Performance Evaluation

7.1 Cleaning performance is frequently taken as a linear function of reflectance using a reflectometer, color difference meter, or gloss meter (specify). Other methods such as visual rating may be useful, depending on the needs and capabilities of the lab. See the examples in the annexes.

8. Statistical Evaluation and Interpretation of Results

8.1 It is strongly recommended that appropriate statistical analysis of test results be conducted to establish confidence limits on test results and to establish a basis for comparison with subsequent or previous test results.

ANNEXES

(Mandatory Information)

A1. GENERAL

A1.1 The following procedures are included as an aid to the development of uniform methodology for lab cleaning tests. The methods described below have been found to work well in other laboratories. For inter-laboratory tests, exact test conditions, including preparation of soils and substrates, must be specified.

A2. GREASY SOIL/PAINTED MASONITE WALLBOARD TEST METHOD[2]

A2.1 *Summary of Test Method*—Latex painted masonite wallboard is soiled with a mixture of melted, oily soils containing a small amount of carbon black, and allowed to set overnight. The detergent is applied to a sponge that scrubs half the soiled substrate using a straight-line washability apparatus. The other half of the soiled substrate is scrubbed with a second detergent. Cleaning performance is taken as a linear function of reflectance value.

[2] Johnson, M. A., "A Greasy Soil Hard Surface Cleaning Test," *Journal Am. Oil Chem. Soc.*, Vol 61, 1984.

A2.2 *Apparatus:*

A2.2.1 *Reflectometer*[3], any photometer capable of accurately measuring changes to substrate reflectance. See Fig. A2.1.

A2.2.2 *Template*, see Fig. A2.1.

A2.2.3 *Straight-Line Washability Apparatus*[4].

A2.2.4 *Graduated Cylinder*, calibrated to deliver 100 mL, and

A2.2.5 *Graduated Volumetric Pipet*, 10 mL.

A2.3 *Materials and Manufacture:*

A2.3.1 *Masonite Wallboard Tiles*—⅛-in. thick, cut 4½ by 4½ in.

A2.3.2 *Latex Paint*[5]—non-yellowing flat white.

A2.3.3 *Vegetable Shortening*[6]—from local grocery store.

A2.3.4 *Lard*[7].

A2.3.5 *Partially Hydrogenated Soybean Oil*[8]—with polyglycerol esters of fatty acids added.

A2.3.6 *Carbon Black*[9].

A2.3.7 *Sponges*[10]—cellulose sponge cut to size, 1¾ by 3⅝ by 1½ in.

A2.3.8 *Tap Water*—80 ppm hardness, as $CaCO_3$.

A2.3.9 *Cheesecloth Wipes*[11], 18 by 36 in.

A2.3.10 *Large Binder Clip*[12], 1- in. capacity.

A2.4 *Procedure:*

A2.4.1 *Tile Preparation*—Double-coat masonite tiles with latex paint using a paint roller, and allow to set overnight. Cure tiles at 45°C for 24 h.

A2.4.2 *Soil Preparation*—Blend a melt of 33 g vegetable shortening, 33 g lard, and 33 g vegetable oil with 1 g carbon black on a steam bath. Prepare fresh soil each day.

A2.4.3 *Soil Application*—Fold the cheesecloth in half several times to end up with a 2½ by 2-in. piece. Put the binder

[3] Photovolt Model 670 with Search Unit 610Y and Green Tristimulus, or its equivalent, has been found suitable for this purpose. Available from Photovolt, Inc. NY, NY.

[4] BYK-Gardner Model AG-8100 available from BYK-Gardner USA, Silver Spring, MD, or the Gardco D-10 available from the Paul N. Gardner Co., Pompano Beach, FL, or equivalents, have been found suitable for this purpose.

[5] California Paints, or equivalent, have been found suitable for this purpose.

[6] Crisco, or equivalent, has been found suitable for this purpose (trademark of Proctor and Gamble, Cincinnati, OH).

[7] Armour lard, or equivalent, has been found suitable for this purpose (trade mark of Armour Co., Phoenix, AZ).

[8] Pathmark vegetable oil, or equivalent, has been found suitable for this purpose (trademark Supermarkets General, Woodbridge, NJ).

[9] Neo Spectra Mark II Powder, or equivalent, has been found suitable for this purpose (trademark of Cities Service Co., Tulsa, OK).

[10] Shop-Rite brand sponges, or equivalent, have been found suitable for this purpose (trademark of Wakefern Corp., Elizabeth, NJ).

