



Designation: D 146 – 97

Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing¹

This standard is issued under the fixed designation D 146; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 These test methods cover the sampling and examination of felts or woven fabrics, saturated or impregnated but not coated with asphaltic or coal-tar materials, for use in waterproofing or for the construction of built-up roof coverings.

1.2 *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:

- D 95 Test Method for Water in Petroleum Products and Bituminous Materials by Distillation²
- D 147 Methods of Testing Bituminous Mastics, Grouts, and Like Mixtures³
- D 645 Test Method for Thickness of Paper and Paperboard⁴
- D 828 Test Method for Tensile Breaking Strength of Paper and Paperboard⁵
- D 1079 Terminology Relating to Roofing, Waterproofing, and Bituminous Materials⁶
- D 1682 Test Methods for Breaking Load and Elongation of Textile Fabrics⁷
- D 1910 Test Methods for Construction Characteristics of Woven Fabrics⁸
- D 4072 Test Method for Toluene-Insoluble (TI) Content of Tar and Pitch⁶
- D 4312 Test Method for Toluene-Insoluble (TI) Content of Tar and Pitch (Short Method)⁶

3. Sampling

3.1 From each shipment of the specified saturated felt or fabric, select at random a number of rolls equal to one half the cube root of the total number of rolls in the lot. If the specification requires sampling during manufacture, consider the lot to be the planned production quantity and select the rolls at uniformly spaced time intervals throughout the production period. The minimum sample shall consist of five rolls. If the calculated number is fractional, express it as the next highest whole number. For convenience, the following table, showing the number of rolls to be selected from lots of various sizes, is given:

Number of Rolls in Shipment	Number of Rolls in Sample
Up to 1 000	5
1 001 to 1 728	6
1 729 to 2 744	7
2 745 to 4 096	8
4 097 to 5 832	9
5 833 to 8 000	10
8 001 to 10 648	11
10 649 to 13 842	12
13 843 to 17 576	13
17 577 to 21 952	14

The rolls so selected constitute the representative sample used for all subsequent observations and tests pertaining to the lot of material being examined. Identify each individual roll.

EXAMINATION OF REPRESENTATIVE SAMPLE

4. Gross Mass per Roll

4.1 Weigh each roll, intact, to the nearest 100 g ($\frac{1}{4}$ lb), and record each weight as the gross mass of that roll.

5. Mass of Wrapping Material and Mandrel (Core)

5.1 Strip each roll of its wrappings and weigh it to the nearest $\frac{1}{4}$ lb (100 g). If mandrels (cores) are used, collect them after the rolls are unwound and weigh them together, to the nearest $\frac{1}{4}$ lb (100 g). Calculate the average mass of the wrappings and mandrels per roll and record.

6. Mandrels (Cores)

6.1 Determine the shape of the cross section of the mandrels

¹ These test methods are under the jurisdiction of ASTM Committee D08 on Roofing, Waterproofing, and Bituminous Materials and are the direct responsibility of Subcommittee D08.04 on Fabrics for Bituminous Roofing and Waterproofing.

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² *Annual Book of ASTM Standards*, Vol 05.01.

³ Discontinued—see *1985 Annual Book of ASTM Standards*, Vol 04.04.

⁴ Discontinued—see *1980 Annual Book of ASTM Standards*, Part 20.

⁵ *Annual Book of ASTM Standards*, Vol 15.09.

⁶ *Annual Book of ASTM Standards*, Vol 04.04.

⁷ *Annual Book of ASTM Standards*, Vol 07.01.

⁸ Discontinued—see *1981 Annual Book of ASTM Standards*, Part 32.



(cores) and report. If circular, measure the outside diameter to the nearest $\frac{1}{16}$ in. (1 mm). If square, measure each outside edge to the nearest $\frac{1}{16}$ in. (1 mm). Measure and report the length of the mandrel projecting beyond each end of each roll to the nearest $\frac{1}{4}$ in. (5 mm).

7. Net Mass

7.1 Subtract the average mass of the wrappings and mandrels (Section 5) from the gross mass of each roll (Section 4) and record as the net mass of each roll. Calculate the average net mass per roll of the representative sample and record as the average for the lot.

