



Designation: D 3394 – 94 (Reapproved 2000)

An American National Standard

Standard Test Methods for Sampling and Testing Electrical Insulating Board¹

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1. Scope

1.1 These test methods cover the sampling and testing of electrical insulating boards. These boards are porous, usually fibrous sheets used for dielectric and structural purposes in electrical apparatus.

1.2 These test methods are not intended for testing vulcanized fibre or molded laminated sheets.

1.3 These test methods are applicable to board materials having a nominal thickness of at least 0.030 in. (0.76 mm).

NOTE 1—For materials thinner than 0.030 in. (0.76 mm) see Test Methods D 202.

1.4 The test methods appear in the following sections:

	Sections	ASTM Method Reference
Apparent Density	18-23	
Aqueous Extract Characteristics	36-42	D 202
Ash Content	43-46	T 413
Compatibility with Dielectric Liquids	47-52	D 664, D 877, D 924, D 971, D 974, D 1169, D 1500, D 1816, D 3455, D 3487
Compressibility	79-85	
Conditioning	11	D 685
Degree of Polymerization	86-89	D 4243
Dielectric Strength in Air	53-59	D 149
Dielectric Strength in Oil	60-65	D 149, D 2413, D 3426
Dimensions of Sheets	12-17	
Moisture Content	31-35	D 644
Oil Absorption	72-78	
Reports	10	
Sampling	6-9	D 3636
Shrinkage	24-30	D 644
Tensile Properties	66-71	D 202

1.5 The values stated in inch-pound units are to be regarded as the standard.

1.6 *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 consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

¹ These test methods are under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee D 09.19 on Dielectric Sheet and Roll Products.

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D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies²

D 202 Test Methods for Sampling and Testing Untreated Paper Used for Electrical Insulation²

D 374 Test Methods for Thickness of Solid Electrical Insulation²

D 586 Test Method for Ash in Paper³

D 644 Test Method for Moisture Content of Paper and Paperboard by Oven Drying³

D 664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration⁴

D 685 Practice for Conditioning Paper and Paper Products for Testing³

D 877 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes⁵

D 924 Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids⁵

D 971 Test Method for Interfacial Tension of Oil Against Water by the Ring Method⁵

D 974 Test Method for Acid and Base Number by Color-Indicator Titration⁴

D 1169 Test Method for Specific Resistance (Resistivity) of Electrical Insulating Liquids⁵

D 1500 Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)⁴

D 1816 Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes⁵

D 2413 Test Methods for Preparation and Electrical Testing of Insulating Paper and Board Impregnated with a Liquid Dielectric²

D 2865 Practice for Calibration of Standards and Equipment for Electrical Insulating Materials Testing⁶

D 3426 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials Using Impulse Waves⁶

D 3455 Test Methods for Compatibility of Construction

² Annual Book of ASTM Standards, Vol 10.01.

³ Annual Book of ASTM Standards, Vol 15.09.

⁴ Annual Book of ASTM Standards, Vol 05.01.

⁵ Annual Book of ASTM Standards, Vol 10.03.

⁶ Annual Book of ASTM Standards, Vol 10.02.



Materials with Electrical Insulating Oil of Petroleum Origin⁵

D 3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus⁵

D 3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials⁶

D 4243 Method for Measurement of Average Viscometric Degree of Polymerization of New and Aged Electrical Papers and Boards⁶

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁷

2.2 TAPPI Standard:

T 413 Determination of Ash in Paper⁸

3. Terminology

3.1 *Description of Term Specific to This Standard:*

3.1.1 *electrical insulating board*—a sheet structure, usually composed of cellulosic fibers, utilized for dielectric or structural purposes or both in a variety of electrical apparatus. Board is herein arbitrarily differentiated from paper in that it is at least 0.030 in. (0.76 mm) thick and is manufactured only in sheets of limited length. Other names for these products are pressboard, transformer board, fuller board, and press pan.

4. Summary of Test Methods

4.1 This standard is a compilation of test methods for electrical insulating board. Provisions are included for sampling, testing, and judging acceptability of a given quantity of board.

5. Reagents

5.1 Reagents shall conform to the requirements set forth in Test Methods D 202.

SAMPLING

6. Scope

6.1 This test method covers the determination of lot acceptability of electrical insulating board. It is designed for the purpose of determining acceptability of all or that portion of a shipment to a customer identified by a manufacturer's lot number. It is not intended to cover internal board mill quality control plans. The method is intended for use in conjunction with product specifications for electrical insulating board.

7. Terminology

7.1 *Descriptions of Terms Specific to This Standard:*

7.1.1 The descriptions of terms used in this test method, with the exception of the definition of "unit of product," are in accordance with Practice D 3636.

7.1.2 *unit of product*—an entity of electrical insulating board on which one or more quality characteristics may be determined. A unit of product may be a sheet, pallet, box, carton, case, package, or bundle. The unit of product is

established by the customer and may or may not be the same as the unit of purchase, supply, production, or shipment.

8. Establishing Acceptable Quality Levels (AQLs)

8.1 Acceptable quality levels (AQLs) for each major and minor property (as defined in Practice D 3636) shall be as mutually agreed upon between the purchaser and the seller. In addition, group AQLs may be established for given groups of properties and these too shall be mutually agreed upon between the purchaser and the seller.

9. Selection of Sample and Identification of Lot Sample

9.1 Samples shall be in accordance with Practice D 3636, with the exception of those paragraphs pertaining specifically to rolls, pads, or bobbins.

