

Part 2.
TESTING STANDARDS
AND
DEFINITION OF TERMS

TESTING STANDARDS AND DEFINITION OF TERMS

General information: The methods given in this Part of the Standards are required to be used in measuring the characteristics of papers that are specified in Part 1, Specifications. Alpha-numeric citations of methods refer to the methods of the Technical Association of the Pulp and Paper Industry, unless otherwise indicated. Testing laboratories are advised to provide themselves with current editions of all methods. Methods of the Technical Association of the Pulp and Paper Industry (TAPPI) can be obtained from TAPPI, P.O. Box 105113, Atlanta, GA 30348 (www.tappi.org). Methods of the American Society for Testing and Materials (ASTM) can be obtained from the Society, 100 Barr Harbor Drive, West Conshohocken, PA 19428 (www.astm.org). Sources of other methods are given in the text.

Paper suppliers are required to make such tests as may be necessary, to ensure the delivery of finished paper fully complies with the applicable specifications and standard samples. When requested by the procuring office, copies of the records developed by the paper supplier in making such tests shall be furnished. All paper, including paper in the manufacturing process, are subject to inspection as authorized or required by the contracting office.

Abrasion: Use method T-476.

Absolute moisture: Use method T-412.

Acidity (pH): (A) For uncoated papers, unless otherwise stated, use method T-435. For test, weigh a specimen of 1.8 g and add 125 ml of distilled water. (B) For paper coating, use T-435, except prepare the test specimen as follows: Using a razor blade, scrape the coating from an area of 5 paper specimens until a sample weighing 0.12 g is accumulated. Place the sample in a clean beaker, add 50 ml of distilled water, let sit, and soak for one hour. (C) For cold extraction, use method T-509.

Alkaline paper: Paper having a pH value greater than 7; made by an alkaline manufacturing process.

Alpha cellulose: Use method T-429.

ANSI: American National Standards Institute, 11 West 42nd Street, New York, NY 10036 (www.ansi.org).

Basis weight (weight per unit area): See grammage.

BCTMP: Bleached "Chemi-Thermo-Mechanical pulp" (CTMP) is pulp that has been bleached to a higher brightness, e.g. >80%. CTMP is a pulp produced from chemically impregnated wood chips, by means of pressurized refining at high consistency.

Bleached: Papermaking fibers treated chemically in order to whiten, purify, and stabilize the fibers.

Blocking: Use method D-918 of ASTM with the following modifications. Take rectangular specimens 4.5 by 6 cm. Use a top plate and weight such that the total mass is equivalent to 70 g/cm² on the specimens for uncoated paper, and 9 g/cm² for coated paper. Prepare the specimens by soaking in water at 25 ± 5 °C for 15 minutes, taking care that the water has free access to both sides of each specimen, then removing the specimens from the water and shaking each one gently to remove excess water from the surface. After stacking, allow the assembly to dry at 25 ± 5 °C.

Brightness: Use method T-452.

Bursting strength: (A) For papers having bursting strengths not more than 1380 kPa (200 lb/in²), use method T-403. (B) For papers having bursting strengths more than 1380 kPa (200 lb/in²), and for boards, use method T-807. (C) For wet bursting strength, heat the cut specimens in an oven 105 °C for 15 minutes, immediately soak them in water at 23 ± 2 °C for 60 minutes, blot them in accordance with method T-456, and test them at once by method T-403 or T-807, as appropriate.

Calcium carbonate: See filler.

Chemical pulp: Wood chips treated with chemicals to remove impurities such as lignin, resins, and gums. There are two basic types, sulfite and sulfate (kraft), and variations of these. Also see stock.

Chlorine-free: A term used to describe a bleaching technology used in manufacturing pulp and paper. Two terms are often used in connection with a chlorine-free paper. They are "elemental chlorine-free" (ECF) or "totally chlorine-free" (TCF). An ECF paper is made from pulp bleached with chlorine dioxide, but not elemental chlorine; whereas, TCF paper is made from

pulp bleached without using chlorine or chlorine compounds (and this includes the recycled fiber component of the paper).

Cleanliness: See dirt, speck.

Color by visual comparison: Use method T-515. Visual color assessments are made in a light booth with light sources having color temperatures of 5000 and 7500 kelvin. Overall matches are described as "fair plus," "fair," "fair minus," or "unacceptable."

Color by spectral reflectance: Use method T-524 and equations for CIELAB.