8. Appearance and Dimensions of Rolls

8.1 Unwind the rolls. Observe the workmanship and finish, and record pertinent defects. Measure and record the length of each roll to the nearest 1 in. (25 mm) and its width to the nearest $\frac{1}{16}$ in. (1 mm). Calculate and record the area of material contained in each roll to the nearest 0.1 m^2 (1 ft^2).

8.2 Measure and record the width of the selvage of each roll to the nearest 1 mm ($\frac{1}{16}$ in.).

9. Net Mass per Unit Area

9.1 From the net mass (Section 7) and the dimensions (Section 8), calculate the net mass per unit area for each roll, as follows:

For Felts:

$$g/m^2 = A/BC \text{ (lb/100 ft}^2 = 1200 A/BC) \quad (1)$$

For Fabrics:

$$g/m^2 = A/BC \text{ (oz/yd}^2 = 1728 A/BC) \quad (2)$$

where:

A = net mass of rolls, kg (lb),

B = width of material, mm (in.), and

C = length of material, m (ft).

Calculate the average net mass per unit area for the rolls in the representative sample and record it as the average for the lot.

10. Selecting a Representative Specimen

10.1 Examine in detail the roll having the unit net mass closest to the average unit net mass of the lot. Discard the outside convolution and cut a specimen from the roll. Make the cuts perpendicular to the sides of the roll, straight and 30 in. (750 mm) apart, to the nearest $\frac{1}{32}$ in. (1 mm). Collect loose material, such as sand, if any, that may become detached from the specimen. Measure the width of the specimen to the nearest $\frac{1}{16}$ in. (2 mm). Weigh it, together with any detached surfacing, to the nearest 1 g. Calculate the net mass per unit area as follows:

For Felts:

$$g/m^2 = 1333.3 D/E \text{ (lb/100 ft}^2 = 1.0582 D/E) \quad (3)$$

For Fabrics:

$$g/m^2 = 1333.3 D/E \text{ (oz/yd}^2 = 1.5238 D/E) \quad (4)$$

where:

D = mass of the specimen, g, and

E = width of the specimen, mm (in.).

The mass so determined should be within 1 % of the average net mass per unit area (Section 9). If the specimen so selected fails to conform to this requirement, cut additional specimens from the same roll until one of the proper mass is obtained. Use this specimen for further examination as described in Sections 11-16 .

11. Detached Comminuted Surfacing

11.1 If the material is surfaced with sand or other finely comminuted material, sweep the detached surfacing from the representative specimen with an Osborn brush (or equivalent), brushing in one direction only. Combine the comminuted material thus removed with the loose material, collected as described in Section 10, and weigh both together to the nearest 1 g. Calculate this mass in lb/100 ft^2 (g/m^2), record, and report as detached comminuted surfacing.

NOTE 1—The Osborn No. 322 Master Duster is the brush prescribed in Section 11. It is filled with Tampico fiber bristles projecting 73 mm ($2\frac{7}{8}$ in.) from its holder.⁹

12. Moisture

12.1 From the representative specimen, cut four 2- by 18-in. (50- by 460-mm) test specimens, as shown in A-1 and A-2 of Fig. 1. Cut them into 1-in. (25-mm) squares and select about 50 g, at random. Weigh to the nearest 0.1 g and distill with 100 mL of solvent as prescribed in Test Method D 95. Read the volume of water collected in the trap and calculate to grams on the basis that 1 mL weighs 1 g. Calculate the moisture to the nearest 0.5 % of the mass of the specimen used (including the detached comminuted surfacing, if any) and report as moisture, percentage of net mass.

