Designation: D 2829 – 97

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
Reprinted from the Annual Book of ASTM Standards. Copyright ASTM

Standard Practice for Sampling and Analysis of Built-Up Roofs[1]

This standard is issued under the fixed designation D 2829; 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 practice is a guide for removing test specimens from built-up roofing systems in the field and for determining the *approximate* quantities of the components of that specimen (Note 1). Components determined may be:

1.1.1 Insulation components when they are part of the roof membrane system,

1.1.2 Plies of roofing felt,

1.1.3 Interply layers of bituminous material,

1.1.4 Top coating, and

1.1.5 Surfacing.

NOTE 1—This procedure is for the investigation of existing roofs and is not intended for new construction inspection.

1.2 The values stated in SI (metric) units are to be regarded as standard.

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 this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary information, see 6.3.2.1.

2. Referenced Documents

2.1 *ASTM Standards:*

D 226 Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing[2]

D 227 Specification for Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing[2]

D 249 Specification for Asphalt Roll Roofing (Organic Felt) Surfaced with Mineral Granules[2]

D 250 Specification for Asphalt-Saturated Asbestos Felt Used in Roofing and Waterproofing[2]

D 371 Specification for Asphalt Roll Roofing (Organic Felt) Surfaced with Mineral Granules; Wide Selvage[2]

D 1079 Terminology Relating to Roofing, Waterproofing, and Bituminous Materials[2]

D 2178 Specification for Asphalt Glass Felt Used in Roofing and Waterproofing[2]

D 2626 Specification for Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing[2]

D 3158 Specification for Asphalt-Saturated and Coated Organic Felt Used in Roofing[3]

D 3617 Practice for Sampling and Analysis of New Built-Up Roof Membranes[2]

D 3672 Specification for Venting Asphalt-Saturated and Coated Inorganic Felt Base Sheet Used in Roofing[4]

D 3909 Specification for Asphalt Roll Roofing (Glass Felt) Surfaced With Mineral Granules[2]

D 4601 Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing[2]

D 4897 Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing[2]

D 4990 Specification for Coal Tar Glass Felt Used in Roofing and Waterproofing[2]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology D 1079.

4. Securing of Specimens in the Field

4.1 Do not disturb any surfacing in the area from which a specimen is to be taken. Cut each specimen at least 300 by 300 mm (12 by 12 in.) and use the total specimen taken in the field for laboratory analysis.

4.2 The recommended practice is to use a cutting template (Fig. 1) consisting of a 300 by 300-mm (12 by 12-in.) metal box with an open bottom. Place the box over the roof area that is to be removed, and while the template is held firmly in position, remove the surfacing around the perimeter and then cut through the roof membrane around the perimeter of the box. Lift the specimen including all associated loose materials, from the roof and place it in a plastic bag. Fully identify the specimen. Note if the insulation is adhered to the specimen or, where insulation is not used, if bitumen is left on the deck, and the type of deck. Estimate bitumen mass per unit area left on the deck.

4.2.1 *Alternate Method:*

4.2.1.1 Mark each sample as at least a square 356 mm (14 in.) on a side. Try to include a seam in each membrane sample. During cold weather, use a square 457 mm (18 in.) on a side,

[1] This practice is under the jurisdiction of ASTM Committee D-8 on Roofing, Waterproofing, and Bituminous Materials and is the direct responsibility of Subcommittee D08.20 on Roofing Membrane Systems.

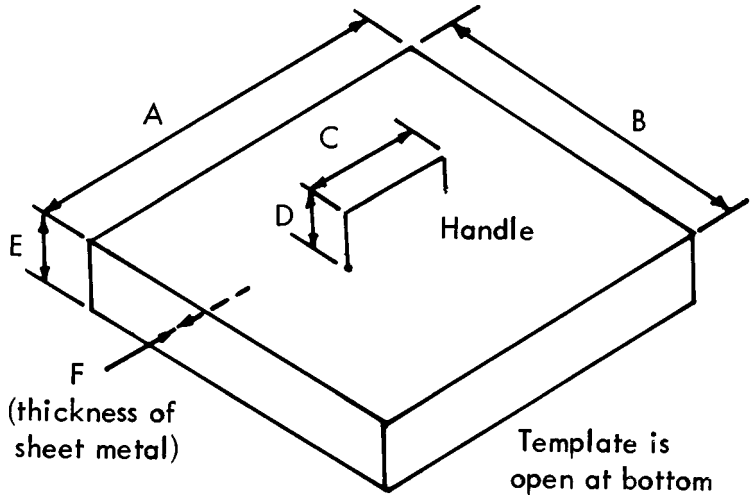
Current edition approved Feb. 10, 1997. Published April 1997. Originally published as D 2829 – 69 T. Last previous edition D 2829 – 95.

[2] *Annual Book of ASTM Standards*, Vol 04.04.

[3] Discontinued—See *1984 Annual Book of ASTM Standards*, Vol 04.04.

[4] Discontinued—See *1990 Annual Book of ASTM Standards*, Vol 04.04.

TABLE 1 Dimensions



Dimension	Square (3.2)		Rectangular (3.4)	
	mm	in.	mm	in.
A	300	12	100	4
B	300	12	1000	40
C	150	6	150	6
D	40	1.5	40	1.5
E	40	1.5	40	1.5
F	3	⅛	3	⅛

FIG. 1 Cutting Template

since cold weather cutting may inadvertently break, distort or delaminate the sample. If the roofing membrane is mechanically fastened, mark rectangular 864 by 457 mm (34 by 18 in.) sample, with the longer dimension perpendicular to the length of the ply felts. Half of these large samples can be shipped to the laboratory for analysis after the number of fasteners in the larger area is recorded.

