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~~Standard Guide for~~ Designation: D 3884 – 09

Standard Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)[1]

This standard is issued under the fixed designation D 3884; 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 ~~guide~~test method covers the determination of the abrasion resistance of textile fabrics using the rotary platform, double-head tester (RPDH).

NOTE 1—Other procedures for measuring the abrasion resistance of textile fabrics are given in Test Methods D 3885, D 3886, D 4157, D 4158, D 4966, and AATCC ~~61~~93.

1.2 The values stated in SI units are to be regarded as standard: the values in English units are provided as information only and are not exact equivalents.

1.3 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 123 Terminology Relating to Textiles
D 1776 Practice for Conditioning and Testing Textiles
D 3885 Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method)
D 3886 Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Apparatus)
D 4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)
D 4158 Guide for Abrasion Resistance of Textile Fabrics (Uniform Abrasion)
D 4850 Terminology Relating to Fabrics and Fabric Test Methods
D 4966 Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method)
D 5034 Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
D 5035 ~~Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)~~ Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
D 7255 Test Method for Abrasion Resistance of Leather (Rotary Platform, Double-Head Method)

2.2 *Other Documents:*

AATCC 93 ~~Impeller Tumble Method~~ Abrasion Resistance of Fabrics: Accelerator Method[3]

3. Terminology

~~3.1 *Definitions:*~~

~~3.1.1 *abrasion*, *n*—the wearing away of any part of a material by rubbing against another surface.~~

~~3.1.2 *abrasion cycle*, *n*—in *abrasion testing*, one or more movements of the abradant across a material surface, or the material surface across the abradant, that permits a return to its starting position.~~

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[1] This ~~guide~~ test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.60 on Fabric Test Methods, Specific.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, http://www.aatcc.org.

~~3.1.2.1*Discussion*—The abrasion cycle is dependent on the programmed motions of the abrasion machine and the test standard used. It may consist of one back-and-forth unidirectional movement such as for the rotary platform test method, or a combination of both such as for the inflated diaphragm test method. For the oscillatory cylinder abrasion method, an abrasion cycle consists of one circular movement of the specimen.~~

~~3.1.3*breaking force*, *n*—the maximum force applied to a material carried to rupture. (Compare *breaking point*, *breaking strength*).~~

~~3.2For definitions of other textile terms used in this test method, refer to Terminology D123~~

3.1 For all terminology relating to D13.60, Fabric Test Methods, Specific, refer to Terminology D 4850.

3.1.1 The following terms are relevant to this standard: abrasion, abrasion cycle, breaking force.

3.2 For all other terminology related to textiles, refer to Terminology D 123.

4. Summary of Test Method

4.1 A specimen is abraded using rotary rubbing action under controlled conditions of pressure and abrasive action. The test specimen, mounted on a turntable platform, turns on a vertical axis, against the sliding rotation of two abrading wheels. One abrading wheel rubs the specimen outward toward the periphery and the other, inward toward the center. The resulting abrasion marks form a pattern of crossed arcs over an area of approximately 30 cm^2. Resistance to abrasion is evaluated by various means which are described in Section ~~12~~13.

5. Significance and Use

5.1 The measurement of the resistance to abrasion of textile and other materials is very complex. The resistance to abrasion is affected by many factors, such as the inherent mechanical properties of the fibers; the dimensions of the fibers; the structure of the yarns; the construction of the fabrics; and the type, kind, and amount of finishing material added to the fibers, yarns, or fabric.

5.2 The resistance to abrasion is also greatly affected by the conditions of the tests, such as the nature of abradant, variable action of the abradant over the area of specimen abraded, the tension of the specimen, the pressure between the specimen and abradant, and the dimensional changes in the specimens.