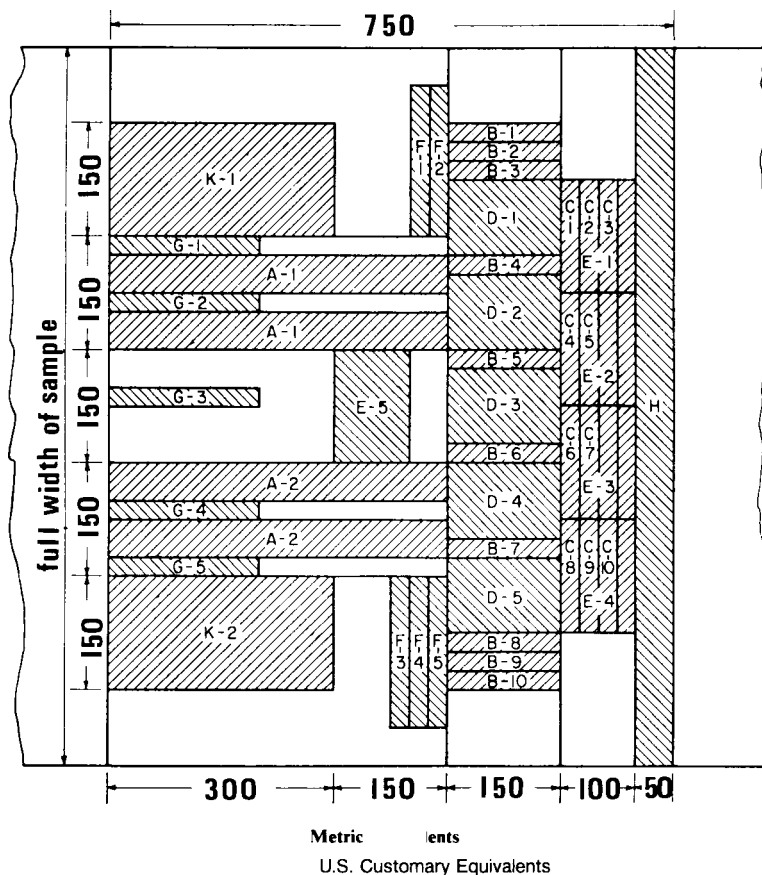
NOTE 2—Any sample taken for determination of moisture shall be protected from the time of sampling against change in moisture by enclosing it in a substantially moisture-proof container.

13. Strength

13.1 *Felts:*

13.1.1 From the representative specimen, cut ten rectangular test strips, 1 by 6 in. (25 by 150 mm) with the fiber grain, as shown at B-1 to B-10 in Fig. 1, and ten strips across the grain, as shown at C-1 to C-10 in Fig. 1. Discard any specimens of perforated felt in which a perforation is within $\frac{1}{32}$ in. (0.8 mm). of an edge. Condition both sets in air at $73.6 \pm 3.4^\circ\text{F}$ for at least 2 h, and test in a room maintained at the same temperature. In case of dispute, specimens shall also be conditioned in a controlled relative humidity of $50 \pm 5\%$. Determine the strength in accordance with Test Method D 828, except as modified herein. At the start of the test, set apart the edges of the jaws of the clamps at 3.0 ± 0.1 in. (75 ± 3 mm). Use a pendulum type tensile tester with a driven clamp speed of 12 in. (305 mm)/min, or a load-cell type tensile tester with

⁹ The Osborn No. 322 Master Duster, available from Osborn Manufacturing Co., 5401 Hamilton Ave., Cleveland, OH 44114. If required in less than dozen lots, the order must be marked "For ASTM Test."



NOTE 1—All dimensions are in millimetres.

FIG. 1 Location of Test Pieces in Representative Specimen

a rate of jaw separation of 2 in. (51 mm)/min, and a response time of 1.25 s (or faster). Cut additional strips from adjacent areas of the representative specimen when needed because of discarded specimens or false breaks. Average the ten readings for each set to the nearest 5 N (1 lbf) and report as the average breaking strength with and across the fiber grain, respectively.

13.1.2 Precision¹⁰—The following data should be used for judging the acceptability of results (95 % probability) on samples from the same lot from the same supplier:

13.1.2.1 Repeatability— Duplicate results by the same operator should not be considered suspect unless they differ by more than the following amount:

Pendulum method	±15%
Load-Cell method	±15%

13.1.2.2 Reproducibility— The results submitted by each of two laboratories should not be considered suspect unless they differ by more than the following amounts:

Pendulum method	±15%
Load-Cell method	±15%

13.2 Fabrics—From the representative specimen, cut five 4- by 6-in. (100- by 150-mm) test pieces with the longer dimension parallel to the warp yarns, as shown at E-1 to E-5 in Fig. 1. Test these pieces at 21.1 ± 1.1°C (70 ± 2°F) in accordance with the grab method described in Test Methods D 1682.