[11] VWR catalog No. 21910-105, or equivalent, has been found suitable for this purpose. Available from VWR Scientific, Plainfield, NJ.

[12] ACCO brand, No. 72100, or equivalent, has been found suitable for this purpose.

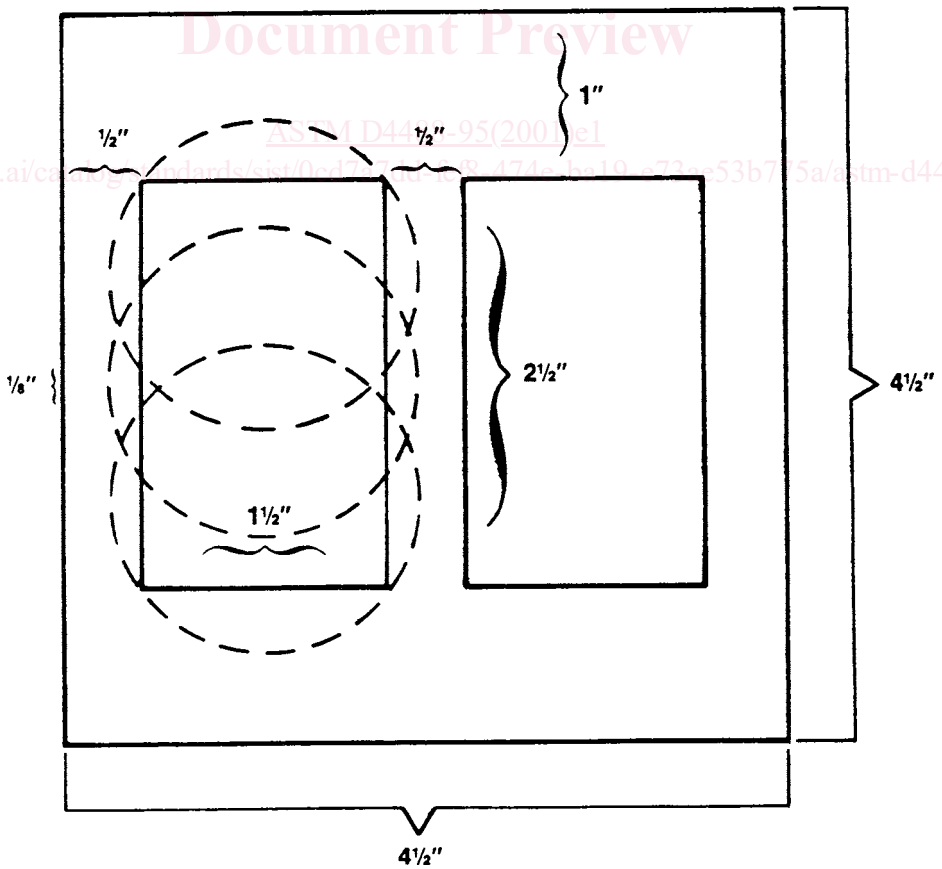

FIG. A2.1 Template for Use With Reflectometer

clip on the open 2½-in. long edge of the folded cheesecloth. Using the clip as a handle, soak the cheesecloth in the hot soil and apply the soil to the white-painted masonite wallboard tiles using six strokes. (see Fig. A2.2). The soil temperature should be maintained and the soil should be stirred throughout the application process. Allow the soiled substrate to dry overnight at room temperature.

A2.4.4 *Cleaner Preparation*—Prepare all cleaner dilutions volumetrically as necessary. Water is at an ambient temperature (20 to 30°C) and a specified hardness.

A2.4.5 *Cleaning Test*—Use a new (previously unused) sponge for each cleaning procedure. Weigh 15 g of cleaner solution onto a pre-wet sponge that has been thoroughly pressed by wringer to remove most of the water then placed in the straight-line washability apparatus without weights. Sponge and holder weigh about 350 g. Place sponge so that the manufactured edge, not a face or edge that has been cut, is the scrubbing surface. Place the tile in the apparatus so that scrubbing action is perpendicular to the direction of soiling (see Fig. A2.2). Set the test apparatus at the predetermined number of cycles established according to the procedure described in A2.4.6. Operate the wash apparatus over one of the soiled areas. Shift the scrubber table and repeat the washing test over the remaining soiled area with the second detergent and a new sponge.

