Designation: D 6650 – 01

Standard Test Method for Determining the Dynamic Wiping Efficiency, Wet Particle Removal Ability, and Fabric Particle Contribution of Nonwoven Fabrics Used in Cleanrooms[1]

This standard is issued under the fixed designation D 6650; 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 the determination of the dynamic wiping efficiency, wet particle removal ability and fabric particle contribution of nonwoven fabrics.

1.2 This test method applies to all nonwoven fabrics used in cleanrooms. For more information see Journal of the IEST[2], [3].

NOTE 1—For dynamic wiping efficiency in non-cleanrooms, refer to Test Method D 6702 Standard Test Method for Determining the Dynamic Wiping Efficiency of Nonwoven Fabrics Not Used in Cleanrooms.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as the standard. Within the text, the inch-pound units are shown in parentheses. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[4]

D 6702 Test Method for Determining the Dynamic Wiping Efficiency of Nonwoven Fabrics Not Used in Cleanrooms[5]

2.2 *Federal Standard:*

209E, "Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones," (September 11, 1992)[6]

3. Terminology

3.1 *Definitions:*

3.1.1 *cleanroom*, *n*—a room in which the concentration of airborne particles is controlled, and which is constructed and used in a manner to minimize the introduction, generation, and retention of particles inside the room.

3.1.1.1 *Discussion*—In addition to particles, other relevant parameters, such as temperature, humidity, and pressure, are controlled as required. The so-called Class of a cleanroom is defined in documents including but not limited to. Federal Standard 209E as the concentration per unit volume of particles of a designated size. The various systems for such classification lie beyond the scope of this document.

3.1.2 *dynamic wiping efficiency*, *n*—in textile fabrics, the ability of a fabric to remove water, or other liquids, from a surface, usually for spill removal.

3.1.2.1 *Discussion*—The ability of a fabric to hold liquid is largely a function of the composition and construction of the fabric. A naturally sorptive fabric made of or with hydrophilic components will ABSORB liquid (usually water) while those made of hydrophobic materials will ADSORB liquid (typically water) between the interstices of the fibers composing the fabric. In many cases, both absorption and adsorption take place.

3.1.3 *fabric particle contribution*, *n*—textile fabrics, the number of particles contributed by a fabric used for spill removal without the intentional addition of any foreign particles.

3.1.4 *wet particle removal ability*, *n*—in textile fabrics, the ability of a fabric to I remove liquid contaminated with small particles of known size and quantity from a surface, usually for spill removal.

3.2 For definitions of terms used in this test method refer to Terminology D 123.

4. Summary of Test Method

4.1 *Dynamic Wiping Efficiency*—A quarter-folded fabric swatch is clipped to the underside of a 1-kg sled and pulled through a known challenge of liquid, usually water, placed on a flat surface directly in front of a wiper fabric and sled. The percent of liquid removed from the surface is determined gravimetrically as the dynamic wiping efficiency.

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[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.64 on Nonwovens.

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[2] Oathout, J. M., "Determining the Dynamic Efficiency of Cleanroom Wipers for Removal of Liquids and Particles from Surfaces," *Journal of the IEST*, 62 (3), 17-26, May/June 1999.

[3] "Evaluating Wiping Materials Used in Cleanrooms and Other controlled Environments," IEST-RP-CC004.2, Institute of Environmental Science and Technology, 940 East Northeast Highway, Mount Prospect, IL 60056 (1992).

[4] *Annual Book of ASTM Standards*, Vol 07.01.

[5] *Annual Book of ASTM Standards*, Vol 07.02.

[6] Available from Institute of Environmental Sciences and Technology, 940 East Northwest Highway, Mount Prospect, IL 60056.

4.2 *Wet Particle Removal Ability*—The dynamic wiping efficiency test is performed as summarized in 4.1 except the liquid challenge is salted with a known quantity and size of contaminants, and the number of residual contaminants left after wiping from a surface are counted with a discrete-particle counter as wet particle removal ability (WPRA).

