# Electrostatic Propensity of Carpets

**Developed in 1969 by AATCC Committee RA32; jurisdiction transferred in 2007 to AATCC Committee RA57; revised 1975, 1979, 1991, 2001, 2011; reaffirmed 1986, 1996, reaffirmed and editorially revised 2006; editorially revised 2007, 2008. Related to ISO 6356.**

## 1. Purpose and Scope

1.1 This test method assesses the static-generating propensity of carpets developed when a person walks across them. This method uses controlled laboratory simulation of the conditions, that may be encountered in use. The simulation is focused on the use of those conditions, which are known from experience to be strong contributors to excessive accumulation of static charges.

1.2 This test method does not include standards of performance. The specification requirements pertinent to any given application can vary considerably, depending on the specific demands of the application. Specifiers should give attention to the variability of the method as described below in Section 11.

## 2. Principle

2.1 Build-up of a static charge on a person walking across a carpet under conditions of low atmospheric humidity has been recognized as a classic example of the triboelectric effect, whereby a separation of electrical charges is produced when two dissimilar surfaces in contact are separated. The magnitude of the charge separation and the resultant voltage on the person vary under the influence of many factors. The most important factors for the purpose of this test are:

(a) the chemical and physical characteristics of the two materials brought into contact, rubbed and separated; i.e., the shoe soles and carpet;

(b) the surface contamination on one or both;

(c) the nature of the rubbing and/or separation, i.e., the method of walk, including the height of the shoe above the carpet; and

(d) the ambient conditions (especially the relative humidity).

2.2 A carpet brought to moisture equilibrium at controlled atmospheric conditions is walked on by a test operator in a specified manner with specified shoe soles and heels. The static charge, which builds up on the operator, is monitored continuously by a voltage indicator with a recorder.

2.3 The maximum voltage, generated on the person by the accumulated charge, measured during the test period is *defined* as the static-generating propensity of the carpet under the conditions of the test.

## 3. Terminology

3.1 **electrostatic propensity,** n.—the ability to produce and accumulate an electrostatic charge.

NOTE: For the purposes of this test, it is the *resultant voltage* on a person walking across the surface of a textile floor covering under specified conditions, which has been caused by the accumulation of an electrostatic charge on the body.

## 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 All chemicals should be handled with care.

4.3 Isopropyl alcohol is a flammable liquid and should be stored in the laboratory only in small containers away from heat, open flames and sparks.

4.4 Manufacturer's safety recommendations should be followed when operating laboratory testing equipment.

4.5 Ground all electrical equipment.

4.6 High-voltage sources should have an internal impedance of not less than $1 \times 10^8$ ohm (or the maximum output current limited to 1 milliampere) to avoid shock hazard in calibration of the detection system.

## 5. Apparatus and Materials

5.1 A room that can be maintained at a temperature of 21 ± 1°C and at 20 ± 2% RH, and suitable means for monitoring these conditions. Special requirements of end-use may dictate the use of other testing conditions (e.g., for aircraft or for controlled-humidity environments) and the test facility should be capable of achieving and maintaining those conditions.

5.1.1 The room should be of such dimensions and so arranged that the test operator comes no closer than approximately 600 mm to extraneous grounded or charged surfaces (such as walls or workbenches) during testing and should be equipped with open-wire shelves, racks or horizontal rods suitable for hanging carpet samples for conditioning. Air must pass freely around all surfaces of the samples to facilitate moisture equilibration.

5.2 Test sandals should be used only for testing carpet. New test sandals should be cleaned before use as prescribed in 8.7.1. Soles must be attached to the sandals by gluing and/or stitching. Tacks or rivets must not be used.

5.2.1 One pair of AATCC TM 134 sandals (see 12.1) manufactured with XS 664 P-HK Neolite soles. A second pair of Neolite test shoes or sandals with optional self-adhesive (i.e., replaceable) suede leather attached to the shoe sole. The second pair of Neolite shoes or sandals must be dedicated to this use only.

5.2.2 Reagent grade isopropyl alcohol and cheesecloth.

5.3 Electrostatic detection and recording means for voltages up to at least 20 kV (see 12.2 and 12.3).

5.3.1 The system should have a high input impedance and be suitably damped such that a steady recorder or meter indication of 3000 V will, when the input is grounded, decay to 1500 V in not less than 1 s or more than 3 s (this corresponds to a time constant of 1.4-4.3 s). To achieve reasonable accuracy in use, the input capacitance, including lead-in wire, should not exceed 30 pF. (See Appendix A for additional information on measurement of damping and Appendix B for information on damping techniques.)