5.3 Abrasion tests are all subject to variation due to changes in the abradant during specific tests. The abradant must accordingly be discarded at frequent intervals or checked periodically against a standard. With disposable abradants, the abradant is used only once or discarded after limited use. With permanent abradants that use hardened metal or equivalent surfaces, it is assumed that the abradant will not change appreciably in a specific series of tests. Similar abradants used in different laboratories will not change at the same rate, due to differences in usage. Permanent abradants may also change due to pick up of finishing or other material from test fabrics and must accordingly be cleaned at frequent intervals. The measurement of the relative amount of abrasion may also be affected by the method of evaluation and may be influenced by the judgment of the operator.

5.4 The resistance of textile materials to abrasion as measured on a testing machine in the laboratory is generally only one of several factors contributing to wear performance or durability as experienced in the actual use of the material. While "abrasion resistance" (often stated in terms of the number of cycles on a specified machine, using a specified technique to produce a specified degree or amount of abrasion) and "durability" (defined as the ability to withstand deterioration or wearing out in use, including the effects of abrasion) are frequently related, the relationship varies with different end uses, and different factors may be necessary in any calculation of predicted durability from specific abrasion data. Laboratory tests may be reliable as an indication of relative end-use performance in cases where the difference in abrasion resistance of various materials is large, but they should not be relied upon where differences in laboratory test findings are small. In general, they should not be relied upon for prediction of actual wear-life in specific end uses unless there are data showing the specific relationship between laboratory abrasion tests and actual wear in the intended end-use.

5.5 These general observations apply to all types of fabrics, including woven, nonwoven, and knit apparel fabrics, household fabrics, industrial fabrics, and floor coverings. It is not surprising, therefore, to find that there are many different types of abrasion testing machines, abradants, testing conditions, testing procedures, methods of evaluation of abrasion resistance and interpretation of results.

5.6 All the test procedures and instruments that have been developed for abrasion resistance of fabrics may show a high degree of variability in results obtained by different operators and in different laboratories, however, they represent the procedures most widely used in the industry. Because there is a definite need for measuring the relative resistance to abrasion, this is one of the several procedures that is useful to help minimize the inherent variation in results that may occur.

5.7 Before definite predictions of fabric usefulness can be drawn from an abrasion test as made on the rotary platform, double-head (RPDH) abrader (Fig. 1), actual end-use trials should be conducted and related to the abrasion test. Different types of wear (for example, wear on men's clothing at cuffs, crotch, etc.) may correspond to different ratings of the RPDH test.

5.8 In making a comparison of different fabrics (that is, of different fibers, weights, etc.) the RPDH test will not always reveal a difference known to exist when the fabrics are actually used. Therefore, end-use trials should be conducted in conjunction with the RPDH abrasion test, at least as a guide for future testing of these fabrics.

5.9 Uncontrolled manufacturing or finishing variations occurring within a fabric or within lots of the same style of fabric can, however, be detected satisfactorily with the RPDH tester.

5.10 Because of the conditions mentioned above, technicians frequently fail to get good agreement between results obtained on

FIG. 1 Rotary Platform Double Head Abrader

the same type of testing instrument both within and between laboratories, and the precision of these test methods is uncertain. This test method is accordingly not recommended for acceptance testing in contractual agreements between purchaser and supplier because of the poor between-laboratory precision of the test method.

5.11 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, the test samples used are to be as homogeneous as possible, drawn from the material from which the disparate test results were obtained, and randomly assigned in equal numbers to each laboratory for testing. The test results from the two laboratories 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.

6. Apparatus

6.1 *Rotary Platform, Double-Head (RPDH) Abrader*[4] (Fig. 1~~), comprised of a housing of compact design, a removable flat-circular specimen holder, a pair of pivoted arms to which the abrasive wheels are attached, a motor for rotating the platform and specimen, a fan for cooling the motor, a vacuum nozzle and vacuum cleaner for removal of lint from specimen, and a counter for indicating the revolutions of the specimen holder. The specimen holder should be mounted so as to produce a circular surface travel of an essentially flat specimen in the plane of its surface.~~

