



Standard Test Method for Abrasion Resistance of Printed Matter by the GA-CAT Comprehensive Abrasion Tester¹

This standard is issued under the fixed designation D 5181; 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.

^{ε1} NOTE—Editorial changes were made throughout in September 1997.

1. Scope

1.1 This test method covers the procedure for determining the abrasion resistance of printed matter using a GA-CAT Comprehensive Abrasion Tester.

1.2 This test method is applicable to packaging labels, book, catalog, and magazine covers, bar codes, corrugated boxes, and other containers having applied graphics on any flat substrate.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

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:

E 171 Specification for Standard Atmospheres for Conditioning and Testing Flexible Barrier Materials²

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *abrasion resistance*—resistance against the act of scraping, smudging, or rubbing off.

3.1.2 *abrasiveness*—the degree to which a product tends to cause abrasion by the act of rubbing or scraping.

3.1.3 *receptor*—film or paper of standard abrasiveness onto which material removed from the specimen is deposited during the abrasion testing process. Alternatively, printed paper from which material is removed onto the specimen that has a higher degree of abrasiveness than the receptor (in case of testing abrasiveness).

4. Summary of Test Method

4.1 The test print and a receptor are sandwiched in the panel holder of the GA-CAT Comprehensive Abrasion Tester,

clamped together with a known force, and made to slide over each other at a known frequency and over a known distance for a predetermined time period.

4.2 The test specimen is examined for degree of print degradation and the receptor for amount of ink or other material transferred from the specimen surface. Results may be rated relative to a comparative control run in the identical manner, or they may be quantified by comparison to a ranking scale numbered from zero to ten (zero being the most abrasion resistant and ten the least abrasion resistant).

5. Significance and Use

5.1 Abrasion resistance during transport and storage is essential to prevent marring of type matter, designs, or protective coatings on the exterior of labels and other printed materials. Recognizing that the actual amount of abrasion occurring in the field depends on relative humidity, temperature, tightness of packing, and a host of other variables, this test method provides a rapid means for comparing the abrasion resistance of test surfaces under laboratory conditions. It is useful for specification acceptance between the supplier and the customer.

5.2 This test method can also be used to evaluate the relative abrasion resistance of printed inks, varnishes, laminates and substrates, and the abrasiveness of inks.

6. Apparatus

6.1 *GA-CAT Comprehensive Abrasion Tester*.³

6.2 *Ranking Book*,³ containing specimens whose degree of ruboff is ranked from 0 (no ruboff) to + 10 (most ruboff).

7. Materials

7.1 *Standard Receptors*, approximately 4 by 4½ in. (102 by 114 mm), of an appropriate grade, as follows:

7.1.1 *C-1³ (least abrasive)*—Glossy coated paper suitable for use with samples of low abrasion resistance.

7.1.2 *A-1, A-3, and A-4 (intermediate abrasiveness)*—

¹ This test method is under the jurisdiction of ASTM Committee D-1 on Paints and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.56 on Printing Inks.

Current edition approved Oct. 15, 1991. Published December 1991.

² *Annual Book of ASTM Standards*, Vol 15.09.

³ The sole source of supply of the apparatus known to the committee at this time is Gavarti Assoc., Ltd., 9240 N. Sleepy Hollow Lane, Milwaukee, WI 53217. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

Imperial lapping film with aluminum oxide abrasive particles of different sizes (9, 12, and 30 μm, respectively).

7.1.3 *A-6 (most abrasive)*, wet or dry, tri-um-ite 600.

7.1.4 *B-2³ (intermediate abrasion resistance)*—Printed single color paper suitable for measuring abrasiveness of samples of average abrasiveness (corrugated).

NOTE 1—Other receptors may be substituted provided they have equal abrasiveness on the same test specimens. Further research and experience may indicate a need for additional grades of standard receptors.

7.2 *Foam Sheeting*, ³ 2 pieces, each approximately 2 mm in thickness and cut to 4 by 4½ in. (102 by 114 mm).

