Designation: F1478 – 17

Standard Test Method for Determination of Abrasion Resistance of Images Produced from Copiers and Printers (Taber Method)[1]

This standard is issued under the fixed designation F1478; 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 a procedure for determining the amount of image abraded from the surface of a document.

1.2 This test method may be used to evaluate the abrasion resistance of images produced by business imaging products, including nonimpact printers, thermal transfer printers, and copiers. The machine shall be capable of producing the specified image.

1.3 Testing focuses on determining the amount of imaged material removed, resulting from forces which impart a rubbing or grinding action principally on the top surface of the image.

1.4 Comparison may be made between various imaging devices or the image-producing components of an individual machine.

1.5 Other test methods employing the Crockmeter and Sutherland Rub Tester may be used to evaluate the smudge and abrasion characteristics. Results by these test methods are not necessarily equivalent to those obtained by this test method.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *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.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F335 Terminology Relating to Electrostatic Copying

F1319 Test Method for Determination of Abrasion and Smudge Resistance of Images Produced from Business Copy Products (Crockmeter Method)

F1571 Test Method for Determination of Abrasion and Smudge Resistance of Images Produced from Business Copy Products (Sutherland Method) (Withdrawn 2017)[3]

F2497 Practice for Abrasion and Scuff Resistance of Inkjet Media by the Sutherland Rub Tester

G195 Guide for Conducting Wear Tests Using a Rotary Platform Abraser

2.2 *ISO Standards:*[4]

ISO 5-3 Photography and graphic technology – Density measurements – Part 3: Spectral conditions

ISO 5-4 Photography and graphic technology – Density measurements – Part 4: Geometric conditions for reflection density

2.3 *ASTM Adjunct:*

Abrasion Test Target[5]

3. Terminology

3.1 *Definitions*—General definitions related to electrostatic copying may be found in Terminology F335.

3.1.1 *abrasion resistance*—the ability of an image to withstand the frictional forces attempting to remove the surface material.

3.1.2 *smudge*—the tendency of an image to smear or streak onto the adjacent area when rubbed, involving the redeposition of abraded material.

[1] This test method is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.04 on Electrostatic Imaging Products.

Current edition approved Aug. 1, 2017. Published August 2017. Originally approved in 1995. Last previous edition approved in 2011 as F1478–06 (2011). DOI: 10.1520/F1478-17.

[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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from ASTM International Headquarters. Order Adjunct No. ADJF1478.

***A Summary of Changes section appears at the end of this standard**

3.1.3 *smudge resistance*—the ability of an image to withstand smudging.

4. Summary of Test Method

4.1 Test specimens are generated of an image described in this test method. Suitable hard copy Abrasion Test Targets for use in copiers are available from ASTM. Abrasion test targets may be converted into digital files for use in computer printers. The specimens are abraded with a specified instrument and evaluated by visual comparison or reflectance measurements, or both.

5. Significance and Use

5.1 The degree of image abraded from a copy or printed image may be affected by various factors, including the type of machine, condition of the machine, supplies employed, time since imaging, and environmental conditions. As many as possible of these variables should be controlled during the test. If available, a control sample with known characteristics should be run along with the test samples.

5.2 This test method may be used to determine image resistance to damage or deterioration as a result of exposure to abrasive forces, such as automated document handling devices.

5.3 This test method may be used for control of product quality, comparative analysis of machines, comparative analysis of imaging components, as well as a research and development tool.

5.4 This test method is adaptable to images produced from most nonimpact printers and copiers. The printers shall be capable of utilizing the available program to produce the specified image.

5.5 If the user wishes to simulate the type of damage or smudge resulting from paper rubbing against the printed image or from normal handling, consideration should be given to using either the Crockmeter Method (Test Method F1319) or the Sutherland Rub Method (Test Method F1571 or Practice F2497).

6. Interferences

6.1 The degree of image fixing is an integral factor in the resistance of the image to damage or deterioration due to abrasion. The image fixing capabilities of copiers and printers may be significantly influenced by the choice of supplies. To obtain an accurate representation of the capabilities of any given machine, the manufacturer's recommendations for toner, fusers, fuser oils, other imaging supplies, and paper should be followed.

6.2 Due to the temperature cycling of some copier and printer fuser systems, the degree of image fixing may vary as a function of the length of time the machine has been turned on or as a function of the number of copies or prints in a given run.

NOTE 1—For example, the degree of image fixing may be different for the first few copies made right after the machine is turned on than it will be for the copies made several hours later. Also, the fiftieth copy of a run may have a different degree of fixing than the second or third copy of that same run.