~~6.1.1The abrasive wheels, which are attached to the free end of the pivoted arms, rotate and have, when resting on the specimen, a peripheral engagement with the surface of the specimen, the direction of travel of the periphery of the wheels and of the specimen at the contacting portions being at acute angles, and the angles of travel of one wheel periphery being opposite to that of the other. Motion of the abrasive wheels, in opposite directions, is provided by rotation of the specimen and the associated friction therefrom.~~

~~6.1.2The abrasive wheels[4] are either rubber-based or vitrified-based. Both types of wheels are manufactured in different grades of abrasive quality. The wheels are lead bushed, 13 mm (0.5 in.) thick and approximately 50 mm (2 in.) in diameter. The wheels customarily used for testing textiles are the rubber-base, resilient type composed of abrasive grains cushioned in rubber; consequently, they are distorted during operation of the abrader. Accordingly, the wheels should be mounted as prescribed in 9.1 so as to compensate for this distortion.~~

[4] The sole source of supply of the apparatus known to the committee at this time is Taber Industries, 455 Bryant St. North Tonawanda, NY 14120. If you are aware of alternate suppliers, please provide this information to ASTM headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

~~6.1.3Vitrified-base wheels are the hard abrasive type. They may be cut with a diamond point to alter the roughness of the wheel, the stroke of cut determining the degree of grit. The position of these wheels is not critical, but it is recommended that they be set as prescribed in 9.1.~~

~~6.2The specimen holder is supported by an adapter that is motor-driven and provides motion for the circular travel of the specimen holder.~~

~~6.2.1Clamping rings are used to secure the specimen to the specimen holder, one for use with lighter weight fabrics, and a larger one for use with heavier-weight fabrics.~~

~~6.3The RPDH abrader is provided with a load adjustment for varying the load of the abrader wheels on the specimen. The pivoted abrader arms without auxiliary weights or counter weights apply a load against the specimen of 250 g per wheel (exclusive of the mass of the wheel itself). The manufacturer provides additional weights that can be used to increase the load to 500 or 1000 g per wheel, , and a counterweight attachment that can be used to reduce the load on the specimen to 125 g per wheel.~~), consisting of the following elements described in 6.1.1-6.1.5

6.1.1 Removeable, turntable platform that includes a rubber pad, clamp plate and knurled nut, and clamp ring to secure the specimen. The specimen holder shall be motor driven, and mounted so as to produce circular surface travel of a flat specimen in the plane of its surface.

6.1.2 Pair of pivoted arms to which the abrasive wheels and accessory weights are attached.

6.1.3 Motor capable of rotating the platform and specimen at a speed of 72 ±2 r/min.

6.1.4 Vacuum nozzle and vacuum cleaner for removal of lint and debris from specimen. The height of the vacuum nozzle shall be adjustable and the nozzle will have two openings – one opening positioned between the two wheels and over the wear path and the other placed diametrically opposite. The distance between the axes of the two openings shall be 76.0 ±1.0 mm.

6.1.5 Counter for indicating the revolutions of the specimen holder.

6.2 *Abrasive wheels*, which are attached to the free end of the pivoted arms and rotate freely about horizontal spindles.

6.2.1 Their internal faces shall be 52.4 ±1.0 mm apart and the hypothetical line through the two spindles shall be 19.05 ±0.3 mm away from the central axis of the turntable (see Fig. 2). When resting on the specimen, the wheels will have a peripheral engagement with the surface of the specimen, the direction of travel of the periphery of the wheels and of the specimen at the contacting portions being at acute angles, and the angles of travel of one wheel periphery being opposite to that of the other. Motion of the abrasive wheels, in opposite directions, is provided by rotation of the specimen and the associated friction therefrom.

6.2.2 The abrasive wheels[4] are either resilient or vitrified-based. Both types of wheels consist of hard particles embedded in a binder material and are manufactured in different grades of abrasive quality. The wheels shall be 12.7 ±0.3 mm thick and have an external diameter of 51.9 ±0.5 mm when new, and in no case less than 44.4 mm.