NOTE 2—Use of foam sheeting as a backing for the test specimen and the receptor is recommended to provide uniform pressure over the test surfaces and to prevent ink, varnish, or other particles from becoming imbedded in the sensitive surface of the panel holders.

7.3 *Comparative Control*, a production or laboratory print preferably having known abrasion resistance. The comparative control must have the same substrate, color(s), and subject matter as the test print.

8. Test Specimen and Conditioning

8.1 The specimen size in the grain direction (or flute in the case of corrugated board) must not exceed 4½ in. (114 mm). The specimen size in the cross-grain direction is less critical; 4 in. (102 mm) is recommended. Care should be taken to avoid contaminating the test surface with fingerprints during specimen cutting and handling.

8.2 Condition the specimens at 73.5 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity in accordance with Specification E 171.

9. Preparation of Apparatus

9.1 Set the abrasion tester on a sturdy bench, preferably in a room conditioned at the temperature and relative humidity prescribed in 8.2. Make sure that the three-prong power cord is correctly connected.

9.2 Periodically, check the liquid level in the hydraulic pressure system. If not full, follow the instructions in the manufacturer’s manual.

9.3 If test conditions have not been specified, select an appropriate receptor by running the reference standard for the length of time required to achieve a visible level of degradation. Start with receptor C-1 (7.1.1). If the test time exceeds 2 min, use a receptor with a higher level of abrasiveness.

NOTE 3—Excessively long rubbing times are to be avoided because they introduce uncontrollable heat development that can alter the results.

10. Procedure for Abrasion Testing

10.1 *Loading the Instrument:*

10.1.1 Move the tray containing the four panel holders to the front black support shelf. Make sure that the inscribed “L” appears on the upper left side of the left panel holder and the “R” in the upper right side of the right panel holder (see Fig. 1). There should be space of at least ½ in. between the two center panel holders.

10.1.2 Face the test specimen on the receptor (selected in 9.3) and sandwich between the foam sheets. Place the sandwich between the two center panel holders so that the grain

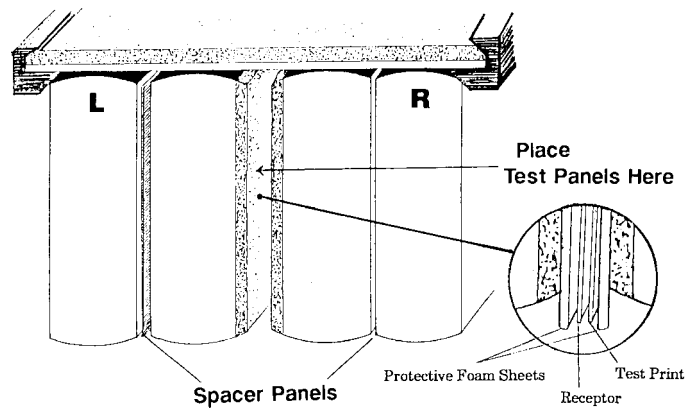


FIG. 1 Panel Holders

direction of the specimen is vertical. Take care that the sandwich does not extend below the bottom of the panel holders.

10.1.3 Push the four panel holders together into an upright parallel position. Make sure that the sandwich is not pinched at the bottom of the panel holders; otherwise, it will tend to slide down during the test. Grab the pins and move the tray inside the instrument so that the two retaining pins drop into the carriage holes. If the pins do not drop into their respective holes, recenter the panel holders on the sample tray.

10.1.4 Apply side pressure by turning the lower black spindle until the corresponding dial reads 20 pounds per square inch (psi). Do not apply top pressure at this time.

10.1.5 The carriage inside the instrument is meant to move between two limit switches (used for centering) approximately 2 in. (50.8 mm) apart. If the carriage is not situated between these limits, manually center the carriage.