6.3 Unusual environmental conditions, such as extremes of temperature and humidity may affect both the degree of image fixing and the copy quality. For this reason, it is recommended that the environmental conditions be noted when conducting comparison tests between machines or supplies. For the most accurate comparisons, the environment should be kept as constant as reasonably possible during the entire test.

7. Apparatus and Materials

7.1 *Abrasion Tester*—Taber Abraser,[6] or equivalent, as described in Guide G195 and consisting of the following elements:

7.1.1 A horizontal turntable platform comprised of a rubber pad, clamp plate, clamping ring, and nut to secure the specimen to the turntable.

7.1.2 A motor capable of rotating the turntable platform at a speed of either 72 ± 2 r/min for 110 v/60 Hz or 60 ± 2 r/min for 230 v/50 Hz.

7.1.3 A pair of pivoted arms to which the abrasive wheels and auxiliary masses may be attached.

NOTE 2—Without auxiliary masses or counterweights, each arm will apply a load against the specimen of 250 g per wheel (exclusive of the mass of the wheel itself).

7.1.4 A vacuum suction system and vacuum pick-up nozzle to remove debris and abrasive particles from the specimen surface during testing. The height of the vacuum pickup nozzle shall be adjustable, and the nozzle openings shall be 8 mm in diameter. The vacuum system shall operate when testing commences.

7.1.5 A counter to record the number of cycles (revolutions) made by the turntable platform.

7.2 *Abrasion Wheels*—Taber Calibrase CS-10F abrasion wheels,[6] which are attached to the free end of the pivoted arms and are able to rotate freely about horizontal spindles. 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.

7.3 *Auxiliary Weights*—can be attached to the pivoted arms to increase or decrease the force at which the wheel is pressed against the specimen, exclusive of the mass of the wheel itself. Accessory weight references are per arm (not combined), and include the mass of the pivoted arm. For the purpose of this test, the auxiliary weights marked 500 g shall be used.

7.4 *Silicon Carbide Paper*—150 grit silicon carbide coated abrasive cut into approximately 102 mm discs with a 7 mm hole punched in the center to fit specimen holder (Taber S-11 Abrasive Disc,[6] or equivalent).

7.5 *Taber Diamond Wheel Refacer.* [6]

7.6 *Compressed Air Source*—240 to 413 KPa.

7.7 *Test Copier or Printer,* adjusted and equipped with appropriate toner, fuser oil, paper, and other supplies as

[6] The sole source of supply of the apparatus known to the committee at this time is Taber Industries, 455 Bryant St., North Towanda, NY 14120. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

required. If a copier or printer is to be used to evaluate a supply item, all other supply items should be unchanged during the duration of the comparison test.

7.7.1 If comparison tests are being made between copiers or printers, all supply items should be as specified by the manufacturer. Unless otherwise specified by the manufacturer, the same paper should be used in each of the machines.

7.8 *Abrasion Test Target*—A printed Abrasion Test Target is available as an ASTM adjunct. Fig. 1 shows a printed example of the target.

7.9 *Reflectometer*—An instrument for the measurement of reflection density meeting the geometric conditions for reflection density specified in ISO 5-4, the spectral conditions specified in ISO 5-3, and having an aperture diameter of 10 mm.

NOTE 3—An aperature of 10 mm will cover the entire area of the test spot. If an instrument with a smaller aperature is used, several readings shall be taken and averaged to obtain the reflectance of the spot.

7.9.1 Measurement should be reported as percent reflectance. If the instrument reads in optical density, convert the values to reflectance, as follows:

$$R,\ \%\ (\text{reflectance}) = \frac{1}{10^{D(\text{density})}} \times 100 \qquad (1)$$

A scientific calculator may be used to aid in this conversion.

8. Preparation of Apparatus

8.1 *Copier or Printer*—Ensure that the test copiers or printers, or both, have been properly adjusted following the manufacturer's instructions. Ensure that an adequate amount of all supplies needed for operation conforms with the manufacturer's specifications and is in a quantity adequate to complete the test without replenishment. If replenishment is necessary, make certain that it is from the same lot.

8.2 *Reflectometer*—Warm the instrument up and calibrate it in accordance with the manufacturer's recommendations. Check calibration frequently while making measurements.

8.3 *Abrasion Tester:*

8.3.1 Prepare abrasive wheels by conducting two independent dressings of 50 cycles each on a 150-grit abrasive disc, discarding the used abrasive disc after each dressing operation. If a thin film of material develops on the edge of the wheels during dressing, it may be removed by gently rubbing with a finger while rotating the wheels by hand on their spindles. Avoid touching the abrading surfaces of the wheels.

8.3.2 Place the 500-g auxiliary weights onto the pivoted arms.

8.3.3 Attach the vacuum source to the abrader and set the vacuum level to 100 % to allow for effective particle removal without lifting or damaging the specimens. Set the vacuum nozzle height to 3 mm above the specimen surface.