Color deviation and variation: Calculate using the CIELAB equations described in TAPPI TIS 0804-04. Measurements are made under the following conditions: Ill D65, 10° observer, and specular component included.

Conditioning for testing: Use method T-402. The atmosphere in the immediate vicinity of the testing machine shall be controlled to the required conditions during testing.

Copper number: Use method T-430.

Cotton fiber paper: Paper containing at least 25 percent or more fibers derived from lint cotton, cotton linters, and cotton or linen cloth cuttings. These papers fall in the broad category of papers containing "recovered material". See recovered material, (2)(ii), below.

Dealing with outlying test determinations: Use method T-1205.

Defects in paper by visual examination: Insofar as practicable, defects in paper which are determined by visual examination shall be classified and defined in accordance with "The Dictionary of Paper", 5th Ed. (1996) published by TAPPI.

Density: Measure the thickness of each specimen in "cm" in accordance with method T-411. Measure the weight per unit area of each specimen, in "g/cm²", in accordance with method T-410. Calculate the density of each specimen in "g/cm³". Report the average density for 5 specimens tested.

Dirt: Use method T-437.

ECF: See chlorine-free.

English equivalent:

Property	To convert from	To	Multiply by
Bursting strength ..	kPa (kilopascal)	lb/in ² (pound per square inch).	0.145
Grammage	g/m ² (grams per square meter).	Pounds (basis weight).	
		Basis size:	
		17 x 22	0.266
		20 x 26	0.370
		22½ x 28½ ...	0.456
		24 x 36	0.615
		25 x 38	0.676
		25½ x 30½ ...	0.553
Tearing strength ...	mN (millinewton)	g (gram)	0.102
Tensile strength	kN/m (kilonewton per meter).	kg/inch (kilogram per inch).	2.549
Temperature	C (Celsius)	F (Fahrenheit)	$t^{\circ}F = 1.8t^{\circ}C + 32$
Thickness	mm (millimeter)	inch	0.0394

Equilibrium relative humidity: Use method T-502.

Erasing quality: The term "erasing quality" shall be construed to mean the retention of good writing and typing quality and appearance of surface after complete erasure using a "hard" eraser for "ink", such as Eberhard Faber® Union 110, Faber Castell Eraser Stik® 7099B, Weldon Roberts No. 38, or equivalent, of ruled lines and written or typed characters. In addition for map paper, texture shall permit redrawing of sharp lines in ink after burnishing.

Executive Order 13101: "Greening the Government through Waste Prevention, Recycling and Federal Acquisition" issued on September 14, 1998, orders Federal agencies and departments to improve the Federal Government's use of recycled products and environmentally preferable products and services. For paper the following section is most relevant:

"Sec. 505. Minimum Content Standard for Printing and Writing Paper. Executive agency heads shall ensure that their agencies meet or exceed the following minimum materials content standards when purchasing or causing the purchase of printintg and writing paper: (a) For high speed copier paper, offset paper,

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forms bond, computer printout paper, carbonless paper, file folders, white wove envelopes, writing and office paper, book paper, cotton fiber paper, and cover stock, the minimum content standard shall be no less than 30 percent postconsumer materials beginning December 31, 1998. If paper containing 30 percent postconsumer material is not reasonably available, does not meet reasonable performance requirements, or is only available at an unreasonable price, then the agency shall purchase paper containing no less than 20 percent postconsumer material. The Steering Committee, in consultation with the AEEs, may revise these levels if necessary.

(b) As an alternative to meeting the standards in sections 505(a), for all printing and writing papers, the minimum content standard shall be no less than 50 percent recovered materials that are a waste material byproduct of a finished product other than a paper or textile product that would otherwise be disposed of in a landfill, as determined by the State in which the facility is located.

(c) Effective January 1, 1999, no executive branch agency shall purchase, sell, or arrange for the purchase of, printing and writing paper that fails to meet the minimum requirements of this section."

Filler: The percent (pct) calcium carbonate in the filler shall be determined as follows:

Method.—Weigh out approximately 1 g of paper to the nearest 1 mg, making a correction for the moisture content (Note 1), and place it in approximately 25 ml of water in a 125 ml Erlenmeyer flask. Pipet 20 ml (Note 2) of standardized 0.1 N HCl into the flask, heat to boiling, and boil for approximately 1 minute. Add 3 drops of aqueous methyl red. Cool to room temperature and titrate to the first lemon yellow with standardized 0.1 N NaOH solution.