6.3 *Accessory Loads*, The RPDH abrader is provided with a load adjustment for varying the load of the abrader wheels on the specimen. The pivoted abrader arms without auxiliary weights or counter weights apply a load against the specimen of 250 g per wheel (exclusive of the mass of the wheel itself). The manufacturer provides additional weights that can be used to increase the load to 500 or 1000 g per wheel, and a counterweight attachment that can be used to reduce the load on the specimen to 125 g per wheel.

6.4 *Auxiliary Apparatus*—~~Resurfacing disks, of carborundum-coated paper, are provided for resurfacing of rubber-base wheels. A stiff brush is provided for the removal of loose particles from the surface of the wheels. (Compressed air is recommended for~~

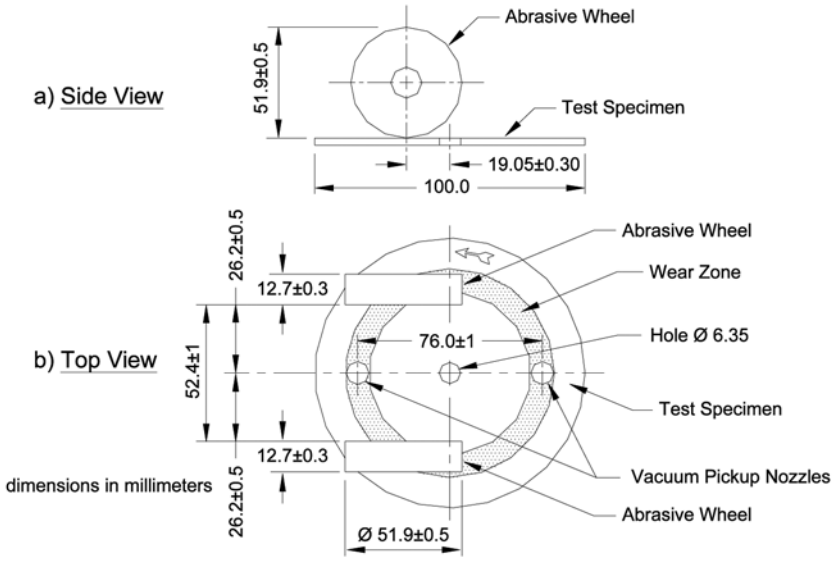

FIG. 2 Position of Abrasive Wheels on Rotary Platform Double Head Abrader

~~cleaning vitrified-base wheels.)~~ —Resurfacing discs (S-11), of carborundum-coated paper, are used to resurface the resilient wheels.

6.5 *Abrasion Wheel Resurfacing Device*~~, for resurfacing uneven wheel wear.~~ , for resurfacing vitrified based wheels or for correcting uneven wheel wear.

7. Sampling

7.1 Take a lot sample as directed in the applicable material specification, or as agreed upon by the purchaser and seller. In the absence of such a specification or other agreement, take a laboratory sample as directed in 7.1.1. Consider rolls or pieces of fabric to be the primary sampling unit.

7.1.1 Take a laboratory sample that is the full width of the fabric and at least 50 cm (approximately 20 in.) long, from each roll or piece of fabric in the lot sample. The laboratory sample should be taken no closer than 1 m (1 yd) from the end of each roll or piece of fabric.

7.2 Sample shipments of garments as agreed upon by purchaser and seller.

8. Number and Preparation of Test Specimens

8.1 If the number of specimens to be tested is not specified by a material specification or an agreement between purchaser and seller, test five specimens.

8.1.1 If the number of specimens to be tested exceeds the number of laboratory samples, randomly select those laboratory samples from which more than one test specimen will be taken. If not, test one specimen per laboratory sample.

8.2 Take specimens from garment samples as agreed upon by all interested parties.

~~8.3Cut ten specimens approximately 15 cm (6 in.) square, five for abrasion tests and five reserved for controls. For the five specimens to be abraded, fold each one twice into a square and using a die or shears, cut off the folded corner to form a 6-mm (¼~~

8.3 Cut ten specimens approximately 15 cm (6 in.) square, five for abrasion tests and five reserved for controls. For the five specimens to be abraded, cut a 6-mm (¼-in.) diameter hole in the center of the specimen.