4.3 *Fabric Particle Contribution*—The dynamic wiping efficiency test is performed as summarized in 4.2 except dynamic wiping efficiency is carried out without any addition of particles, and the particles left on the surface from the wiping material after wiping are counted with a discrete-particle counter. These particles above a previously determined blank are counted as the fabric particle contribution.

5. Significance and Use

5.1 This test method can be used for acceptance testing of commercial shipments but comparisons should be made with caution because information on estimates of between-laboratory precision is limited as noted in the precision and bias section of this test method.

5.1.1 If there are differences of practical significance between reported test results for two laboratories (or more), comparative tests should be performed to determine if there is a statistical bias between them, using competent statistical assistance. As a minimum, samples used for such comparative tests should be as homogeneous as possible, drawn from the same lot of material as the samples that resulted in disparate results during initial testing, and randomly assigned in equal numbers to each laboratory. Other fabrics with established test values may also be used for these comparative tests. The test results from the laboratories involved should be compared using a statistical test for unpaired data, at a probability level chosen prior to the testing series. If bias is found, either its cause must be found and corrected, or future test results must be adjusted in consideration of the known bias.

5.2 This test method depends on the ability to accurately place a known mass/volume of liquid and number of particles on a surface, so that an accurate mass of liquid adsorbed, number of particles contributed by a wiping fabric, and the number of particles contributed by a known contaminant to the liquid may be determined.

5.3 This test method is useful to select fabrics with superior cleaning and drying properties that can minimize the costs for spill removal. It can also be used to research fabrics for improved spill removal and for production control.

5.4 It is beneficial to perform the dynamic wiping efficiency test in unison with the wet particle removal ability test. This allows for a more precise correlation of these variables.

6. Apparatus and Materials[7]

6.1 *Dynamic Wiping Efficiency Test Apparatus*, consisting of a polyester string attached to two stainless steel screws on a stainless steel sled (6.1.1), forming a yoke, and with a second polyester string, approximately 1.5 m (5 ft) long having one end of attached at the midpoint of the yoke and the other end free. (See Fig. 1)

6.1.1 *Sled*, # 304 stainless steel, 1 kg ± 10 g, 117 × mm × 117 mm base, 9.53 mm thick (4.63 in. by 4.63 in. base, 0.375 in. thick), with 1 mm (0.05 in.) tolerances; a curved leading edge, 13 ± 1 mm (0.50 in. ± 0.05 in.) radius on the base of the sled forms a lip to which the quarter-folded sample is attached using a spring-loaded clip. Two stainless steel screws are affixed to either outboard edge of the sled in the leading curved edge. (See Fig. 2)