5.4 A grounded metal plate approximately 1200 × 1200 mm.

5.5 A standard 1350 g/m$^2$ rubberized jute/hair cushion underlay (see 12.1) at least 1200 × 1200 mm. The vertical resistance through the cushion shall not be less than $10^{12}$ ohms (see 12.6).

5.6 A set of AATCC TM 134 AATCC Static Control Carpets (see 12.1) consisting of static unprotected and static protected versions.

5.7 An optional metronome.

5.8 An optional handheld blowing-fan balanced ionizer (see 12.4).

## 6. Specimens

6.1 Cut each carpet test specimen to a size of approximately 900 × 900 mm or 1000 × 1000 mm. If test specimens are less than this size, multiple specimens may be pieced together to reach the required test size.

## 7. Conditioning

7.1 Condition specimens under the required test conditions, 21 ± 1°C and 20 ± 2% RH, for a minimum of 48 h prior to testing. This will equilibrate the moisture content of the specimens to the test conditions. The temperature and relative humidity should be automatically recorded during the conditioning period with a chart recorder or other electronic recording device.

7.1.1 Hang or lay specimens in such manner that free circulation of air over both surfaces is possible.

## 8. Procedure

8.1 Test AATCC TM 134 Static Unprotected Control Carpet *without* an underlay (to avoid charging the underlay) and the Static Protected Control Carpet *with* an underlay at the beginning of each testing session. If the results are outside of the test laboratory's Control Chart Control Limits, then seek the cause of the deviation and correct the problem. Check relative humidity and temperature (current values and recorded values during the specimen conditioning period) (see 5.1). Test backup Control Carpets if available (see 5.6), reclean soles (see 8.7) and check instrument calibration. Use a blowing-fan, handheld, balanced high-voltage ionizer to neutralize any charge on the underlay pad between tests and prior to testing any specimen, moving it slowly over the entire surface at a height of about 100-200 mm above it for at least 1 min.

8.2 Test the specimen once a day until two reproducible voltages are obtained. Voltages are considered reproducible when consecutive tests agree within 10% or 0.5 kV, whichever is greater. Leaving the specimen in the test chamber overnight should allow any static charges to be dissipated. This process may be accelerated by using a blowing-fan, balanced high-voltage ionizer to neutralize any charges. If an ionizer is used to thoroughly neutralize the specimen (held about 100-200 mm above the specimen and moved slowly over its entire surface, requiring approximately 1-2 min), the same specimen may be retested the same day.

8.3 Test the specimen over the standard underlay (see 5.5), which is placed on the grounded metal plate.

8.3.1 Residual static charges on the specimen and underlay have been found to be a major source of error. Residual charges should decay naturally over a period of several hours. Specimens should be hung undisturbed for a minimum of 4 h, or thoroughly neutralized with a blowing-fan, balanced high-voltage ionizer, prior to each testing, as above.

8.3.2 Lay the underlay on the grounded metal plate, rubberized side up. Avoid dragging the underlay across the surface or rubbing different parts of it together.

8.3.3 If a blowing-fan, balanced high-voltage ionizer is available, thoroughly and slowly cover the entire surface of the underlay with the ionizer output, holding the ionizer about 100-200 mm above the underlay. This will neutralize any residual charges from handling.

8.3.4 Lay the specimen on the underlay carefully to avoid excessive friction against the mat or rubbing different parts of it together.

8.3.5 If a blowing-fan, balanced high-voltage ionizer is available, thoroughly and slowly cover the entire surface of the sample with the ionizer output, holding the ionizer about 100-200 mm above the sample. This will neutralize any residual charges from handling.

8.3.6 Zero the test apparatus. Place clean test sandals (see 8.7) on the specimen, grasp the test probe and ground the test operator while standing off the specimen in stocking feet. Ensure that the recorder reads "0." Step into the clean test sandals specified for the test while standing on the specimen and holding the test probe, being careful not to move the sandals around on the specimen.

8.4 After following the procedure in 8.3, there should be very little voltage indication. Presence of significant voltage (more than 200 V) indicates excessive initial charge somewhere in the system and the procedures in 8.2 and 8.3 must be repeated to avoid possible significant errors. Since the location of the spurious charge is important in affecting the final test results, it is not sufficient to simply reground the test subject, although this will obviously create a new zero value.