8.3.1 For ~~the~~fabric widths 125 mm (5 in.) or more, take no specimen closer than 25 mm (1 in.) from the selvage edge.

8.3.2 For fabric widths less than 125 mm (5 ~~m),~~in.), use the entire width for specimens.

8.3.3 Cut specimens representing a broad distribution diagonally across the width of the laboratory sampling unit. Take lengthwise specimens from different positions across the width of the fabric. Take widthwise specimens from different positions along the length of the fabric.

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

8.3.5 If the fabric has a pattern, ensure that the specimens are a representative sampling of the pattern.

9. Preparation, Calibration, and Verification of Apparatus

9.1 *Wheel Position*—~~The mounted position of rubber-base wheels, with respect to the center of the specimen holder, is critical. The lateral distance from the left-hand wheel mounting flange to the center of the specimen holder should be 25.8 mm (1 1/64 in.) (see Dimension *A* in Fig. 2); and from the same point to the right-hand wheel mounting flange, the distance should be 27.4 mm (1 5/64 in.) (see Dimension *B* in Fig. 2). Since the position of vitrified-base abrasive wheels with respect to the center of the specimen holder is not critical, it is recommended for convention that they should be equally spaced on both sides, 26.6 mm (1 3/64 in.) (see Dimensions *A* and *B* in Fig. 2) from the wheel mounting flange to the center of the specimen holder.~~ —The wheels should be spaced equally on both sides from the wheel-mounting flange to the center of the specimen holder. The distance from the inside of the wheel mounting flange to the center of the specimen holder should be 38.9 ±0.5 mm (1.53 in.).

9.2 *Wheel Bearings*—~~The abrader wheel bearings, that is, the two pairs of bearings installed in the free end of the pivoting arms to support the abrader wheels, should not stick when caused to spin rapidly by a quick driving motion of the forefinger. The degree of freedom of rotation of these bearings, however, is not critical.~~ —The abrader wheel bearings, installed in the free end of the pivoting arms to support the abrader wheels, should not stick when caused to spin rapidly by a quick driving motion of the forefinger.

9.3 *Platform Position*—~~The vertical distance from the center of the pivot point of the abrader arms to the top of the specimen holder should be approximately 25 mm (1 in.). This measurement is specified to prevent the possibility of errors incurred by installing a thrust bearing or the like to support the specimen platform. Adaptations should be made to maintain that the platform will remain at the above specified level. The specimen platform should rotate in the plane of its surface. If it fails to do so and exhibits a tendency to wobble, the holder and adapter should be replaced or a thrust bearing installed to support the specimen holder.~~ —The vertical distance from the center of the pivot point of the abrader arms to the top of the specimen holder should be approximately 25 mm (1 in.). The specimen platform should rotate in the plane of its surface, with no visible wobble. This can be checked with a dial indicator at the top outer edge of the platform.

9.4 *Platform Speed*—~~The platform should rotate at approximately 70 rpm.~~

~~9.5*Load Adjustment, Counterweight*— A counterweight attachment is provided with the RPDH abrader to reduce the load of the abrader wheels on the specimen. The use of this counterweight is not recommended, because studies have indicated variability in~~

~~results due to the unequal counterweighting of the individual arms.~~

~~9.6*Selection of Wheels for Test :~~

~~9.6.1Since variations exist in abrasive quality between and within rubber-base wheels of the same grade, a method should be followed in the selection of wheels for a particular test that will reduce this variation. Test all rubber-base wheels individually on a selected reference fabric known to have a minimum of variation in its abrasion resistance. Group the wheels in sets of three pairs such that the average abrasiveness of the three falls within a specified tolerance. Then use the wheels in sets as established.~~

~~9.6.2In the use of vitrified-base wheels, both wheels of the pair to be used should be similar in abrasion characteristics. Check this on a selected reference fabric. Once a satisfactory pair is obtained, it may be used for an indefinite period without changing its abrasive quality provided neither wheel becomes clogged with finishing material, which is not easily removed.~~

~~10.~~—The platform should rotate at the speed stated in 6.1.3.