If a trace of pink indicator remains adsorbed on the surface of the paper, boil the paper briefly to desorb the pink color. Usually a further drop of NaOH solution will restore the lemon yellow to the solution.

Calculations.—Calculate the carbonate content of the paper as percent calcium carbonate (CaCO₃) as follows:

$$\text{CaCO}_3, \text{ pct} = \frac{[(\text{ml} \times \text{N})_{\text{HCl}} - (\text{ml} \times \text{N})_{\text{NaOH}}] \times 0.050}{g} \times 100$$

where 0.050 is the milliequivalent weight of CaCO₃ and g is the weight of the specimen. Duplicate determinations should agree within 0.3 pct CaCO₃.

Report.—Report the carbonate content as percent CaCO₃ of the oven-dry paper to the nearest 0.1 pct.

Note 1—The specimen for analysis may be dried and weighed, or a separate portion may be used for moisture determination.

Note 2—For a 1 g specimen, 20 ml of 0.1 N HCl is sufficient to neutralize the carbonate in a paper containing about 10 pct carbonate.

Note 3—This is not a direct determination of CaCO₃, but a measure of alkalinity expressed as CaCO₃. Other alkaline materials will affect the determination.

Flap adhesive thickness: Adhesive thickness shall be determined by subtracting the average thickness (T-411) of the ungummed portion of the flap from the average thickness of the gummed portion of the flap.

Fluorescence: See optical brightener.

Folding endurance: Use method T-423 (Schopper) or T-511 (M.I.T.). Report the average of not less than 5 measurements.

Formaldehyde: Use method 111, "Tentative Method of Analysis for Formaldehyde Content of the Atmosphere (Colorimetric Method)" (43502-01-69T), by the Intersociety Committee, *Methods of Air Sampling and Analysis*, American Public Health Association, Washington, D.C., 1972, pp 194-198. Additional information may be obtained from the Association, 1015 15th Street, N.W., Suite 300, Washington, DC 20005 (www.apha.org).

Gloss: Use method T-480 for 75° or T-653 for 20°.

Grain: See machine direction.

Grammage: Use method T-410.

Groundwood pulp: Papermaking fibers produced by mechanical means; does not include bleached chemi-thermo-mechanical pulps (BCTMP), a semi-chemical pulp. Also see stock.

Ink absorbency: Use method T-431.

Light transmission: Use method E-308 of ASTM.

Lignin: The percent (pct) lignin in paper shall be determined spectrophotometrically as follows:

(1) Remove the calcium carbonate filler from a 5 by 5 cm paper sample by placing it in hot (99 °C) 0.1 N HCl until effervescence is complete.

(2) Rinse paper sample with distilled water.

(3) Place sample in 85 °C oven (for a few minutes) until dry.

(4) Trim paper to fit the sample holder of spectrophotometer.

(5) Clamp the paper sample which has been moistened with a drop of tetrachloroethylene between the potassium bromide windows.

(6) Obtain an infrared (IR) spectrum by averaging 50 scans with a Fourier transform infrared spectrometer.

(7) IR spectral data must be expressed in "absorbance" rather than "transmittance". The background spectrum (air blank) should be no more than two hours old.

(8) Calculate lignin using the following equation:

$$\begin{aligned} &\text{pct lignin (of fibrous material)} \\ &= (L/C + 0.033) \times 132.45 \end{aligned}$$

where

L=the integrated area bounded by the IR absorption band and baseline from 1540 cm⁻¹ to 1490 cm⁻¹

C=the integrated area bounded by the IR absorption band and baseline from 3000 cm⁻¹ to 2800 cm⁻¹.

Machine direction: Use method T-409.

Metric Conversion Act: The P.L. 100-418 (The Omnibus Trade and Competitive Act of 1988) section 5164 designates the Metric system of measurement as the preferred system of weights and measures for the United States trade and commerce.

Metric equivalent:

Property	To convert from	To	Multiply by
Basis weight	Pounds	g/m ² (grammage or grams per square meter).	
	Basis size:		
	17 x 22		3.759
	20 x 26		2.704
	22½ x 28½		2.193
	24 x 36		1.627
Bursting strength	25 x 38		1.480
	25½ x 30½		1.808
	lb/in ² (pound per square inch).	kPa (kilopascal)	6.895
Tearing strength	g (gram)	mN (millinewton)	9.807
Tensile strength	kg/inch (kilogram per inch).	kN/m (kilonewton per meter).	0.3923
	F (Fahrenheit)	C (Celsius)	t° c=(t° F-32)/1.8
Thickness	inch	mm (millimeter)	25.40

Mimeograph quality: See No. 9 *Government Paper Specification Standards* for details of this test.