8.5 If the carpet is not intended for installation over an underlay, then the specimen shall be tested without an underlay. In such cases, test the specimen on the grounded metal plate and record the fact that the test was performed on the specimen mounted directly on a grounded surface. Otherwise, follow the procedure outlined in 8.3.

8.6 Proceed with the tests described below in 8.6.1 with the neolite soles, and if required, the suede leather soles. NOTE: Be sure to keep SEPARATE shoes or sandals for the Neolite and suede leather tests; do not remove the leather and test with the underlying Neolite, since it will be contaminated by the adhesive. Note that the samples and underlay must be discharged between repeat tests or between types of tests or between tests with different soles, in order to avoid errors. Discharge may be achieved by allowing natural discharge over 4 h or overnight, or neutralization with a blowing-fan, handheld balanced high-voltage ionizer, as above.

8.6.1 Tests.

Test I—Step Test/Neolite Soles

Test II—Scuff Test/Neolite Soles (Optional)

Test III—Step Test/Self-adhesive suede leather soles (Optional)

Test IV—Scuff Test/Self-adhesive suede leather soles (Optional)

8.6.2 **Step Test Procedure.** While holding the hand probe, walk on the specimen using a simple box step, lifting the sandals as close as possible to 80 mm above the specimen at the rate of 120 ± 10 steps per min (a metronome can be used). Always keep the plane of the sandal soles parallel to the plane of the specimen. Do not scuff or rub the sandals over the specimen. Cover the entire surface of the specimen during stepping, for a total test time of 1 min or until a consistent peak voltage is observed for each step. Touch the ground with the hand probe to bring the body voltage to "0." Neutralize the carpet and underlay prior to any further testing.

8.6.3 **Scuff Test Procedure.** While holding the probe, scuff (or wipe) as though wiping chewing gum from the bottom of both sandals. The wiping action is always in a backward motion. As above, the bottom of the sandal should reach a height of as close as possible to 80 mm above the specimen, parallel to the sample. Repeat scuffing at a rate of 60 ± 5 steps per min and continue the motion for about 1 min while covering the entire specimen. Touch the ground with the hand probe to bring the body voltage to "0." Neutralize the carpet and underlay prior to any further testing.

8.7 Remove and clean the sandal. Hang or lay the specimen on the conditioning rack. The procedures in 8.7.1 and 8.7.2 will usually suffice to clean the sandals. Sandals must be cleaned with extreme care after testing specimens, which have had surface-type (spray-on, topical) antistatic treatments (see 12.7). Failure to do so may transfer material from one specimen to another.

8.7.1 Clean Neolite sandal soles by swabbing with cheesecloth or paper towel moistened with isopropyl alcohol, using a fresh cheesecloth or paper towel. In case of extensive contamination, repeat this procedure, sand the sole with fine sandpaper to expose fresh material and clean again.

8.7.2 The suede leather soles are difficult to clean, once contaminated. Sanding the sole may remove the contamination. Other cleaning methods may contaminate the leather or change its electrical properties (such as water absorption from isopropanol/water cleaning solution). Replace these soles if sanding does not readily remove the contamination.

8.7.3 Store the test sandals in the controlled relative humidity of the test area.

8.8 Record the test parameters, including specimen identification, specimen tested "as received" or "cleaned," date, temperature, relative humidity, sandal sole and walking procedures (Step or Scuff).

8.9 In case of any uncertainty about the consistency of the test conditions, retest the AATCC Static Control Carpets at the end of and throughout the testing session to assure that testing conditions have not changed. If the Control Carpet measurements are significantly different (outside of the test laboratory's established Control Limits for the control specimens), then the specimen test results are unreliable.

## 9. Analysis of Results

9.1 The chart trace serves as a permanent record of the test and characterizes the carpet for electrostatic propensity. The maximum voltage (at the highest point of each step), the sign of the voltage and the rate-of-rise of voltage are characteristics available from the chart trace and have been found to be relevant to the performance of a carpet under use conditions similar to those of the test.

9.2 Maximum voltage, Step and Scuff. The maximum voltage is defined as the maximum achieved for several successive steps. An example is given in Fig. 1.

9.2.1 Rate of rise of voltage may be reported, Step and Scuff. The average rate of increase of voltage (in kV/s) is taken as the reported maximum voltage divided by the time required to reach that voltage from the start of the test walk.