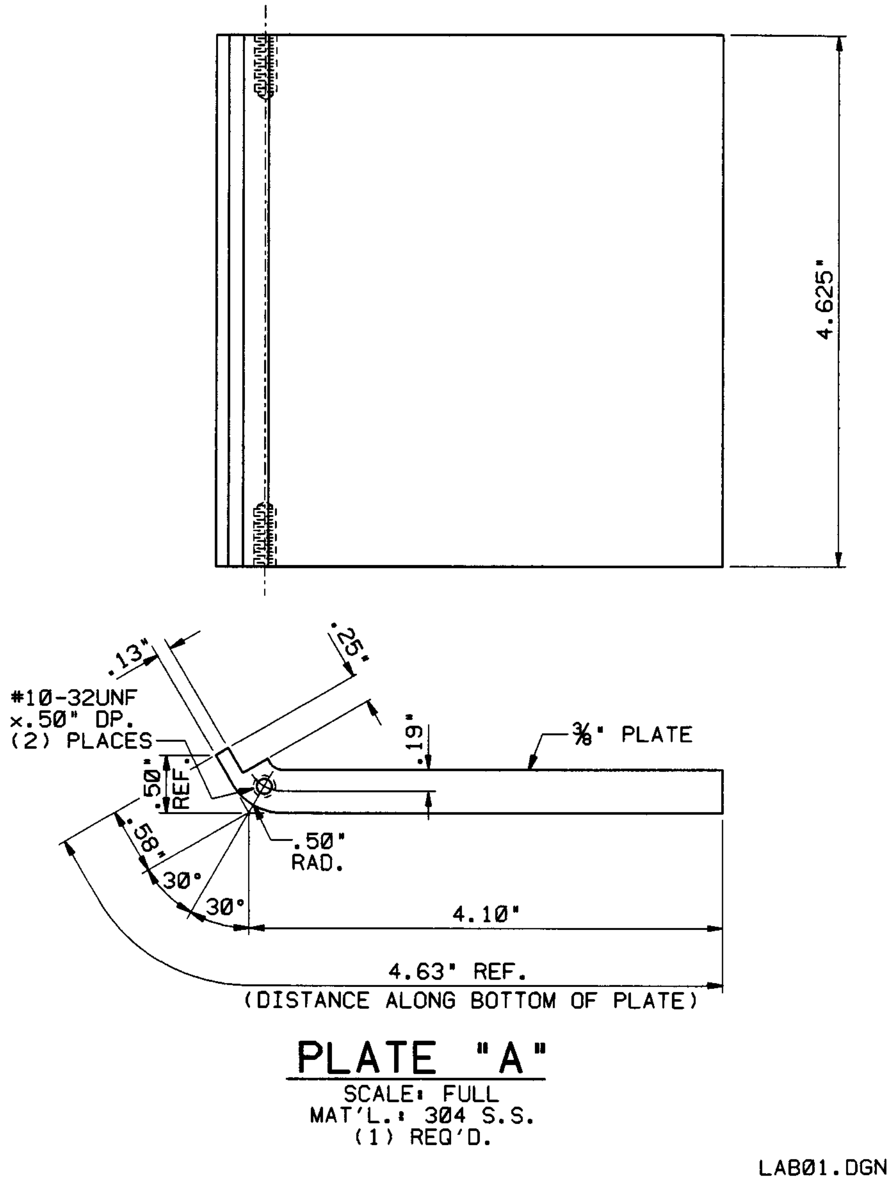
6.1.1.1 If necessary, drilling into the upper surface of the sled or lead inserts can be utilized to meet the sled weight requirement.

6.2 *Balance*, top loading, shielded, at least 0.01 g readability.

6.3 *Dispenser*, digital bottletop burette, for reproducible and accurate delivery of liquid volumes, Brinkmann Bottletop Buret, Model 25, or equivalent.

[7] Apparatus and materials are commercially available, except for 6.1.1 which requires fabrication.

FIG. 1 Illustration of Apparatus to Determine Dynamic Wiping Efficiency, Wet Particle Removal Ability, and Fabric Particle Contribution



(For SI units in millimeters, multiply inches by 25.4)

FIG. 2 Drawing of Sled

6.4 *Cleanroom Water System*, capable of providing clean water as described in 6.5.1.

6.5 *Liquid*, usually water at least distilled grade, or other liquid when specified.

6.5.1 For wet particle removal ability and fabric particle contribution, when using water, the water must have fewer than 10 particles/mL, ≥ 0.5 µm diameter as obtained from a Millipore system consisting of a reverse osmosis unit (Milli-RO 10 Plus), an arrangement of filters and ion exchange beds (Milli-Q UF Plus), and a 0.2 µm filter (Millipak 40) at the point of use, or equivalent.

6.6 *Tray*, stainless steel, with inside dimensions of 45 cm × 28 cm × 7 cm (17.7 in. × 11 in. × 2.75 in.).

6.7 *Mono-Disperse Spheres*, poly(styrene)-latex, 1.59 µm diameter at a concentration of 3×10^8/mL, Duke Scientific Surf Cal Scanner, PD 1600, or equivalent.

6.8 *Syringe*, microliter, Hamilton, 50 pL, Model 705RN, point style 3 (blunt end for accurate delivery), or equivalent.