A2.4.6 *Establishing a Standard Number of Cycles for Test Product Evaluation*—Place tiles in the washability apparatus with the line of soil on the tile running perpendicular to the cleaning direction of the scrubbing apparatus. Using extra tiles, run standard products to determine product performance profiles. It is suggested that the standard reference products remove approximately 75 % of the soil, in order to allow for maximum product differentiation. Identify the cycle number at which maximum differences in product performance are demonstrated. Run all test products with this predetermined standard number of cycles.

A2.4.7 *Reflectometer Measurements*—After zeroing the instrument, adjust reflectance to 100 on a standard white reflectance and color tile. For example, one that has worked well has the following values: 76.3 % y, 77.6 % x, and 76.6 % z. Place a template (Fig. A2.1) over a scrubbed board so that only the scrubbed area to be measured shows through the cut-out portions. Take three readings in each cut-out portion, moving from one end to the other. Estimate readings to the nearest tenth reflectance unit. Record and average these three readings.

A2.5 *Data Handling.*

A2.5.1 Record reflectance values (three per cleaned area) and established and compared mean values using appropriate statistical methods. Paired comparisons may use a simple T-test. Multiple comparisons require some multi-variate statistical analysis.

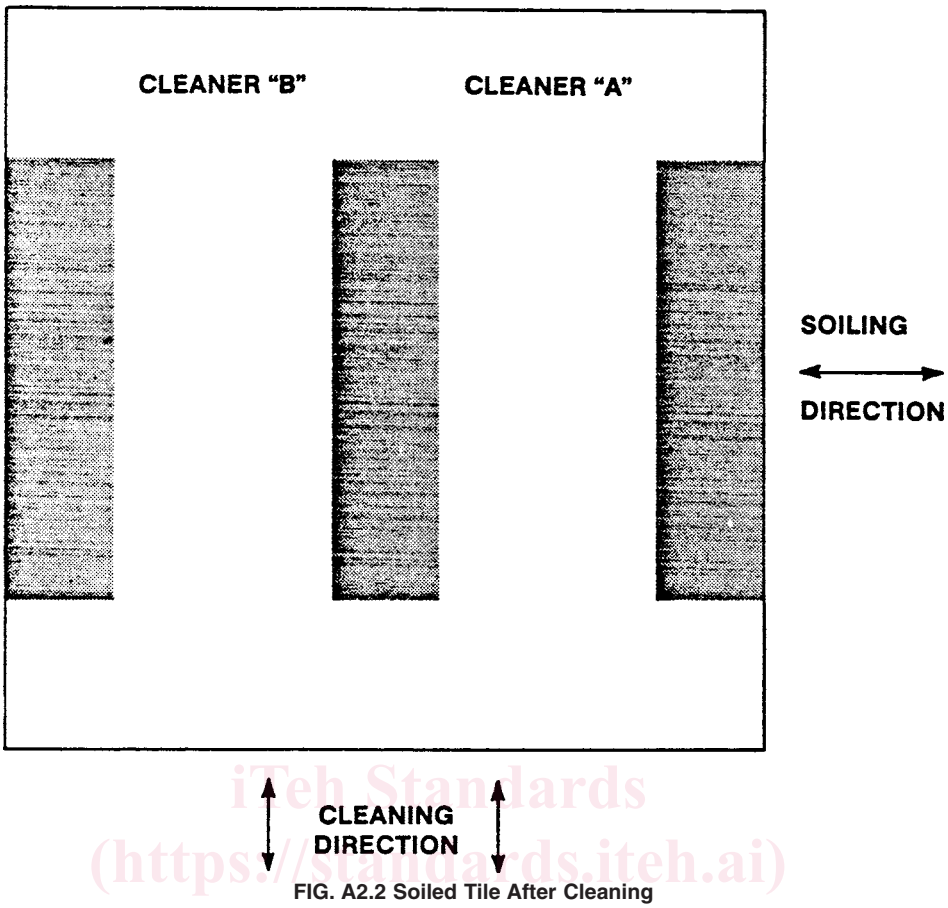

FIG. A2.2 Soiled Tile After Cleaning

A3. IRON OXIDE PIGMENT/LINOLEUM TEST METHOD[13]

A3.1 *Summary of Test Method*—Linoleum is soiled with an iron oxide pigment dispersed in an oil-solvent system. Soil is applied using a pastry brush or other applicator. A fine-celled sponge scrubs the soiled substrate, which is immersed in the detergent system being tested. Cleaning performance is evaluated by comparing reflectance measurements made on the clean, unsoiled test panel and on the soiled panel after scrubbing using a colorimeter[14]. Results are reported as percent soil removed.