8.3.4 Blow particles off from wheels after abrasion of each specimen.

8.3.5 Dress wheels 50 cycles with a new 150-grit abrasive disc after every four specimens.

NOTE 4—Discoloration of the abrasive wheels with image material does not necessarily indicate dirty or ineffective wheels.

8.3.6 Should either wheel become out-of-round, it will be necessary to simultaneously reface both wheels using the diamond wheel refacer. Out-of-round wheels are indicated by a slight up and down motion of the pivoted arms as the wheels rotate on the specimen. Refacing must continue until both wheels are again round.

NOTE 5—Observe the wheel manufacturer's recommendations with respect to minimum wheel diameter and maximum shelf life. Store wheels in their original protective case when not in use.

8.3.7 After wheels have been refaced with the diamond wheel refacer, it is necessary to dress them once using 50 cycles on a new 150-grit abrasive disc.

9. Procedure

9.1 This test method may be used to either make a comparative evaluation between two or more printers or copiers or to evaluate a supply item for a printer or copier. When evaluating a supply item, a single copier or printer shall be used and all other supply items shall remain constant. In any event, the procedure for sample generation and selection, abrasion testing, and evaluation is the same.

9.2 *Sample Generation and Selection:*

9.2.1 Turn the copier or printer on for 30 min and ensure that the machine has been idle in "standby" mode for at least five continuous minutes immediately before the test has begun.

9.2.2 Generate test copies or prints using a suitable abrasion test target in the case of a copier, or computer program in the case of a printer.

9.2.3 Run the copier or printer in continuous mode for 2 min to ensure a representation of the varying degrees of toner fixing that may occur within a given system. Save all copies or prints. Maintain them in the sequence in which they were generated.

9.2.4 For machines rated at less than 40 copies per minute, select sample sets of three consecutive sheets from the beginning, middle, and end of the run. For machines rated at 40 or more copies per minute, select sample sets of three consecutive sheets from the beginning, one third, two thirds, and end of run.

9.3 *Abrasion Testing:*

9.3.1 Cut out the test specimens from two of the three sheets of the sample sets in such a manner that the test patterns may be abraded when the specimens are mounted on the abraser specimen holder. Specimens should be cut into approximately 105 mm diameter circles with a 7 mm center hole.

9.3.2 Place a white calibration tile on the back side of the specimen, and using the reflection densitometer, measure the percent reflectance reading of each of the test spots. The reflection density may be recorded in pencil on the inner edge of each spot. Indicate which spot was the top position as it was generated.

9.3.3 Mount one of the specimens on the turnable platform securing it with the clamp plate, nut, and clamping ring. Be careful not to crease or wrinkle the specimen when mounting.

9.3.4 Carefully lower abraser arms and vacuum nozzle. Abrade the specimen for 20 cycles (revolutions) ensuring the vacuum starts when testing commences.