NOTE 3—As a referee method, or in case any dispute arises regarding the strength, repeat the test, with the exception that the fabric before being tested shall be exposed at least 2 h in an atmosphere of 65 % relative humidity at 21.1°C (70°F).

14. Pliability

14.1 Felts—From the representative specimen, cut ten 25- by 1- by 8-in. (200-mm) test pieces, five in the direction of and five across the fiber grain, as shown at F-1 to F-5, and at G-1 to G-5 in Fig. 1, respectively. Immerse them in water at 25 ± 1°C (77 ± 2°F) for 10 to 15 min; then remove each specimen separately and immediately bend it 90° over the rounded edge of a block at a uniform speed in approximately 2 s. The block shall be 3.0 in. (75 mm) square by 2.0 in. (50 mm) thick, with one long edge rounded on a radius of 0.50 in. (12.7 mm) and another edge on the same 3 in. (75 mm) face rounded on a radius of 0.75 in. (19 mm). In bending, hold the specimen

¹⁰ Supporting data are available from ASTM International Headquarters. Request RR: D-8-1005.



tightly against the upper 2-in. (50-mm) face of the block and bend its projecting end over the specified rounded edge without exerting any stress other than that required to keep the specimen in contact with the block and to avoid kinking. Consider any surface rupture visible to the normal eye and exceeding $\frac{1}{8}$ in. (3 mm) in length as a failure.

14.2 *Fabrics*—Cut five 1.0- by 8.0-in. (25- by 200-mm) test pieces from the representative specimen in the direction of the warp, as shown at G-1 to G-5 in Fig. 1. Immerse them in a cooling mixture of ice and water at 32°F (0°C) for 10 to 15 min; then remove each specimen separately and immediately bend it over a 0.063-in. (1.60-mm) diameter mandrel through an arc of 180° at a uniform speed in approximately 2 s and then through 360° over the same mandrel in the opposite direction. Dry the specimens thoroughly and examine them. If one or more of the test specimens crack, cut ten specimens from another portion of the sample and repeat the test. If one or more of these specimens crack, consider the material as failing.

15. Loss on Heating

15.1 From the representative specimen, cut two 12.0- by 6.0-in. (300- by 150-mm) test pieces as shown at K-1 and K-2 in Fig. 1. Weigh each specimen to the nearest 1 mg. Suspend both specimens 2 in. (50 mm) apart and parallel near the center of an oven maintained at $221 \pm 5^\circ\text{F}$ ($105 \pm 3^\circ\text{C}$). Insert a thermometer in the oven to such a depth that its bulb will be in line with the center of the specimens. Keep them in the oven for $5 \text{ h} \pm 3 \text{ min}$; then remove them carefully and cool and weigh each specimen. Calculate the average loss to the nearest 0.5 % of the specimen weights (including the detached comminuted surfacing, if any). Report this figure as the loss on heating. Subtract the percentage of moisture and report as the loss on heating exclusive of moisture.

EXAMINATION OF DESATURATED FELT OR FABRIC

16. Weight of Desaturated Felt or Fabric

16.1 Cut a $2 \pm \frac{1}{32}$ -in. (50 ± 0.5 -mm) strip from the representative specimen as shown at H in Fig. 1. Measure its length to the nearest $\frac{1}{16}$ in. (1 mm) and calculate its area to the nearest 1 in.² (500 mm²). Extract the test strip with 1,1,1-Trichloroethane or other suitable solvent (see Note 4) in a suitable extractor (such as the one shown in Fig. 2) or centrifuge until washings are colorless. Dry the extracted specimen in the basket or thimble, first at room temperature in a ventilated fume chamber and then in a ventilated oven at $221 \pm 5^\circ\text{F}$ ($105 \pm 3^\circ\text{C}$), and cool in a desiccator. Remove the desaturated felt or fabric, brush off any adherent comminuted surfacing into the filter, and quickly weigh the felt or fabric to the nearest 0.1 g. Repeat the heating, cooling in desiccator, and weighing of the desaturated felt or fabric to constant weight. From the area of the specimens and the mass of the desaturated felt or fabric, calculate the mass per unit area of moisture-free desaturated felt or fabric. Report this mass to the nearest 0.1 lb/100ft² (5 g/m²) for felts and to the nearest $\frac{1}{2}$ oz/yd² (10 g/m²) for fabrics.