A3.2 *Apparatus*:

A3.2.1 *Straight-Line Washability Apparatus*[4].

A3.2.2 *Test Sponge Holder*—Standard brush holder for the straight-line washability apparatus unit, ⅞-in. deep with one open face, nominally 1½ by 3½ in.

A3.2.3 *Test Sponge Mounting Block*—A ¾-in. thick piece of polymethyl methacrylate[15] cut to nominal 1½ by 3½ in. dimensions (block should fit loosely in sponge holder).

A3.2.4 *Metal Template*—A ¾- in. thick, 4 by 17¾-in. aluminum plate, with a center cut-out of 2 by 16 in., used to hold the substrate in place, provides a reservoir for test scrubbing solution, and functions as a guide for the sponge holder. It is designed to prevent splashout loss of solution during operation. See Fig. A3.1.

A3.2.5 *Rubber Template Insert*—A ⅛-in. thick, 4 by 17¾-in. rubber template insert, with a 3 by 6-in. cut-out to accommodate the test substrates. If the test substrate is less than ⅛-in. thick, a spacer should be used to bring the test substrate flush with the surface of the rubber insert. If the thickness of the test substrate is more than ⅛ in., a heavier gage rubber insert can be used.

A3.2.6 *"C" Clamps*—Four clamps large enough to hold the template to the scrubbing machine table.

A3.2.7 *Soil Applicator*—Pastry brush[16].

A3.2.8 *Reflectometer*[3]—Any photometer capable of accurately measuring changes in substrate reflectance.

A3.2.9 *Drying Oven*.

A3.3 *Materials:*

[13] "*A Hard Surface Cleaning Test Method for Artificial Soil Removal from Linoleum Surfaces*," Technical Bulletin SC: 135-81, Shell Chemical Co.

[14] Gardner LX-23 Tristimulus Colorimeter, or equivalent, has been found suitable for this purpose. Available from Pacific Scientific, Silver Springs, MD 20910.

[15] Lucite brand acrylic plastic, or equivalent, has been found suitable for this purpose (trademark of E. I. duPont de Nemours and Co. Inc., Wilmington, DE).

[16] EKCO No. 06640 CA, or its equivalent, has been found suitable for this purpose, (trademark of EKCO Housewares Co., Franklin Park, IL).

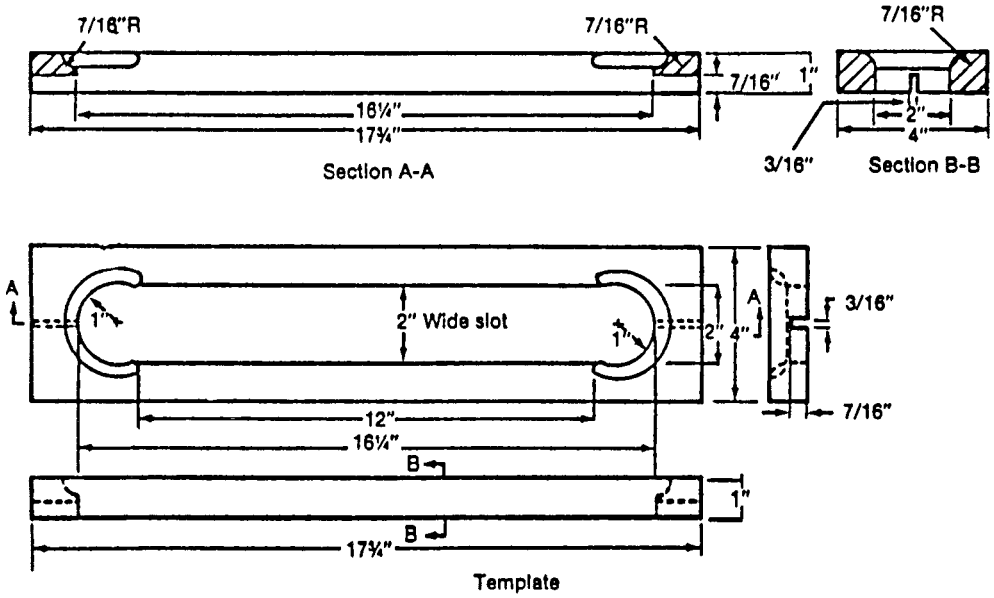

FIG. A3.1 Reservoir Template

A3.3.1 *Test Substrate*—Off-white drawing board desk pad[17], felt-back lineoleum (0.80 in.).