Minimum content standards: The minimum percentage of recovered fiber recommended by the Environmental Protection Agency (EPA) for Federal procurement of paper and paper products and stated in the paper specification standard. This percentage is based on fiber weight. (Paper RMAN II, 63 FR 31214)

NISO: National Information Standards Organization, 4733 Bethesda Avenue, Suite 300, Bethesda, MD 20814. (www.niso.org).

Oil holdout (of coating): Use method T-462, except the end point shall be evaluated at 200 seconds. When viewing from the underside of the paper in the mirror, record the time it takes the oil to penetrate the coating or at 200 seconds: "did the oil penetrate the coating of the paper?" The report shall be the number of seconds it took the oil to penetrate the coating or ">200 s" if the oil does not penetrate the coating at 200 seconds. (Note: The endpoint for this test is not the same as the endpoint for oil penetration T-462.)

Oil penetration: Use method T-462.

Opacity: Use method T-425.

Optical brightener: Use method T-452, appendix C.

Paper Products Recovered Materials Advisory Notice II (Paper RMAN II): EPA guidance issued June 8, 1998 (63 FR 31214) for recovered fiber content in printing and writing paper.

Permanent paper: (A) A paper that can resist chemical and physical changes over an extended time period (several hundred years). This paper is generally acid free, has a fairly high initial strength, and will retain its strength over time.

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(B) The P.L. 101-423, Joint Resolution to Establish a National Policy on Permanent Paper, passed October 1990, states: "It is the policy of the United States that Federal records, books, and publications of enduring value be produced on acid free permanent papers."

Pick resistance: Use method T-459 (wax pick) for uncoated papers. *Note: There is no standardized pick test for coated papers.*

PMU (phosphor meter unit): Specialized equipment for measuring this property available from the U.S. Postal Service.

Porosity: Use method T-460.

Postconsumer fiber: Pulp fiber derived from postconsumer recovered paper.

Postconsumer material: "(1) Paper, paperboard and fibrous wastes from retail stores, office buildings, homes and so forth, after they have passed through their end-usage as a consumer item including: Used corrugated boxes; old newspapers; old magazines; mixed waste paper; tabulating cards and used cordage; and

(2) All paper, paperboard and fibrous wastes that enter and are collected from municipal solid waste." (40 CFR 247.3)

Recovered material: Waste material and by-products that have been recovered or diverted from solid waste, but such term does not include those materials and by-products generated from, and commonly reused within, an original manufacturing process. In the case of paper and paper products, the term "recovered materials" includes:

(1) Postconsumer materials such as:

(i) Paper, paperboard, and fibrous wastes from retail stores, office buildings, homes, and so forth, after they have passed through their end usage as a consumer item, including: Used corrugated boxes, old newspapers, old magazines, mixed waste paper, tabulating cards, and used cordage, and,

(ii) All paper, paperboard, and fibrous wastes that enter and are collected from municipal solid waste; and

(2) Manufacturing, forest residues, and other wastes such as:

(i) Dry paper and paperboard waste generated after completion of the papermaking process (that is, those manufacturing operations up to and including the cutting and trimming of the paper machine reel into smaller rolls or rough sheets) including envelope cuttings, bindery trimmings, and other paper and paperboard waste, resulting from printing, cutting, forming, and other converting operations; bag, box and carton manufacturing wastes; and butt rolls, mill wrappers, and rejected unused stock; and

(ii) Finished paper and paperboard from obsolete inventories of paper and paperboard manufacturers, merchants, wholesalers, dealers, printers, converters, or others;

(iii) Fibrous by-products of harvesting, manufacturing, extractive, or wood-cutting processes, flax, straw, linters, bagasse, slash, and other forest residues;

(iv) Wastes generated by the conversion of goods made from fibrous material (e.g., waste rope from cordage manufacture, textile mill waste, and cuttings); and

(v) Fibers recovered from waste water that otherwise would enter the waste stream." (40 CFR 247.3)

Recovered Materials Advisory Notice (RMAN): EPA guidance regarding certification and verification of the use of recovered fiber in printing and writing papers clarifying section 6002(i)(2)(c) of the Resource Conservation and Recovery Act (RCRA) of 1976.