6.9 *Particle Counter*, discrete-particle counter with the ability to enumerate particles of 1.0-2.0 µm diameter, PMS Liquilaz S05, or equivalent.

6.10 *Cleanbench*, laminar flow, providing cleanroom quality air of Class M2.5 or better as described in Federal Standard 209E.

6.11 *Cleanroom Gloves*, latex, unpowdered.

6.12 *Die Cutter*, to prepare 229 by 229 mm (9.00 by 9.00 in.) specimens with tolerances of 1 mm (0.05 in.).

7. Sampling and Test Specimens

7.1 *Primary Sampling Unit*—Consider rolls, bolts, or prepackaged pieces of textile fabric to be the primary sampling unit, as applicable.

7.2 *Laboratory Sampling Unit*—Consider the primary sampling unit as the laboratory sampling unit for the source of specimens.

7.3 *Test Specimen Size and Preparation*—From each laboratory sampling unit, prepare one set of eight square test specimens 229 mm by 229 mm (9.00 in. by 9.00 in.) with a 1 mm (0.05 in.) tolerance for the dynamic wiping efficiency and wet particle removal ability tests, and one like set of eight specimens for fabric particle contribution. For each set of eight specimens, four are used for the 10 mL challenge test and four for the 50 % capacity challenge test. Specimen preparation need not be carried out in the standard atmosphere for testing. Label to maintain specimen identity.

7.3.1 *For Prepackaged Wipes, Nominal 229 by 229 mm (9.00 by 9.00 in.)*—Open the package. Select a stack of wipes that is at least two greater than the number needed for the test. Select the number of specimen wipes required for the tests from the central portion of the stack. Use the entire square, quarter-folded, as the test specimen. Place these specimens into plastic bags to prevent contamination. In any event, do not use the uppermost and bottom-most wipes in the stack as test specimens.

7.3.2 *For Rolls or Bolts of Fabric*—Using a utility knife, cut a plug, approximately 300 by 300 mm (12 by 12 in.) and about 25 mm (1.0 in.) deep from the roll or bolt to provide a suitable number of fabric layers for the necessary specimens. Using the die cutter, cut through the entire plug thereby providing a stack of 229 by 229 mm (9.00 by 9.00 in.) specimens. Place these specimens into plastic bags to prevent contamination. In any event, do not use the uppermost and bottom-most wipes in the stack as test specimens.

7.3.3 Typically the dynamic wiping efficiency and wet particle removal ability tests are performed in unison on the same test specimen set. If these tests are performed separately, an additional set of eight specimens will be required.

7.4 *Test Specimen Selection*—Select test specimens as follows:

7.4.1 Take no specimens closer than 25 mm (1.0 in.) from the machine direction edge, except as noted in 7.3.1.

7.4.2 Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, grease, etc. on the specimens when handling.

8. Conditioning

8.1 No conditioning is required unless otherwise specified in a material specification or contract order.

9. Preparation of Test Apparatus and Calibration

9.1 Conduct preliminary trials using a stopwatch and by manually pulling the sled until an approximate pulling rate of 25 cm/s (10 in./s) is sensed, and the sled pull rate is consistently performed by the operator.

9.2 Separate challenges of 10 mL and the volume representing 50 % of the ply's capacity are required.

9.2.1 If the intrinsic sorptive capacity, A_i [mL/g], of a fabric is not already known, determine it on a separate ply of the material as directed in Annex A1. From the calculated A_i and the measured mass of each fabric, calculate the per-ply capacity A_{ip} [mL] for each fabric. This quantity is needed in order to calculate to volume representing a 50 % capacity challenge [0.5 A_{ip}].

9.3 Verify the required challenge of $10(10^6)$ particles by placing a known quantity of particle concentrate in the cleaned pan, diluting with an appropriate volume of cleanroom water to avoid overloading the particle counter, and determining the particle count per mL. For example, 33.3 µL of a $3 \times (10^8)$ particle/mL concentrate, diluted in 2000 mL should result in 5000 particles/mL in the 1.0 to 2.0 µm channel of the counter. Adjustments to this theoretical 33.3 µL volume may be necessary due to concentration or particle counter differences, and should be made to validate the presence of $10(10^6)$ particles.