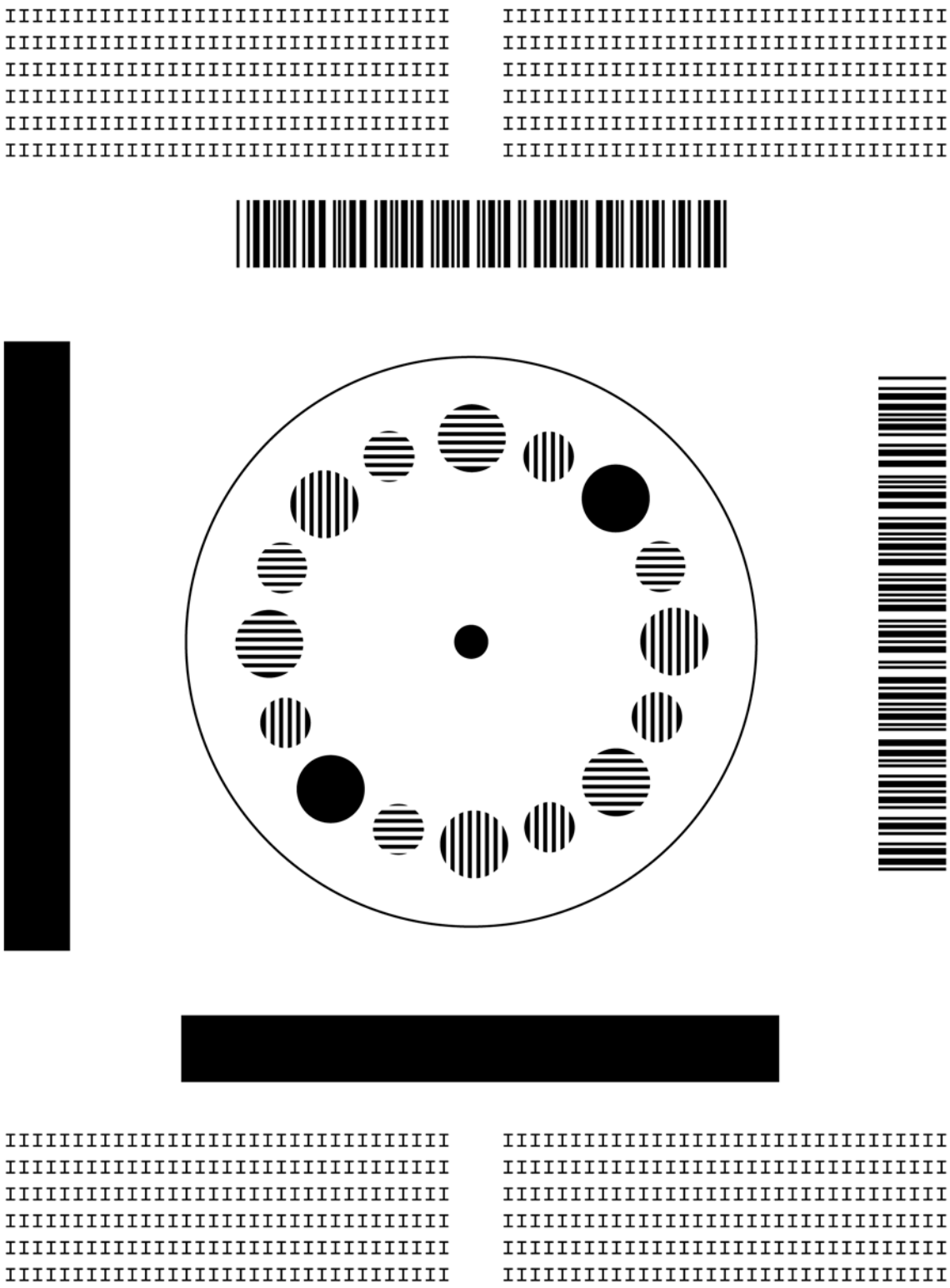

FIG. 1 Abrasion Test Target

9.3.5 At the conclusion of each test, remove the specimen, taking care not to touch the abrasion area. Blow loose material off from the specimen and abrasion wheels with compressed air.

9.3.6 Measure reflectance of each of the test patterns on the specimen. The values may be penciled on the specimen adjacent to the initial reflection density values.

9.3.7 Repeat the abrasion and reflectance measurements for any remaining specimens.

9.3.8 Calculate abrasion resistance index. This number is a dimensionless index number which may be used to generate comparative ranking between test samples. The larger the abrasion resistance index number, the greater the resistance of the test image to degradation caused by abrasive forces.

$$A_I = 100 - (2[R_f - R_i]) \quad (2)$$

where:

A_I = abrasion resistance index,
R_i = initial reflectance prior to abrasion, and
R_f = final reflectance after abrasion.

10. Evaluation of Results

10.1 A ranking order or comparison with control sample shall be established by a combination of the abrasion resistance index and a visual comparison, or by visual comparison if a suitable instrument (7.9) is not available.

10.2 When making the visual comparison, the two abraded test specimens, along with the unabraded specimen shall constitute a set for visual comparison purposes. The visual comparison shall incorporate observation of image removal, image smudge, which is movement of the imaging material into the open spaces between the lines of the image, and paper surface degradation. The non-abraded specimen shall be compared with the abraded specimens to give an observation of the degree of difference caused by abrasion.

10.3 The ranking order beginning with the least amount of abrasion noted should indicate the order established by visual observation and by abrasion resistance index if used.

11. Precision and Bias

11.1 A consistent ranking order may be established within a laboratory and between laboratories by either reflectance or instrumental means, providing there is sufficient difference in image quality.[7]

11.2 Bias is unknown.

12. Keywords

12.1 abrasion resistance; image permanence; smudge resistance; taber abrasion

[7] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:F05-1008. Contact ASTM Customer Service at service@astm.org.

SUMMARY OF CHANGES

Committee F05 has identified the location of selected changes to this standard since the last issue (F1478-06 (2011)) that may impact the use of this standard.

(1) Changed to SI Units (added 1.6).
(2) Removed reference to Gavarti GA-CAT (company is out of business).
(3) Added ASTM referenced documents for Sutherland rub test to 2.1 and 5.5.
(4) Changed inactive ANSI Standards PH2.17 and PH2.18 to ISO 5-4 and ISO 5-3.
(5) Included detailed information for apparatus (Section 7).
(6) Removed reference to diskette for Printer Test Target (7.12) and sole source supplier (no longer offered).