Electrostatic Clinging of Fabrics: Fabric-to-Metal Test

Developed in 1965 by AATCC Committee RA32; revised 1969, 1973, 2000; editorially revised 1974, 1976, 1977, 1978, 1991, 1999; reaffirmed 1977, 1980, 1989, 2005; editorially revised and reaffirmed 1986, 1995.

1. Purpose and Scope

1.1 This test method evaluates the relative clinging tendency of certain fabrics due to electrostatic charge generation. The test integrates the effect of fabric weight, stiffness, construction, surface character, finish application and other fabric parameters which affect the tendency of fabrics to cling.

2. Principle

2.1 Clinging of positively or negatively charged fabrics to the human body occurs due to instantaneous induction of an equal and opposite charge on the surface of the body when the charged fabric is brought close to it. A basic law of physics states that oppositely charged materials attract each other. A metal plate exhibits a similar phenomenon of instantaneous charge induction as would the human body when placed in the field of a charged material. Therefore, a metal plate can be used to simulate the problems of clinging observed between charged garments and the human body. Some individuals are more prone to electrostatic clinging than others, and a given individual may be more prone at one time than at another time. Therefore, fabric-to-metal cling times cannot be related directly to fabric-to-body clinging for different individuals.

2.2 In this test method, the time (t_d) is measured for the charge on a fabric specimen to decay to a level where the electrical attractive forces between the specimen and the metal plate are overbalanced by the gravitational forces of the specimen acting to pull the specimen away from the plate (see 12.6).

3. Terminology

3.1 **electrostatic clinging,** n.—adherence of one substance to another caused by an electrical charge on one or both surfaces.

4. Safety Precautions

NOTE: These safety precautions are for information purposes only. The precautions are ancillary to the testing procedures and are not intended to be all inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this test method. Manufacturers MUST be consulted for specific details such as material safety data sheets and other manufacturer's recommendations. All OSHA standards and rules must also be consulted and followed.

4.1 Good laboratory practices should be followed. Wear safety glasses in all laboratory areas.

4.2 The radioactive bar emits alpha radiation which is externally harmless to the human body. The radioactive isotope polonium 210 is toxic and precaution should be exercised to prevent ingestion or inhalation of the solid material. Do not take the radioactive bar apart or touch the radioactive strip under the grid. If the strip is touched or handled, wash hands thoroughly at once. Return the device to the manufacturer when it loses its effectiveness as a static eliminator for reactivation when tested in accordance with 12.3.1 or for disposal if use is to be discontinued. ***Do not discard as scrap.***

5. Uses and Limitations

5.1 This test method is not intended for use in determining the suitability of fabric for use in hazardous areas where the electrostatic generation of sparks might result in fires or explosions.

5.1.1 Certain fabrics, particularly those of heavy construction, which do not exhibit a clinging propensity by this method might cling under some conditions of use.

5.1.2 This test method is primarily useful for determining clinging properties of lightweight apparel fabrics, such as those intended for use in lingerie.

6. Apparatus and Materials

6.1 Test plates.

6.1.1 Standard Test Plate—A test plate (see 12.2) is made by bending 100 × 450 mm strips of 18 gauge Type 304 stainless steel across the width 150 mm from one end so that an included angle of 1.22 ± 0.04 RAD is formed between the 100 × 150 mm base and the 100 × 300 upright plate. The grain of the finish should be such that the 450 direction of the test plate corresponds to the length or grain direction of the stainless steel sheets from which they are made. The face of the 100 × 300 plate must have a No. 4 finish (see 12.2.1) on the included angle side, and should be kept clean and smooth at all times. A fine line is indented across the test plate surface 230 mm from the top of the plate and this is used to position the lower edge of the specimen (see 12.2).

6.1.2 Variable Angle Experimental Test Plate—The sensitivity of this test depends on the included angle of the metal plate and can be diminished by decreasing the included angle or vice versa. A more versatile version of the test plate, suitable for research work, which allows facile change of the sensitivity, uses a 25 × 100 × 100 mm aluminum base with several slots machined into the base at different angles (e.g., 0.017, 0.087, 0.175, 0.35, 0.52, 0.70, 0.87, 1.05 RAD) from the vertical axis into which a 100 × 360 mm stainless steel plate fits (see 12.4).