9.4 Verify calibration of the burette dispenser. For example, for a burette delivery of 10.00 mL of water, the water at 25 °C has a density of 0.997 g/mL that must have a mass of 9.97 g.

9.5 Verify the calibration of the balance.

10. Procedure

10.1 Use cleanroom gloves when performing tests. Handle the test specimens carefully to avoid altering the natural state of the material.

10.2 *Dynamic Wiping Efficiency*:

10.2.1 Quarter-fold a 229 mm by 229 mm (9.00 in. by 9.00 in.) test specimen, place on the balance and record its dry mass, M_d, to the nearest 0.01 g.

10.2.2 Clip the quarter-folded test specimen to the sled so that the single convex fold is at the leading edge without the test specimen extending beyond the footprint of the sled.

10.2.3 Position the sled in the stainless steel tray at one end with the leading edge perpendicular to the axis of the long dimension of the tray.

10.2.4 Using the dispenser, place a 10 ± 0.02 mL volumetric challenge of liquid, v_c, onto the tray at a point 1-2 cm (0.5-0.75 in.) in front of the leading edge of the sled.

10.2.5 Grasp the free end of the string and manually pull the sled at a rate of speed of approximately 25 cm/s (10 in./s) along the long axis of the steel tray for a distance of about 36 cm (14 in.) allowing sufficient room to remove the sled and test specimen at the end of the test without touching the side of the tray.

10.2.6 At the end of 36 cm (14 in.) travel, remove the folded test specimen and sled by lifting the sled with the string, using a smooth and rapid motion.

10.2.7 With the sled turned fabric-side-up, remove the folded fabric from the sled, place on the balance and record its wetted mass, m_w, to the nearest 0.01 g.

10.2.8 Continue as directed in 10.2.1-10.2.7 until four specimens have been tested using a 10 mL challenge for each laboratory sampling unit. Using the remaining four test specimens, test each as directed in 10.2.1-10.2.7 using a 50 % capacity challenge for each laboratory sampling unit.

10.2.9 Calculate the dynamic wiping efficiency as directed in Section 11.

10.3 *Wet Particle Removal Ability*:

10.3.1 Using clean water as described in 6.5.1, thoroughly clean the stainless steel tray interior. Use good laboratory practices to clean the tray which may include manual cleaning, multiple rinses, use of high velocity CO_2 snow, etc. Cleaning must provide a cumulative background count (blank) fewer than 10 particles/mL, ≥ 0.5 µm diameter when measured as directed in 10.3.2.

10.3.2 Add a 200-1000 mL volume of conditioned water to the tray and using the particle counter as directed in the manufacturer's directions, measure the CUMULATIVE particles ≥ 0.5 µm diameter. Record the particle count/mL as "B". (See 11.3 and 11.4)

10.3.3 If a higher count than 10 particles/mL, ≥ 0.5 µm diameter is obtained, reclean the tray and repeat 10.3.1 and 10.3.2 until the required particle count is obtained.

10.3.4 Using the particle counter as directed in the manufacturer's directions, measure the background concentration of particles (in the 1.0 µm to 2.0 µm range) in a 200-1000 mL volume of water placed therein. This measurement represents the background count or blank.

10.3.5 Quarter-fold a single ply of wiping material, nominally 229 mm by 229 mm (9.00 in. by 9.00 in.) and determine its mass, md, to the nearest 0.01 g.

10.3.6 Clip the quarter-folded test specimen to the sled so that the single convex fold is at the leading edge without the test specimen extending beyond the footprint of the sled.

10.3.7 Position the sled in the stainless steel tray at one end with the leading edge perpendicular to the axis of the long dimension of the tray.