16.2 Where coal-tar saturant has been used (see Section 17), correct the moisture-free weight of the desaturated felt or fabric

for carbonaceous matter retained mechanically in its interstices by multiplying by $(100-F)/100$, where F is the percentage of retained carbonaceous matter as determined in Section 17.

16.3 Recover the mineral matter in the filter medium by drying to constant weight in a vented oven at 220 to 230°F. Calculate the entrapped mineral by subtracting the initial weight of the filter medium and record as adherent mineral matter and stabilizer.

NOTE 4—Coaltar-saturated felt cannot be thoroughly desaturated by any known means; only an approximate value may be obtained through desaturation. For coaltar products use Test Method D 4072 or Test Method D 4312.

17. Retained Carbonaceous Matter

17.1 Determine the carbonaceous matter derived from a coal-tar pitch saturant and retained by the desaturated fabric by means of the following colorimetric method. Please note that the results obtained for this determination are only an approximation.

17.1.1 Macerate by boiling in water about 15 g of an unsaturated fabric of the same general character as the one under examination, disintegrate with a rotary beater, and pick the fibers apart with needles. Filter the fibers through fine cloth and dry to constant weight at 107°C (225°F). Accurately weigh a 1-g portion of the fiber into a flask and dilute to exactly 100 mL with distilled water at room temperature. Add about 50 g of glass beads and shake the contents of the flask vigorously until the fibers are reduced to a homogeneous pulp in uniform suspension.

17.1.2 Procure a distilled coal tar, having approximately 10 to 25 % of insoluble carbonaceous matter. Extract the carbonaceous matter with benzol until it is free of soluble matter, then dry to constant weight at 225°F (107°C). Accurately weigh out 1 g of the purified carbonaceous matter and dilute to exactly 100 mL at room temperature with a starch solution of a consistency sufficient to carry the carbonaceous matter into temporary suspension. (A 12.5 weight % solution is recommended.)