10.2 *Testing Under the Preset Mode:*

10.2.1 Turn the power switch on by pressing the upper side of the flip switch at the right side of the instrument.

10.2.2 After the control box window (LCD) displays “GA-CAT ready,” press CNTR; the LCD will read “check limits” to make sure the carriage is within the range of the limit switches. Press CNTR again and the LCD will read “release top pressure.” Press CNTR once more and the carriage will move to the extreme right (limit switch) and then back to stop exactly in the center. At this point, the LCD will show that the carriage has been centered by showing a flashing square after “GA-CAT READY.”

10.2.3 After the instrument is centered, apply the top pressure of 40 psi.

10.2.4 Push the “STRT” button. The LCD will read “computing” and after 3 s, the instrument will run under the following default values:

Time	5.0 s
Frequency	2.0 Hz
Span	1.0 in.
Offset	0.0 in.

10.2.5 When the instrument stops, release the top pressure, making sure that the top pressure plate is high enough to clear the panel holders. Push CNTR to re-center the carriage. Release the side pressure and pull the panel holders out of the carriage. Remove the sandwich and examine the test specimen and the receptor.

10.2.6 To continue running the test with the same settings, reload the instrument as in 10.1, apply the top pressure as in 10.2.3, and push STRT. When the instrument stops, follow the procedure in 10.2.5. Turn the switch off only at the conclusion of testing.

10.3 Changing the Default Values:

10.3.1 The default values may be changed to any of the following settings:

Time	Continuous from 1 to 3600 s
Frequency	0.2 to 3.0 Hz (cycles per s) with a resolution of 0.1 Hz
Span	0.1 to 1.9 in. with a resolution of 0.1 in.
Offset	0.1 to 0.4 in. (increments of 0.1 in.)

10.3.2 In order to change a setting, press the “mode” button until the LCD displays the default value to be altered. Enter the new value on the number buttons and then press “enter.” The LCD will read “new value?”. If the value is correct, press “enter” a second time. If incorrect, enter another value or press “clear” and start over again.

NOTE 4—The instrument reverts to the original default values by pressing “reset” and any time the instrument is turned off.

10.3.3 When running thick samples such as corrugated material, follow the procedure in 10.1 through 10.2.1. If the center of the panel holders is not aligned with the center mark of the carriage, use the “offset” mode. Press the “mode” button until “offset” appears and then enter the new setting. A setting of 0.1 or 0.2 is recommended. An additional adjustment for overall width of the panel holders may also be necessary by removing one or two black separators.

10.3.4 Proceed further as in 10.2.2 until 10.2.6.

11. Interpretation of Results

11.1 Run the test material and the comparative control in the identical manner. Examine each print for degree of degradation

and each receptor for amount of material transferred from the print. Report results for abrasion relative to the comparative control as equal, slightly or appreciably less, or slightly or appreciably greater.

11.2 A numerical record of degree of abrasion ranging from zero to ten can be obtained from a comparison of the test specimen with examples in the Ranking Book (6.2).

12. Precision and Bias

12.1 *Precision*—An interlaboratory study of this test method was conducted in which operators in 17 laboratories tested six prints in triplicate on each of two days. The prints consisted of three density levels of two different colors and were ranked for abrasion resistance from 1.0 to 4.0. The within-laboratory pooled standard deviation was 0.54 at 15 df and the between-laboratories pooled standard deviation was 0.58 at 18 df. Based on statistical analysis of the results, the following criteria should be used for judging the acceptability of results at the 95 % confidence level:

12.1.1 *Repeatability*—Two results, each the mean of two determinations obtained by the same operator on different days, should be considered suspect if they differ by more than 1.5 ranking units.

12.1.2 *Reproducibility*—Two results, each the mean of results obtained on different days by operators in different laboratories, should be considered suspect if they differ by more than 2.2 ranking units.

12.2 *Bias*—Bias cannot be determined as there are no standard materials.

13. Keywords

13.1 abrasion; abrasiveness; printed matter; printing inks; smudging

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 100 Barr Harbor Drive, West Conshohocken, PA 19428.