10.3.8 With the microliter syringe, deposit a challenge of $10(10^6)$ particles 1-2 cm (0.5–0.75 in.) in front of the leading edge of the sled. (See 9.3)

10.3.9 Using the dispenser, place the required volumetric challenge of water, v_c, (See 9.2) on top of the particles (determined in 9.3 to be $10(10^6)$ in number).

10.3.10 Grasp the free end of the string and manually pull the sled at a rate of speed of approximately 25 cm/s (10 in./s) along the long axis of the steel tray for a distance of about 36 cm (14 in.) allowing sufficient room to remove the sled and test specimen at the end of the test without touching the side of the tray.

10.3.11 At the end of 36 cm (14 in.) travel, remove the folded test specimen and sled by lifting the sled with the string, with a smooth and rapid motion.

10.3.12 With the sled turned fabric-side-up, remove the folded fabric from the sled, place on the balance and record its wetted mass, m_w, to the nearest 0.01 g.

10.3.13 Add a known volume of clean water to the tray (200 mL to 1000 mL is convenient). Record the volume added as "D". (See 11.3 and 11.4).

10.3.14 Using the particle counter, determine the concentration of particles in the 1.0 µm to 2.0 µm range. Record the particle count, mL as "P". (See 11.3 and 11.4).

10.3.14.1 The volume of dilution may be adjusted to increase the particle count against the background (blank). That is, fabrics with efficient particle removal leave few particles behind, and the dilution used is required to be low to measure significant particles above the blank.

10.3.15 Continue as directed in 10.3.1-10.3.14 until four specimens have been tested using a 10 mL challenge for each laboratory sampling unit.

10.3.16 Using four additional test specimens, test each as directed in 10.3.1-10.3.14 using a 50 % capacity challenge for each laboratory sampling unit.

10.4 *Fabric Particle Contribution*:

10.4.1 Conduct the test for fabric particle contribution from the fabric using the directions in 10.3 except do not add any particles to the liquid challenge.

11. Calculations

11.1 *Volume of Liquid Sorbed: Individual Specimen*—Calculate the volume of liquid sorbed for individual specimens to the nearest 0.01 unit of measurement, using Eq 1.

$$v_s = (m_w - m_d)/ D_w \tag{1}$$

where:

v_s = volume of liquid sorbed, mL,
m_w = mass of the test specimen after wetting, g (from 10.2.7 or 10.3.12 as applicable),
m_d = mass of the test specimen before wetting, g (from 10.2.1 or 10.3.5, as applicable), and
D_w = 0.997 g/mL (density of water at 25 °C).

11.1.1 If liquids other than water are used, substitute the appropriate density in Eq 1.

11.1.2 If Particle Removal Ability is determined in unison with Dynamic Wiping Ability, it is necessary to include the volume of contaminated fluid deliberately added to the pan as a portion of the volume challenge, v_c.

11.2 *Dynamic Wiping Efficiency*—Calculate the dynamic wiping efficiency of individual specimens for both the 10 mL challenge and the 50 % capacity challenge to the nearest 0.1 % using Eq 2.

$$DWE = 100\ v_s/v_c \tag{2}$$

where:

DWE = Dynamic Wiping Efficiency, %,
v_s = volume of liquid sorbed, mL (from 11.1), and
v_c = volume of the liquid challenge, mL.

11.3 *Wet Particle Removal Ability, Individual Specimens*—Calculate the wet particle removal ability (WPRA), that is, the number of particles remaining from the challenge (which includes some contributions from the fabric) using Eq 3.

$$WPRA = (P - B) \times D \tag{3}$$

where:

$WPRA$ = Wet Particle Removal Ability, particle count,
P = the number of particles per mL in the tray counted in the 1.0 to 2.0 µm channel of the particle counter, after the test. (from 10.3.14),
B = the blank count, represented by the number of particles per mL in the empty tray counted in the 1.0 to 2.0 µm channel of the particle counter, prior to the test. (from 10.3.2), and
D = the dilution represented by the number of mL of liquid added to the pan after wiping to suspend the particles for counting. (from 10.3.13).