6.2 Grounding Plate—This is a 200 × 360 mm, flat, 18 gauge Type 304 stainless steel plate, attached to a ground, such as a water pipe, with wire (e.g., No. 18 stranded, plastic-covered electronic wire). One such grounding plate is required for each test plate.

6.3 Radioactive bar (see 12.3).

6.4 Rubbing blocks, white pine, approx. 20 × 50 × 150 mm adjusted to weigh 65 g and with strips of 20 mm wide, double-faced tape on the ends of each block to attach ends of the rubbing fabric.

6.5 Polyurethane foam, 25 × 100 × 300 mm non-rigid, having a density of 21 kg/m^3 and an ILD (Identification Load Deflection) firmness of 6.8 kg when tested (see 12.2 and 12.10) as directed in ASTM Method D 3574.

6.6 Clamps, metal (e.g., No. 3 Bulldog Clamp or Di-acro Toggle Clamp, see 12.4), with 70 mm edges covered with 20 mm electrical tape to prevent scratching of the surface of the test plates.

6.7 Stopwatch, with 0.01 min or one of equivalent precision marked in other units.

6.8 Forceps or tweezers, non-conducting, ivory-tipped, forceps used with analytical balances.

6.9 Oven, forced-draft type, capable of maintaining a temperature of 105 ± 2°C.

6.10 Conditioning chamber, capable of providing relative humidity control of 40 ± 2% and temperature at 24 ± 1°C with circulating air.

6.10.1 If tests are to be conducted at relative humidities or temperatures other than 40 ± 2% RH and 24 ± 1°C, the conditioning test chamber should be capable of providing the necessary range of test

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conditions (such as 20-65 ± 2% RH and from 10-30 ± 1°C).

6.11 Rubbing fabrics.

6.11.1 Nylon rubbing fabric—100% spun nylon 6,6 (Style No. 361) (see 12.5).

6.11.2 Polyester rubbing fabric—100% spun polyester (Style No. 777) (see 12.5).

6.12 Fabric iron, domestic hand type, with appropriate settings (see Table I).

6.13 Cleaning solvent: halogenated hydrocarbon metal-cleaning solvent, such as DuPont's Vertrel MCA or Vertrel X-P10, hereinafter called HH Solvent (see 12.1).

Table I—Safe Ironing Temperature Guide

Class 0 Below 121° C	Class I 121-135° C	Class II 149-163° C	Class III 177-191° C	Class IV 204° C and Above
Modacrylic 93-121°C	Acetate		Nylon 6,6	Cotton
Olefin (Polyethylene) 79-121°C	Olefin (Polypropylene)	Acrylic	Polyester	Fluorocarbon
		Azlon		
		Nylon 6		Glass
				Hemp, Jute, Ramie
Rubber 82-93°C	Silk	Spandex		Linen
		Wool		Rayon, Viscose
Saran 66-93°C				Triacetate (heatset)
Vinyon 54°C				

7. Test and Rubbing Specimens

7.1 Test fabrics—Twelve 75 × 230 mm test specimens are required. Using die or scissors, cut six specimens with the longer dimension parallel to the warp, or wale, direction and six with the longer dimension parallel to the fill, or course, direction. (Do not cut fabric specimens with a hot soldering iron or heated wire since the edges can cause localized static problems due to heat degradation of the fibers and antistatic agents.)

7.2 Rubbing fabrics—Both nylon and polyester rubbing fabrics are required. Using die or scissors, cut six nylon and six polyester rubbing fabrics, each 75 × 230 mm, with the longer dimension parallel to the warp, or wale, direction of the fabric.

7.3 Do not contaminate the test specimens or the rubbing fabric by unnecessary handling or by allowing them to come in contact with transferable materials.

7.4 If either the test or rubbing fabric specimens do not lay completely flat, press them free of creases or wrinkles with a dry, clean iron at the appropriate setting as directed in Table I. Do not use test specimens with curled edges.