9.2 Mark each unit of the sample so that it may be identified at any time by the seller and the purchaser.

REPORTS

10. Report

10.1 At the completion of all tests record the results in a test report that includes the following:

10.1.1 Identification (of the board sampled and tested) by lot number, type, grade, etc.,

10.1.2 Dates of testing,

10.1.3 Location of the testing laboratory and the name of the person responsible for testing,

10.1.4 Remarks indicating the method used and any deviation from the standard,

10.1.5 Test results as specified in the individual method, and

10.1.6 Specification limits for each property measured for the board being tested.

10.2 Report the results as calculated or observed values rounded to the nearest unit in the last right-hand place of figures used in the material specification to express the limiting value (see Practice E 29).

CONDITIONING

11. Conditioning

11.1 Condition samples and specimens cut from the samples (with the exception of samples taken for moisture determination or as otherwise specified) in a circulating-air atmosphere maintained at 50 ± 2 % relative humidity and a temperature of $23 \pm 2^\circ\text{C}$, using procedures as specified in Method D 685.

11.2 For referee purposes, the conditioning specified in 11.1 will give most consistent results. However, for routine testing under factory or other non-standard atmospheric conditions, if the board has a moisture content within the range from 5 to 7 % as determined in Sections 31-34, there will be only slight variations from properties as determined after conditioning specified above.

DIMENSIONS OF SHEETS

12. Apparatus

12.1 *Scale*—A scale of suitable length graduated such that lengths, widths, and diagonals can be directly read to within

⁷ Annual Book of ASTM Standards, Vol 14.02.

⁸ Available from Technical Association of the Pulp and Paper Industry, One Sunwoody Park, Atlanta, GA 30338.

half of the allowable tolerance for these dimensions. The scale shall be properly calibrated in accordance with Practice D 2865.

12.2 *Thickness-Measuring Device*—Machinist micrometer with ratchet as specified in Test Methods D 374.

13. Sampling

13.1 Sample in accordance with Sections 6-9.

14. Test Specimens

14.1 Specimens for determination of length, width, and squareness of sheets shall be whole sheets. For thickness determinations, a whole sheet may be used or, if desired, a portion of a whole sheet will serve as a specimen. If a portion is selected as a specimen for thickness determination, that portion shall be representative of the full width (cross-grain direction) of the sheet.

14.2 Determine the dimensions as received, provided the moisture content is in the specification range for the material being tested (see 11.2).

15. Procedure

15.1 Measure the length and the width of each specimen to the nearest appropriate unit. Make at least two measurements in each direction.

15.2 Measure each of the two diagonals of each specimen.

15.3 Measure the thickness in accordance with Test Methods D 374, Method A. Make at least five thickness determinations across the sheet.

NOTE 2—Points of measurement should be selected to include the areas most likely to be the extremes.

16. Report

16.1 The report shall conform to Section 10 and shall include the following:

16.1.1 Sheet size, reported as the average of the measurements in each direction.

16.1.2 Squareness of the sheet, reported as the quotient of the shorter diagonal divided by the longer diagonal (for convenience, squareness is expressed as a percent).

NOTE 3—This method of calculating squareness assumes that the sheet closely approximates a parallelogram in shape. If measurements of width or length vary at different points, it is possible that a high squareness value may be calculated from measurements on a sheet that differs significantly from being rectangular.

16.1.3 Average thickness, and

16.1.4 Variation in thickness, reported as the difference between the highest and the lowest thickness value obtained in 15.3.

17. Precision and Bias

17.1 The precision and bias of this test method are not known.

APPARENT DENSITY

18. Scope

18.1 This test method may be used for determination of apparent density of insulating board, using measurements of dimensions and weight made after appropriate conditioning.

18.2 Procedures are given for determining either the “wet-wet” or the “dry-dry” density.

19. Significance and Use

19.1 Apparent density affects the dielectric and physical characteristics of insulating board and is a factor in the economics of its use in apparatus. This test is useful for specification, design, and quality control purposes.

20. Apparatus

20.1 *Scale or Calipers*, graduated in units of length, with the smallest graduation equal to, or less than, 0.25 % of the smallest dimension to be measured, calibrated in accordance with Practice D 2865.

20.2 *Balance*, graduated in units of weight, with the smallest graduation equal to, or less than, 0.25 % of the specimen weight, calibrated in accordance with Recommended Practice D 2865.

20.3 *Thickness-Measuring Device*, conforming to the requirements of Test Methods D 374, Method A.

20.4 *Oven*, conforming to the requirements of Test Method D 644.

21. Procedure

21.1 From each unit of product in the sample obtained in accordance with Sections 6 through 9, prepare at least two rectangular specimens having an area of at least 75 in.² (0.05 m²) each.

21.2 *Procedure A: Wet-Wet Density*—Condition the specimens in accordance with Section 11.

21.3 *Procedure B: Dry-Dry Density*—Dry the specimens to constant weight in an oven at 105 ± 3°C, in accordance with Test Method D 644. Cool to room temperature, using a desiccator or other means to prevent reabsorption of moisture. Exposure to the open air while making the measurements specified in 21.4 shall be sufficiently brief that there will not be a weight increase of more than 0.1 % of the oven-dry weight of the specimens.

21.4 Measure the width, length, and thickness in accordance with Section 15 to determine the weight of each specimen.

21.5 From the dimensions and weight of each specimen, calculate the apparent density and report the results in units of grams per cubic centimetre, calculated as follows:

$$\text{Apparent density, g/cm}^3 = \frac{\text{weight} \times \text{factor}}{\text{volume}} \quad (1)$$

Weight Units	Volume Units	Factor
g	cm ³	1
g	in. ³	0.0610
lb	in. ³	27.68

22. Report

22.1 The report shall be in accordance with Section 10, and include the individual results for the apparent density of each specimen.

23. Precision and Bias

23.1 The precision and bias of this test method are not known.