"Recycled" content paper: This term is not specifically defined in any EPA guidance documents or in the statutes, but has come to mean paper containing any of the recovered material categories of fiber, such as postconsumer or cotton (or equivalent).

Reflectance (brightness) drop: Measure brightness on a marked area of the sheet, using method T-452. Expose the marked area in a water-cooled xenon-arc lamp, continuous Lamp fading apparatus for 48 Standard Fading Hours, using method 16E of the American Association of Textile Chemists and Colorists (One Davis Drive P.O. Box 12215, Research Triangle Park, NC 27709; www.aatcc.org). Recondition the sheet in the standard atmosphere, and again measure the brightness of the marked area. Calculate reflectance drop as the difference between the two brightness results. Report the average reflectance drop of not less than five sheets.

Rosin: See sizing.

Sampling: Sampling shall be conducted in accordance with T-400. Agencies shall specify detailed plans, and criteria for acceptance or rejection, tailored to specific end products, grades, end uses, or other particular conditions. Each agency shall also specify detailed plans for visual examination of lots of paper for properties not included in these Testing Standards. Agencies shall make documents incorporating such plans available to bidders and contractors.

Sizing: (A) For animal glue, use method T-504. (B) For rosin, use method T-408.

Smoothness: Use method T-538.

Speck: A unit of dirt; any foreign matter 0.02 mm² or larger embedded in the sheet which when examined by reflected light has a contrasting color to the rest of the surface. Use method T-537. *Note, in making the visual count, the specks should be visible when the specimen is examined in well lit room at a 45° angle from the normal, 30 to 45 cm (12 to 18 inches) from the surface of the sheet. It is not necessary to lift or rotate the specimen to see the specks.* Also see dirt.

Stiffness: Gurley test—use method T-543. Test specimen size is 64 mm long by 51 mm wide. Taber test—use method T-489.

Stock (fiber analysis): Use method T-401, except for those paper specification standards containing the following language:

"Free from groundwood and/or unbleached pulp," or

"100 percent or the remainder bleached chemical (wood) pulp."

These requirements shall be interpreted to mean that "the paper is essentially free from lignin."

To evaluate for the presence of lignin, use lignin test method above. Alternatively, use TAPPI T-401 and the Graff C-Stain for fiber analysis. A yellow color reaction shall be interpreted to signify the presence of lignin and **shall be sufficient cause for rejection of the paper.** Note, (1) In the case of hardwood pulps, the yellow reaction may be masked by the strong blue kraft reaction and thus give the fibers a greenish appearance. See Appendix H.1.2 of T-401 for specific Color descriptions. (2) Some pulps such as BCTMP also produce a yellow reaction to the Graff C-stain. Should this occur, the paper manufacturer should be contacted for a certification of the composition of the fiber furnish used in the manufacture of the paper. If hardwood BCTMP has been used, the lignin content of the paper shall not exceed 3 percent when measured spectrophotometrically.

TCF: See chlorine-free.

Tearing strength (resistance): Use method T-414.

Tensile strength: Use method T-494. For wet tensile strength, heat the specimens at 105 °C for 15 minutes, then use method T-456. Report time of the immersion.

Thickness: Use method T-411.

Thread count: Use method 5050 of Federal Test Method Standard No. 191 or D 1910 of ASTM.

Unbleached: Paper or pulp not treated with bleaching agents. See stock.

Vegetable-fiber paper: Paper which typically contains a significant amount of "renewable" plant fibers, not wood or cotton fibers.

Wastepaper: The term is obsolete.

Watermark: A translucent design impressed on paper by the raised pattern on the dandy roll used during the manufacture of paper.

Water resistance: (A) For papers, use method T-433. (B) For boards, use method T-441, except that the depth of water shall be 75 mm and the time of exposure 60 minutes.

Writing quality: When "pen and ink" is specified, the degree of feathering shall be determined by using a 1 pct ink solution of either C.I. Acid Red 1, C.I. 18050 or C.I. Acid Green 3, C.I. 42085 using an extra fine pen nib such as Estabrook Falcon #048, Hunt #107, Hunt #512 or equivalent. If "ball point and felt tip pens" are specified, any commercially available brand name may be used.