9.3 Effect of contaminants. Carpets that have been contaminated by spills, soiling, contact with other carpets or materials that have removable chemical components, etc., will yield results that are different from clean carpets. Since the triboelectric effect depends upon the difference between the flooring and the shoes, these contaminants may increase or decrease the measured electrostatic propensity. Similarly, non-permanent topical treatments will affect the results; the variation of such treatments over time and after cleaning should be considered by the test requester. To remove contaminants, a hot-water extraction procedure is recommended, such as AATCC Method 171, Carpets: Cleaning of; Hot Water Extraction Method.

9.4 Effect of sole materials. Very large differences in laboratory and field results will often occur as a result of use of different shoe sole materials. The triboelectric, surface roughness and conductivity characteristics of the materials are important. Higher conductivity soles will tend to suppress the accumulation of charge on a person particularly when carpets having static-control filaments are tested.

9.4.1 Neolite XS 664 P-HK has been chosen as the primary reference material because its static performance is much like that of many common shoe soles; it is easy to keep clean and its chemical and physical properties are believed to be quite uniform. Its triboelectric properties are distinct from those of nylon, the dominant carpet fiber polymer. Other types of carpet should also be tested with the secondary reference material for a more complete characterization of the static propensity of the carpet.

9.4.2 Suede leather has been chosen as the secondary reference material because typically it is representative of a certain class of leathers whose triboelectric performance differs significantly from that of Neolite soles, in that they tend to give high values on acrylic, polyester and polypropylene carpets.

9.4.3 For some purposes it may be desirable or necessary to characterize carpet performance with special shoes, such as ESD (electrostatic discharge) control footwear. Equivalent test procedures can be conducted with any relevant sole materials or shoes, but such tests should be considered supplementary information only.

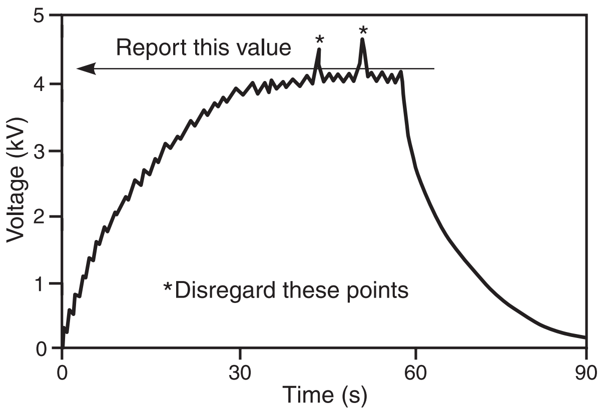


**Fig. 1—Typical chart trace indicating maximum voltage.**

## 10. Report

10.1 Two reproducible voltages and their average should be reported (see 8.2) for the Step test method with neolite soles with the highest voltage or for each optional test method as requested, with the polarity indicated as positive or negative. (The polarity does not affect the impact of static buildup on people or equipment, but does serve a diagnostic purpose. Only the magnitude of the results should be considered when comparing the test results with floorcovering static-control specifications.) Optional scuff test measurements should also be reported, if required, for comparison; Scuff test measurements are more variable *within-lab* and *between-lab* than step test results. If Scuff test measurements differ from Step test results by more than 2.5 kV, the report should explain that this may be an indication that a topical treatment or contaminant may be present on the specimen. When a carpet is evaluated for the full triboelectric effect the step and scuff methods should be performed with neolite and suede leather soles.

10.2 Report the AATCC Static Control Carpet test results for the same day(s) as the specimen test(s), the laboratory's Upper Control Limit and Lower Control Limit, and the laboratory's established measurement standard deviation for each control, for each type of test (see 12.5).

10.3 The test report should include the testing conditions (relative humidity and temperature), test method and version, and any observations or apparent anomalies.

10.4 The report should state whether an ionizer was used to neutralize charges on the samples prior to each test. If specimens were tested without an underlay, the presence or absence of the underlay should be noted.

10.5 The report should state whether the carpet was tested "as received" or what preparation technique (e.g., "cleaned using AATCC Method 171") was used. A caveat on the use of AATCC Method 134 should be included which states, "The results of this test relate to the sample of carpet tested. Its static performance may be altered in service as a result of wear, soiling, cleaning, temperature, relative humidity, etc."

## 11. Precision and Bias

11.1 Users of data from AATCC Method 134 should be aware that large variations in results have been noted during interlab and intralab testing. Preliminary evaluation of the round robin test results, in the range of 0-6 kV, shows that differences of less than approximately 0.5 kV are not significant, and this must be considered when comparing test results to specification requirements. An initial study on AATCC TM 134 Static Protected Control Carpet with shoes fitted with XS 664 P-HK Neolite soles (not AATCC TM 134 sandals) produced a Step procedure average voltage of 2.7 kV with a standard deviation of 0.3 kV, based on data from seven test sites.

