



Standard Test Method for Curl of Carbonless Copy Papers¹

This standard is issued under the fixed designation F556; 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 curl of carbonless copy papers, that is, the degree of curvature of a sheet of these papers when exposed to varying conditions of humidity.

1.2 This test method may be used for manufacturing control, development, and research.

1.3 *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:*²

[D585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product \(Withdrawn 2010\)](#)³

[D685 Practice for Conditioning Paper and Paper Products for Testing](#)

[E104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions](#)

[F221 Terminology Relating to Carbon Paper and Inked Ribbon Products and Images Made Therefrom](#)

[F549 Terminology Relating to Carbonless Copy Products](#)

2.2 *TAPPI Standard:*

[TIS 0808 Equilibrium Relative Humidities over Saturated Salt Solutions](#)⁴

¹ This test method is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.06 on Carbonless and Thermal Imaging Products.

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

⁴ Available from Technical Association of the Pulp and Paper Industry (TAPPI), P.O. Box 105113, Atlanta, GA 30348; 15 Technology Parkway South, Norcross, GA 30092.

3. Definitions

3.1 For the definitions of terms *curl* and *carbonless copy paper*, refer to Terminology [F221](#) and [F549](#), respectively.

4. Summary of Test Method

4.1 Sheets of carbonless copy paper are placed on a flat surface under different conditions of humidity and with a controlled temperature. The amount of curl is expressed as height above a flat surface attained by the edge of a carbonless copy paper sheet.

5. Significance and Use

5.1 This test method is intended to measure the amount of curl of a carbonless copy paper sheet relative to the flat surface supporting the sample. The test is useful as a quality control method and for predicting field performance.

6. Interferences

6.1 Test results may be subject to change depending on the previous handling of the samples. The samples should be kept smooth and flat, preferably in closed plastic bags. Exposure of the sample to moisture from hands, contact with liquids, or extremes of temperature or humidities above 58 % relative humidity may alter the samples' curl characteristics.

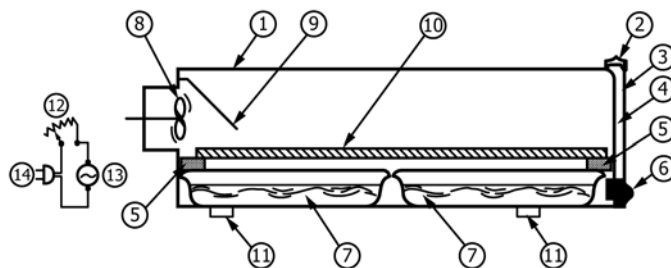
7. Apparatus

7.1 *Template*—6-in. (152-mm) square metal.

7.2 *Sharp Knife*.

7.3 *Rule*, 6-in. (or an equivalent metric rule 150 mm)—The rule shall be graduated either in inches with 0.1-in. subdivisions or in centimetres with 1-mm subdivisions, and the zero mark must be at the edge of the rule. Also, the width of the rule should be a minimum of 1/2 in. (12.7 mm) to facilitate supporting the rule in an upright perpendicular position relative to the flat supporting surface.

7.4 *Conditioning Cabinets*—(see [Fig. 1](#).) Humidity cabinets, electric with positive uniform air circulation, capable of maintaining the relative humidity and temperature ranges specified. The cabinets should be free of any hygroscopic materials such as wood, fabric, paper, and so forth; sealed from external moisture and either insulated from external temperature changes or used in a room maintained at constant



- 1—Poly(methylmethacrylate) (PMMA) chamber: 14 in. wide by 8 in. high by 26 in. long (356 by 203 by 660 mm)
- 2—Hinge
- 3—Soft rubber gasket
- 4—PMMA door
- 5—PMMA bar on each side of chamber to support shelf
- 6—Rotary-type window pull catches
- 7—Glass trays containing saturated salt solution
- 8—Fan connected to motor
- 9—Air deflector sheet
- 10—Shelf, perforated
- 11—Chamber support bars
- 12—Rheostat
- 13—Motor
- 14—Electrical connection, 115 V, 60 Hz

FIG. 1 Side View of Curl Test Chamber

temperature. The cabinets should be small, constructed with transparent sides, 14 in. wide by 8 in. high by 26 in. long (metric units 356 by 203 by 660 mm). The front shall overlap the sides and be hinged to serve as the door. An inverted 6-in. (152-mm) rule can be supported on each wall of the conditioning cabinet to facilitate testing. The zero mark of the rule shall coincide with the top of the shelving upon which the sample is placed. A glass tray holding a saturated salt solution shall be placed on the bottom of the conditioning cabinet and below the shelving which is perforated to assist circulation.

7.5 *Hygrometer*—Accurate to $\pm 1\%$ relative humidity over a range of 20 to 80 % relative humidity. Size should be appropriate so that it will fit within a conditioning cabinet. Electronic sensing units may be substituted. The accuracy of the humidity measuring unit should be periodically checked.

7.6 *Shelving*—Flat wire screens or similar shelving, sufficiently rigid to hold its flatness, to fit inside the conditioning cabinets, approximately 3 in. (76 mm) above the bottom of the cabinets. They shall be so constructed as to allow uniform air circulation.