11.4 *Fabric Particle Contribution, Individual Specimens*—Calculate the number of particles contributed to the surface by the fabric, using Eq 4.

$$FPC = (P - B) \times D \tag{4}$$

where:

FPC = Fabric Particle Contribution, particle count,

P = the number of particles per mL in the tray counted in the 1.0 to 2.0 μm channel of the particle counter, after the test. (from 10.3.14 with no particles added),

B = the blank count, represented by the number of particles per mL in the empty tray counted in the 1.0 to 2.0 μm channel of the particle counter, prior to the test. (from 10.3.2), and

D = the dilution represented by the number of mL of liquid added to the pan after wiping to suspend the particles for counting. (from 10.3.13 with no added particles).

NOTE 2—For fabrics leaving very few particles behind in the pan, dilution with minimum water may be required to measure a significant number of particles over the background count.

NOTE 3—Eq 4 is the same as Eq 3, however for fabric particle contribution, only particles contributed from the fabric are counted, whereas for wet particle removal ability the number of particles left from the added challenge plus particles which may have been contributed form the fabric are counted.

11.5 Calculate the average Dynamic Wiping Efficiency, Wet Particle Removal Ability, Fabric Particle Contribution for both the 10 mL challenge and the 50 % capacity challenge for the laboratory sample and for the lot.

11.6 Calculate the Standard Deviation, Coefficient of Variation as applicable.

12. Report

12.1 Report that the Dynamic Wiping Efficiency, Wet Particle Removal Ability, Fabric Particle Contribution was determined as directed in Test Method D 6650. Describe the material or product sampled and the method of sampling used.

12.2 Report the following information for the laboratory-sampling unit and for the lot as applicable to a material specification or contract order.

12.2.1 Dynamic wiping efficiency for each the 10 mL challenge and the 50 % capacity challenge.

12.2.2 Wet particle contribution ability for each the 10 mL challenge and the 50 % capacity challenge.

12.2.3 Fabric Particle Contribution for each the 10 mL challenge and the 50 % capacity challenge.

12.2.4 When calculated, the standard deviation or the coefficient of variation.

13. Precision and Bias

13.1 *Summary*—Limited information from one laboratory shown in Tables 1 and 2 illustrates what one laboratory found when all the observations are taken by the same well-trained operator using the same piece of equipment and specimens randomly drawn from the sample of material. For this laboratory, in comparing two averages for fabrics, the critical differences are not expected to exceed values shown in Table 1 in 95 out of 100 cases when the number of tests is four. Differences for other fabrics or other laboratories may be larger or smaller.

TABLE 1 Maximum Property Critical Differences when Comparing Averages, for N Equals 4[A] (Single-Operator Precision)

Property	10 mL Challenge As Standard Deviation	50 % Capacity Challenge As Standard Deviation
Wet Particle Removal Ability (WPRA), (10^3) particles	12.4	2.63
Dynamic Wiping Efficiency (DWE), %	0.95	0.19
Fabric Particle Contribution (FPC), (10^3) particles	0.80	0.66

[A] The critical differences were calculated using t = 1.960, which is based on infinite degrees of freedom.

TABLE 2 Average and Standard Deviation for Property and Units as Noted

Property and Units	Average and Standard Deviation	
Wet Particle Removal Ability (WPRA), (10^3) particles	19.9 ± 9.35	5.51 ± 1.97
Dynamic Wiping Efficiency (DWE), %	97.5 ± 0.72	99.6 ± 0.14[A]
Fabric Particle Contribution (FPC), (10^3) particles	0.55 ± 0.60	0.88 ± 0.50

[A] 50% capacity challenge determined and used for the fabric described in 13.2 was 7.48 mL.