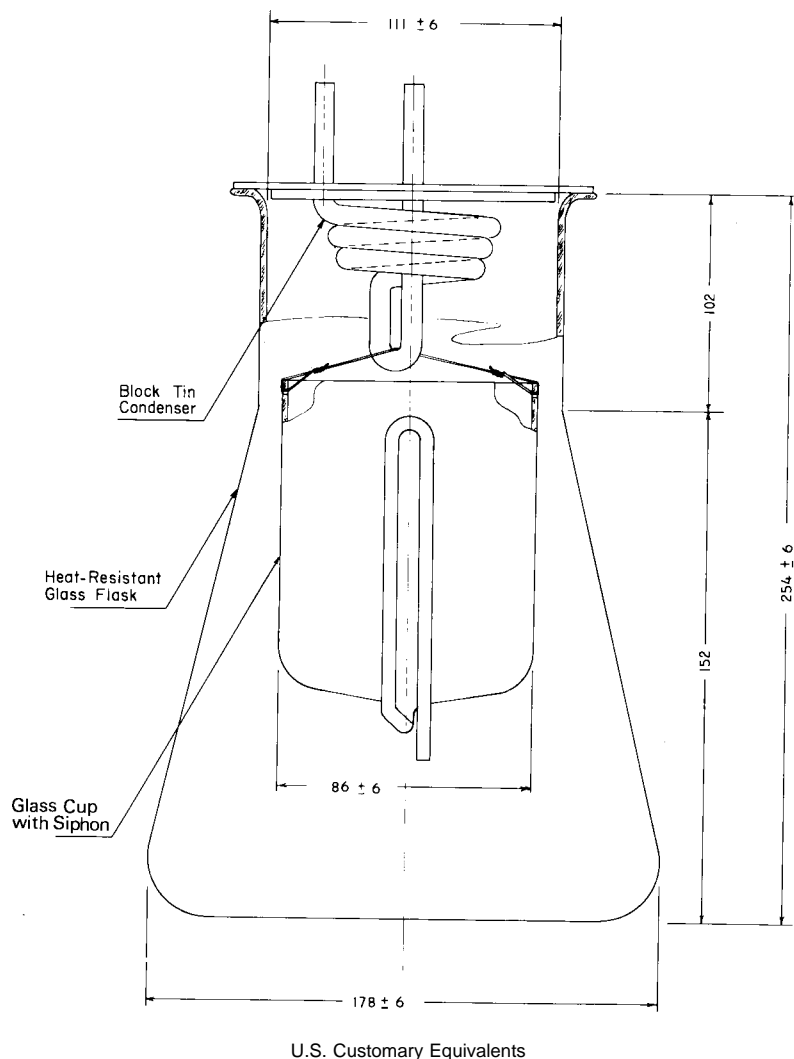
17.1.3 Titrate the liquid carrying the fibers obtained as described in 17.1.2 with the suspension of carbonaceous matter, obtained as described in 17.1.2 and examine from time to time a field prepared from a drop of the well-agitated mixture, under a microscope at 100× until the color exactly matches a field prepared from the desaturated fabric under examination (obtained as described in Section 16) when both are viewed side by side under identical conditions. The end point is fairly sharply defined. The buret reading gives directly the percentage of carbonaceous matter adhering to the moisture-free fabric under examination.

18. Total Comminuted Surfacing

18.1 Add the mass of adherent mineral matter, lb/100 ft² (g/m²) (Section 16) to the mass of detached comminuted surfacing (Section 11), and record as the total comminuted surfacing per area in lb/100 ft² or oz/yd² (g/m²).

19. Bituminous Saturant

19.1 Determine the mass of saturant by subtracting the sum of the masses of the moisture-free desaturated felt or fabric



U.S. Customary Equivalents

mm	6	86	102	111	152	178	254
in.	¼	3⅜	4	4⅜	6	7	10

NOTE 1—All dimensions are in millimetres.

FIG. 2 Extraction Apparatus

(Section 16), the moisture (Section 12), and the total comminuted surfacing (Section 18), from the mass of the sample (Section 10) all expressed in grams per square metre, (or pounds per 100 square feet) for felts, or grams per square metre (or ounces per square yard) for fabrics. Report these masses, and calculate the ratio of the mass of the saturant to the mass of the desaturated moisture-free felt or fabric (Section 15) and report as the ratio of saturant to dry felt or fabric.

20. Thread Count of Fabrics

20.1 Test fabrics for number of threads per centimetre (or inch) in accordance with Test Methods D 1910.

21. Thickness of Felts

21.1 Measure the thickness of the desaturated felt at 20 equally spaced spots along the length of the sample strip obtained in Section 16. In all other respects follow Test Method D 645.

22. Ash

22.1 If the mass of desaturated moisture-free felts or fabric (Section 16) is 25 g or less, ignite the whole desaturated specimen. If it is greater than 25 g, cut the specimen into approximately 1-in. (25-mm) squares, mix them, and select about 25 g at random for ashing. Dry the ashing sample to constant weight at 221 ± 5°F (105 ± 3°C). Weigh to the nearest 10 mg and ignite in a weighed porcelain or quartz dish or crucible until all carbon has been consumed. Cool in a desiccator, weigh, and record the weight as ash. Calculate the percentage on the basis of the desaturated moisture-free felt or fabric (Section 16) and report to the nearest 0.1 %.

23. Precision and Bias

23.1 No information can be presented on the precision and bias of Test Methods D 146 because there is no evidence available to make a determination. It is unlikely that data will

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become available because of the volume of work necessary, the hazardous materials involved and the fact that the test methods

have been successfully used in the industry for more than 15 years.

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