8. Reagents

8.1 *Reagents for maintaining appropriate relative humidities*—Saturated solutions of:

Reagent	Relative Humidity, %	Temperature °F (°C)
Potassium acetate, $KC_2H_3O_2$	22.9	73 (23)
Potassium acetate, $KC_2H_3O_2$	20.4	100 (38)
Magnesium nitrate, $Mg(NO_3)_2 \cdot 6H_2O$	53.5	73 (23)
Magnesium nitrate, $Mg(NO_3)_2 \cdot 6H_2O$	49.0	100 (38)
Sodium chloride, NaCl	75.5	73 (23)

A saturated salt solution is one in which the dissolved salt is in equilibrium with undissolved material of the same composition. Therefore, in order to be certain that saturation exists, there should always be some solid visible in the same tray that

contains the saturated solution. Distilled water should be used in making up the salt solution.

8.2 The temperature at which the salt solutions are maintained governs the humidity level. These salt solutions have been chosen because over the range from 73 to 100°F (23 to 38°C), the relative humidity variation is small. It is intended for this test to be performed at the 73°F (23°C) level. Refer to Practice E104 or TAPPI TIS 0808 for information on other relative humidity conditions.

9. Sampling

9.1 Sample the carbonless copy paper in accordance with Practice D585.

9.2 Samples shall be kept flat, free from wrinkles and folds. Protect from exposure to direct sunlight, liquids, varying humidity conditions, and any other harmful influences. Storage of the samples in closed plastic bags is recommended. Handle the sample by the edges only.

10. Test Specimens

10.1 From each test unit of the sample, take a flat strip 8 or 10 in. (203 or 254 mm) wide across the web of the paper.

10.2 Using the template and knife, cut 6-in. (152-mm) square specimens and mark the grain direction of each with a soft pencil on the top side.

11. Conditioning

11.1 Condition the carbonless copy paper sheets in accordance with Method D685.

11.2 The recommended test conditions are three levels of relative humidity (22.9 ± 2.1 ; 53.5 ± 2.0 ; and $75.5 \pm 2.0\%$) at a temperature of $73 \pm 3.5^\circ F$ ($23 \pm 2^\circ C$) and an exposure

time of 2 h for the coated front (CF), the coated front and back (CFB), and the coated back (CB) carbonless copy papers.

12. Procedure

12.1 Check that the relative humidity value in the cabinet is near the value expected before placing samples in the cabinet. Also check that undissolved salt is visible in the lower tray.

12.2 Place three separate test specimens top or face side up and three separate test specimens top or face side down in the conditioning cabinets. Repeat this procedure for each test condition specified.

12.3 At the end of the exposure time, visually inspect the three pairs of samples. Record which samples have curled, for example, the sheets positioned face up or the sheets positioned face down, or both. Record the relative humidity, temperature, and time duration of conditioning.

12.4 Without removing the sheets from the cabinet, quickly measure and record the height of the curled-up edge of the curled sheets. Record the class of curl as 0, ¼, ½, I, II, III, IV, or tube curl, described as follows:

12.4.1 *Class 0*—No curl by visual inspection. Paper will be flat.

12.4.2 *Class ¼*—Curl greater than Class 0 where any edge or corner of the paper measures not more than ¼ in. (6.3 mm) above a flat surface.

12.4.3 *Class ½*—Curl greater than Class ¼ where any edge or corner of the paper measures more than ¼ in. but not more than ½ in. (12.7 mm) above a flat surface.

12.4.4 *Class I*—Curl greater than Class ½ where any edge or corner of the paper measures more than ½ in. but not more than 1 in. (25.4 mm) above a flat surface.

12.4.5 *Class II*—Curl includes any edge or corner of the paper greater than Class I but equal to or less than the point of intersection of a vertical line tangent to the paper.

12.4.6 *Class III*—Curl includes any edge or corner of the paper greater than Class II but equal to or less than the point of intersection of a horizontal line tangent to the paper.

12.4.7 *Class IV*—Curl includes any edge or corner of the paper greater than Class III but less than a point of actual contact with any other point in the paper.

12.4.8 *Tube Curl*—Curl includes any edge or corner of the paper greater than Class IV.

12.5 Record the direction of the curl and type of curl described as follows:

12.5.1 *Normal Curl*—Direction of curl towards the top or face side of the sample.

12.5.2 *Reverse Curl*—Direction of curl away from top or face side of the sample.

12.5.3 *“Against the Grain” Curl*—Type of curl where the edge of the sample which has lifted is perpendicular to the machine direction of the paper. May also be referred to as tension, roll, or machine direction curl.

12.5.4 *Cross Directional Curl*—A type of curl where the edge that has lifted is parallel to the machine direction of the paper.

12.5.5 *Diagonal Curl*—A type of curl where one corner or two opposite corners of the paper lift.

12.6 Report the curl data of each set of samples indicating the class of curl, the direction (normal or reverse) and type (cross direction, machine direction, or diagonal). In the event one of the samples is much different than the other tests, it may be advisable to repeat this test.

13. Precision and Bias

13.1 Repeatable ranking order is obtained that is reproducible within a laboratory and between laboratories. The test is a comparative test, is subjective, and no quantitative data are intended.

14. Keywords

14.1 carbonless copy paper; carbonless paper; curl; paper curl

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