A3.3.2 *Test Sponge*—A1½ by 3½-in. section cut from a ½-in. thick sheet of foam[18] containing 60 to 80 pores per linear inch. This material is a fine-celled, reticulated, open-pore, chemically resistant, ester-type polyurethane foam.

NOTE A3.1—A uniform, fine-celled, cellulose sponge should be employed if a more chemically resistant sponge is required.

A3.3.3 *Test Sponge Mounting Adhesive*—The test sponge is attached to the mounting block, using rubber cement[19] by applying adhesive only around the perimeter of the sponge. (**Warning—**Complete attachment across the entire 1½ by 3½-in. face causes warping of the sponge.)

A3.3.4 *Pigment*—Metallic brown oxides[20].

A3.3.5 *Mineral Oil*[21]—Liquid petrolatum.

A3.3.6 *Turbine Base Oil*[22]—A50–50 blend of 100 HVI neutral and 250 HVI neutral oil stocks with an aromatic content approximately 40 millimoles per 100 g and a viscosity of about 30 centistrokes at 40°C, or equivalent.

A3.3.7 *Vegetable Oil*.

A3.3.8 *Jet Turbine Fuel*[23]—A kerosene-range turbine fuel. It contains, typically, 18 to 19 % aromatics and boils in the range of 310 to 572°F.

A3.3.9 *Naphthenic Hydrocarbon Solvent*[24], boiling in the 318 to 360°F range and containing, typically, 96 % paraffins, 2 % aromatics, and 2 % olefins.

A3.3.10 *Non-Ionic Surfactant*[25].

A3.3.11 *Anhydrous Tetrapotassium Pyrophosphate*.

A3.4 *Procedure:*

A3.4.1 Prepare soil by adding parts by weight of the following in the order listed: 1.0 of vegetable oil, 1.0 of mineral oil, 1.0 of base oil, 12.0 of jet turbine fuel, 20.0 of metallic brown oxides, and 12.0 of naphthenic hydrocarbon solvent[24].

A3.4.2 *Soil Blending*—Add vegetable oil, and jet turbine fuel to a high-shear blender, and then add pigment slowly with the mixer speed set to create a slight liquid vortex. Run the covered blender at high speed for 15 min after all pigment has been added. Cool the container (ice bath), and add napthenic hydrocarbon solvent and continue mixing only long enough to achieve homogeneity. Transfer the product to a wide-mouth bottle that can be sealed. At this point, the finished soil blend has a high viscosity due to entrained air that should be expelled before using. Accomplish this by stirring the mixture, using a magnetic stirrer, or by rolling the bottle of soil, perhaps as long as overnight.

A3.4.3 *Substrate Preparation*—Wash each 3 by 6-in. test coupon using a commercial hand dishwashing liquid diluted 1:125 (1 oz/gal) with warm water. Utilizing a large cellulose sponge, scrub each panel 25 strokes with pressure applied to the sponge, and then rinse well with warm water, front and back. Hang the washed panels to dry at room temperature for about 16 to 18 h (overnight) in such a way that air passes freely

[17] A desk pad found suitable for this purpose is available from Kieffer International Products, Inc., Grand Rapids, MI. An equivalent may be used.

[18] Scott Industrial Foam, or equivalent, has been found suitable for this purpose. Available from Scott Paper Co., Foam Division, Chester, PA.

[19] Duco Cement, or equivalent, has been found suitable for this purpose (trademark of E. I. duPont de Nemours and Co. Inc., Wilmington, DE).

[20] Code B-01085, or equivalent, has been found suitable for this purpose. Available from Pfizer Minerals, Pigments and Metals Div., New York, NY.

[21] Nujol, or equivalent, has been found suitable for this purpose (trademark of Plough Inc., Memphis, TN).

[22] Tellus, or equivalent, has been found suitable for this purpose (trademark of Shell Chemical Co., Houston, TX).

[23] ASTF-640, or equivalent, has been found suitable for this purpose. Available from Shell Chemical Co., Houston TX.

[24] Shell Sol 340, or equivalent, has been found suitable for this purpose. Available from Shell Chemical Co., Houston, TX.

[25] Neodol 23.6.5, or equivalent, has been found suitable for this purpose. Available from Shell Chemical Co., Houston, TX.