9.5 *Load*—The load to use is dependent on the type of textile fabric being tested, and should be agreed upon by the interested parties.

9.6 *Vacuum Suction*—The vacuum suction force should be adjusted to lift the abraded particles, but not lift the specimen. A setting of 75 – 100 has been found to be sufficient and should be used, unless otherwise agreed upon by the interested parties. At a vacuum level of 100, the suction force shall be 137 millibar (55 in. of water column) or greater, as measured by a vacuum gage.

9.7 *Selection of Wheels*—The abrasive wheels are manufactured in different grades and selection of which wheel type to use must be agreed upon by the interested parties. A wheel selection guide is presented in Appendix A to help with this selection process.

10. Standardization of Abrading Wheels

10.1 *Preparation of resilient abrading wheels*—To ensure that the abrading function of the wheels is maintained at a constant level; prepare the resilient wheels following 10.1.1-10.1.4

10.1.1 Mount the selected resilient wheels on their respective flange holders, taking care not to handle them by their abrasive surfaces. Adjust the load on the wheels to the load agreed upon between the interested parties.

10.1.2 Mount the resurfacing disc (S-11) on the turntable and affix using the clamp plate and nut, and clamp ring. Lower the abrading heads carefully until the wheels rest on the resurfacing disc. Place the vacuum pick-up nozzle in position and adjust it to a distance of 7 ±1 mm above the surface of the disc.

10.1.3 Set the counter to 'zero' and adjust the vacuum suction force to 100.

10.1.4 If the vacuum system does not turn on automatically at the start of the test, start the vacuum suction and then the turntable. Resurface the wheels by running them for the appropriate number of cycles against the resurfacing disc as shown in Table 1. Each resurfacing disc is good for one 25 or 50 cycle resurfacing operation, after which it must be discarded.

NOTE 2—*New Set of Wheels (break-in procedure)* - The composition of resilient wheels can make them subject to slight changes of form. Before placing in service a new set of resilient wheels they must be subjected to two (2) resurfacings of 50 cycles to ensure perfect contact of the abrading faces with the specimen surface. The resurfacing disc is used only once (maximum of 50 cycles), therefore this initial resurfacing of new wheels will require two (2) resurfacing discs.

NOTE 3—*Starting a test with previously used wheels* – Before testing a specimen with previously used wheels, resurface 25 or 50 cycles on a new resurfacing disc. When the previous test was short in duration (<1,000 cycles), resurfacing of 25 cycles is sufficient. When the previous test was 1,000 cycles or more, a resurfacing of 50 cycles is recommended. Wheels that have not been used for an extended period of time may require a break-in resurfacing like a new set of wheels.

NOTE 4—*Resurfacing during testing* - To maintain consistency and avoid clogging of wheel faces, the wheels may need to be resurfaced periodically during the test. Remove the specimen and resurface the wheels for 25 or 50 cycles with a new resurfacing disc. The sample should be carefully replaced on the specimen holder after resurfacing of the wheels. To prevent the integrity of the test from being jeopardized when removing and replacing the sample, specimens may be affixed to a mounting card (see Note 5).

10.2 *Preparation of vitrified abrading wheels* – Vitrified wheels do not require refacing unless the abrading surface becomes clogged, chipped or out of round. A wheel refacer should be used to correct any of these conditions.

11. Conditioning

1~~0~~1.1 Condition the test specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles in accordance with Practice D 1776 or, if applicable, in the specified atmosphere in which the testing is to be performed.

TABLE 1 Preparation of Abrasive Wheels

Wheel Status	Resurfacing Cycles
New	2 resurfacings of 50 cycles
Used (previous test < 1 000 cycles)	25 or 50 cycles
Used (previous test > 1 000 cycles)	50 cycles
During Test (after every 1 000 cycles)	25 or 50 cycles