8. Conditioning

8.1 Since equilibration of a test specimen from the dry versus the wet condition relative to the humidity of the test chamber may show hysteresis, precondition the specimens from the dry side relative to the humidity in the test chamber. To accomplish this, place the test and rubbing specimens in the forced-draft oven at 105 ± 2°C for 30 min. Transfer them immediately to the controlled humidity chamber allowing no more than 15 s for the transfer.

8.2 Condition and test the test and rubbing specimens at 40 ± 2% RH and 24 ± 1°C in the controlled humidity chamber for at least 16 h. If the test is conducted at lower humidities (such as 30 ± 2% or at 20 ± 2%), or at higher humidities (such as 65 ± 2%), keep the temperature at 24 ± 1°C for standard testing. If other temperature conditions are used for nonstandard testing, state the temperatures used in the report. For any humidity or temperature test conditions that are to be used, the test and rubbing specimens should be conditioned for at least 16 h (see 12.11).

9. Procedure

9.1 Clean the metal test plate before testing every different lot of fabric. To clean, swab with a facial tissue saturated with HH Solvent (wear protective gloves). Allow the plate to dry at least 5 min in the conditioning test chamber before using. Make sure that HH Solvent does not accumulate in the conditioning test chamber as a result of cleaning the metal test plate. If the No. 4 finish on the surface of the test plate is changed noticeably due to use, replace the test plate with a new one.

9.2 Handle the fabric test specimens and rubbing fabrics at only one marked corner to minimize transfer of impurities to the remainder of the fabric.

9.3 Adhere double-faced adhesive tape around all four 20 mm thick sides of the rubbing block. Completely discharge the rubbing fabric on both sides with the radioactive bar (*Caution*, see 4.2). Place a 50 × 150 mm side of wood block on the rubbing fabric in such a way that the 150 mm dimension of the block parallels the 230 mm dimension of the rubbing fabric and the block is centered on the fabric. Bring up the protruding edges of the fabric so that they adhere tightly to the double-faced tape on all four sides of the rubbing block. Take care that the double-faced tape does not extend to the area between the rubbing surface of fabric and the block.

9.4 Grasp a test specimen at one corner and allow it to hang free. Discharge both sides of the test specimen using the radioactive bar, holding the bar not over 25 mm away from the fabric as it moves up or down (*Caution*, see Section 4 and Fig. 1, Step A). Fasten the test specimen at the top of the long arm of the metal plate on the 1.22 RAD included angle side with a metal bulldog or toggle clamp with the face of the test specimen out. Position the lower edge of the test specimen even with the indented line on the metal plate.

9.5 Attach the metal grounding plate with the wire to a suitable ground and place it horizontally in the controlled humidity chamber and lay the polyurethane foam on top.

9.6 Place the metal test plate with attached test specimen in a horizontal position on the polyurethane foam in such a way that the long arm of the plate completely rests on the polyurethane foam with the short arm of the test plate closest to the operator and pointing upward. The clamp should extend over the edge of the supporting foam so that the back of the plate is completely supported.

9.7 Place the rubbing block with attached rubbing fabric at the top of the plate so that the long axis of the rubbing fabric and the long axis of the test specimen are at right angles (see Fig. 1, Step B). The side of the rubbing block that does not expose the cut edge of the rubbing fabric should be down. Keep the test plate and rubbing block perfectly flat on their facing surfaces to ensure complete contact between test and rubbing fabrics during charge generation.

9.8 Place the middle fingers on the back edge of the rubbing block and pull the rubbing assembly the full length of the test specimen (see Fig. 1, Step C). Grasp the lock between the thumbs and middle fingers at the ends of the block, lift the assembly from the test specimen and return the rubbing assembly to its original position at the top of the test specimen. Repeat this rubbing sequence 12 times at a cycle of approx. 1 rubbing cycle per second. The total 12 rubbing cycles should be completed in no more than 15 s. For constant rubbing pressure, take care that the only downward pressure on the test specimen comes from the weight of the rubbing block and fabric.

9.9 Quickly place the assembly in an upright position on a grounded plate.

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