13.2 *Single-Laboratory Test Data*—A single-laboratory test was run in 1999 in which a randomly-drawn fabric was tested. One operator in the laboratory tested ten specimens from the material using both a 10 mL challenge and a 50 % capacity challenge as directed in this test method. The test specimens were tested over several days. The fabric was of nonwoven (hydroentangled) construction, having a basis weight (mass per unit area) of 70.6 g/m^2, and composed of 55 % woodpulp (cellulose) and 45 % poly-(ethylene)-terephthalate and was white in color without apparent patterning.

13.2.1 The average and standard deviation for each property are shown in Table 2.

13.3 *Precision*—Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established, with each comparison being based on recent data obtained on specimens taken from a lot of material of the type being evaluated so as to be as nearly homogeneous as possible and then randomly assigned in equal numbers to each of the laboratories. (see 5.1). Interlaboratory testing wilt continue to provide between-laboratory precision statements.

13.4 *Bias*—The procedure of this test method produces a test value that can be defined only in terms of a test method. There is no independent, referee method by which bias may be determined. This test method has no known bias.

14. Keywords

14.1 dynamic wiping efficiency; fabric particle contribution; nonwoven fabrics; wet particle; removability

ANNEX

(Mandatory Information)

A1. ESTABLISHING INTRINSIC SORPTIVE CAPACITY OF A FABRIC

A1.1 The test for establishing intrinsic sorptive capacity of a wiper fabric should be conducted in the test room environment. It is performed by saturating a known area of the wiper fabric with a selected liquid and then calculating the volume sorbed per unit mass and per unit area as directed in A1.2-A1.9.

A1.2 Determine to three significant figures the mass and area of square fabric swatch of the same material to be tested having the same dimension as the test specimen.

A1.3 Place the specimen flat in a tray containing the selected liquid.

A1.3.1 The depth of the liquid should be such that the specimen is completely submerged.

A1.4 Allow ample time for the wiper material to sorb as much liquid as possible (usually no more than 30 s). If necessary, use physical persuasion to coax the wiper fabric to sorb to its capacity.

A1.5 After sorption is complete, grasp two adjacent corners of the specimen and remove it from the tray.

A1.6 Suspend the specimen at an angle to the horizontal, allowing the excess liquid to drip into the tray.

A1.6.1 The angle should be steep enough to facilitate dripping but not so steep that pleating of the fabric occurs. The wiper should not be stretched or otherwise dimensionally deformed as it is dripping.

A1.7 After 60 s, determine the mass of the wetted wiper to three significant figures.

A1.8 Repeat steps A1.3-A1.7 twice, using the same specimen.

A1.9 Average the three values for the mass of the wetted wiper fabric and calculate the sorbency as follows:

A1.9.1 Calculate sorbency per unit mass of wiper fabric (intrinsic sorbency) using Eq A1.1:

$$A_i = (m_{ww} - m_w)/(m_w \times d_0) \qquad \text{(A1.1)}$$

where:
A_i = (intrinsic sorbency) is the volume of liquid sorbed per unit mass of the wiper fabric (mL/g),
m_{ww} = the mass of the wiper fabric wetted with the liquid (g),
m_w = the mass of the dry wiper fabric, g, and
d_0 = the density of the liquid (g/mL).

A1.9.2 Calculate the sorbency per unit area of wiper fabric (extrinsic sorbency) using Eq A1.2:

$$A_e = 10^6\,(m_{ww} - m_w)/(d_0 \times l_w \times w_w) \qquad \text{(A1.2)}$$

where:
A_e = (extrinsic sorbency) is the volume of liquid sorbed per unit area of wiper (mL/m^2),
m_{ww} = the mass of the wiper fabric wetted, g,
m_w = the mass of the dry wiper fabric, g
d_0 = the density of the liquid (g/mL),
l_w = the length of the wiper fabric (mm), and
w_w = the width of the wiper fabric (mm).

A1.9.2.1 Eq A1.2 can be seen to be equivalent to Eq A1.3:

$$A_e = A_i \times bw = [(m_{ww} - m_w)/(m_w \times d_0)] \times bw \qquad \text{(A1.3)}$$

where:
bw = the basis weight (mass per unit area) of the wiper fabric (g/m^2).