## 12. Notes

12.1 AATCC TM 134 sandals, both large and small sizes, suede leather, rubberized jute/hair cushion carpet underlay and AATCC TM 134 Static Control Carpets (Protected and Unprotected) are available from AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: 919/549-8141; fax: 919/549-8933; e-mail: orders@aatcc.org; web site: www.aatcc.org.

12.2 A suitable electrometer, (digital) or (analog), a 1000:1 voltage divider probe. This apparatus may require slight modification to conform to requirements in 5.3.1.

12.3 Two methods for system damping testing are outlined in Appendix A.

12.4 Handheld blowing-fan, balanced high-voltage ionizers are available from a number of distributors under various names including ionized-air blowers. These are typically 4" fans with integral electronics and high-voltage ion-emission points.

12.5 The test laboratory must maintain a record of AATCC Static Control Carpet results, and generate suitable Control Charts. The Upper Control Limit and Lower Control Limit Values established through this analysis are to be used to define when all of the experimental conditions and equipment parameters are operating within the expected range. Nonrandom long-term drift in control carpet readings should be investigated to determine the nature of the changes that have taken place and corrective action taken.

12.6 If required, use National Fire Protection Association Test Method 99 or ESD/EOS STM 7.1 to measure resistance. For products intended to be installed in electrostatic-discharge-sensitive areas (i.e., electronics component manufacturing or assembly areas), several test methods developed by the Electrostatic Discharge Association (ESD Association) may be appropriate (ESD/EOS Standard Test Methods).

12.7 If the shoe soles or heels become permanently contaminated by testing carpets with topical antistats or yarn overfinishes, they should then be resoled or discarded immediately. The standard reference carpets recommended in the method can be very helpful in determining when soles or heels are contaminated, but these are also subject to contamination by contaminated shoes. Spare reference carpets should be stocked in case of contamination carry-over when testing the shoe condition.

## Appendix A
## Damping Testing

A.1 Two methods to test the damping are as follows:

A.1.1 With a high-voltage power supply capable of producing at least 3000 volts:

(a) Set up the electrometer (and recorder, if available) for at least 3 kV maximum range (10 kV preferred).

(b) Connect the power supply high-voltage output to the electrometer input to the divider probe.

(c) Check the power line grounds, and if in doubt, run a line from both the electrometer and power supply ground terminals to a common ground.

(d) After allowing the electrometer and power supply to warm up per the manufacturer's specifications, adjust the power supply output for a steady 3 kV reading on the electrometer.

(e) Switch the power supply off for a moment and observe the electrometer response. Most commercial high-voltage units have a built-in grounding of the output when turned off for safety reasons. If the unit in use does not show grounding when switched off, a properly shielded single pole, double throw switch must be connected to the electrometer input so it can be quickly switched from high-voltage to ground.

(f) With a steady 3 kV reading on the electrometer (and recorder), switch the electrometer input to ground (see Section 5) and measure the time it takes the voltage reading to drop to 1.5 kV. This should be between 1-3 s.

A.1.2 Electrometer without a high-voltage power supply:

(a) Set up as for a standard carpet test using a sample known to generate reading of 5 kV or over (AATCC TM 134 Static Unprotected Control Carpet).

(b) Have the operator proceed to walk (or scuff) test normally and observe the electrometer reading.

(c) When the reading reaches 5 kV or more, the operator should stop moving and watch the reading without touching anything.

(d) When the voltage has leaked off enough to drop the reading to 3 kV, the operator will ground the electrometer input (touch probe tip to ground, use a jumper wire, or a wire and switch combination). Record the time it takes the reading to drop to 1.5 kV.

(e) This procedure should be repeated five times or more, and the tests averaged to smooth out reading inaccuracies.

A.1.3 The decay to 50% of the original signal has been selected as a convenience to simplify the readout of the electrometer and recorder. The 1-3 s delay corresponds to a time constant ($t$ = 1/e) 1.4-4.3 s.

## Appendix B
## Damping Techniques

B.1 For electrometers with recorders, the preferred method of adjustment of response time is a filter network between electrometer and recorder. Details of how to select a network can be found in electronic handbooks under integrating or low pass filter headings.

B.2 An electrometer with an analog display often has a built-in response in the desired range. Modification of a noncomplying unit should be referred to the manufacturer or an electronics engineer.