4.2.1.2 Carefully broom off the loose aggregate, and spud off the adhered aggregate and flood coating at the perimeter of the sample. (The application of dry ice at the areas to be spudded will ease the removal of the top coating during hot weather. A large propane torch can also be used as an alternate to the dry ice method, to melt the top coating so that it can be easily removed with a scraper and facilitate cutting.) Record the length and width of the sample. If the quantities of unadhered surfacing or total surfacing are desired, collect and package the unadhered surfacing from the sample area.

4.2.1.3 Cut through the roofing membrane with a razor knife or sharp power cutting tool, taking care not to damage the edge of the sample. Do not pound on the sample, as this might cause interply delamination. Carefully loosen and remove the roofing membrane including all adhered insulation. Observe and record the kind and degree of attachment between the roofing membrane and the insulation or deck.

4.2.1.4 Cut through the roof insulation with a blade long enough to penetrate all of the insulation layers. Observe and record the type and thickness of each insulation layer, and the percent of the sample area adhered between the layers and between the insulation and the deck and vapor retarder.

4.2.1.5 Cut and remove a small specimen of the vapor retarder, if it is present, to observe its attachment to the deck and to obtain a specimen for moisture content and analysis.

NOTE 2—This procedure will not provide as accurate a measure of total aggregate as the procedure described in 4.2.

4.3 If bituminous material has been absorbed by the insulation (4.2), remove sufficient insulation to allow laboratory analysis of absorbed bitumen mass (weight).

4.4 If felt lapping is to be determined, take a separate specimen at least 100 mm (4 in.) wide and not less than 1 m (40 in.) long, cut at right angles to the long dimension of the roofing felts.

4.5 Protect each specimen from physical damage such as bending or breakage of the felts or coating layers during removal and transportation. Protect from moisture, excessive heat, and loss of material.

5. Significance and Use

5.1 This practice is for the sampling and analysis of built-up roofs. For roofs under construction, use Practice D 3617.

6. Procedure

6.1 Preserve all identifications and log the specimens in the laboratory. Ensure continued identity and location of the components within each specimen. Remove the insulation fully (if present), removing as little bituminous coating from the underside of the membrane as possible.

6.2 Calculate the area of the specimen from eight different measurements taken in each direction. Weigh the specimen, including all associated loose materials (except insulation), being careful to avoid loss of any component, and calculate the mass per unit area. Dry the insulation removed in 4.3 to constant mass and record.

6.3 Place the specimen on aluminum foil or release paper and carefully scrape off the top surfacing (if any) and top coating without damaging the top felt. Use heat only to produce the lowest temperature required to remove the coating.

NOTE 3—This will usually leave 200 to 400 g/m^2(4 to 8 lb/100 ft^2) of bituminous material on the surface of the roofing felt.

6.3.1 Collect the surfacing and top coating, including any loose material taken with the specimen, and weigh.

6.3.2 Separate surfacing material from the surfacing-top coating mixture by solvent washing on an 850-µm (No. 20) sieve.

NOTE 4—The recommended solvent for coal-tar pitch is carbon disulfide (CS_2). Complete extraction of coal-tar pitch is not possible. Extraction with carbon disulfide may result in a recovery error of coal-tar pitch in the range from 17 to 38 %.

6.3.2.1 **Caution**—Carbon disulfide is toxic when taken internally or when inhaled. Conduct the test in a hood, or other well-ventilated location. Avoid prolonged or repeated contact with the skin and inhalation of vapors.

6.3.3 When all traces of bituminous materials have been removed, dry the surfacing retained on the sieve in an oven at 100°C (212°F), cool, and weigh. The approximate mass per unit area of the top coating is the difference between this mass and the mass obtained in 6.3.1, divided by the specimen area obtained in 6.2.

6.4 Remove all bituminous material from the bottom of the membrane (see 6.3), then weigh the membrane. Separate the plies, using a heat lamp as needed to achieve minimum temperature required for separation. Do not distort the felts (see 6.8 for an alternative method of separating the plies).

6.4.1 Measure the individual felts and calculate the area of each ply (due to lapping, not all plies will be the size of the original specimen). Follow the procedure in 6.2. Record the total area of all felts.

6.4.2 Divide the sum of all individual felt areas (6.4.1) by the area of the original specimen (6.2) and record the results as "number of plies."

6.5 Calculate the mass per unit area of the original saturated felts by multiplying the area of each ply determined in 6.4.1 by the following values in g/m^2(lb/100 ft^2) and dividing by the specimen area determined in 6.2. Add the masses per unit area for each felt, to find the total mass per unit area of the original saturated felts. If all plies are the same, simply multiply the assumed felt mass per unit area by the number of plies (6.4.2). Use the manufacturer's information for components not within the scope of the specifications in Table 1, using the factor 48.825 to convert from lb/100 ft^2 to g/m^2, and 0.02048 to convert from g/m^2 to lb/100 ft^2.

6.6 Calculate the total interply bituminous material per unit area by subtracting the total mass per unit area of the original" saturated felts" determined in 6.5 from the mass per unit area determined by dividing the mass of felts and interply bitumen in 6.4 by the specimen size in 6.2.

6.6.1 To obtain the average interply mopping, take the" total interply bitumen per unit area" determined in 6.6 and divide by one less than the previously determined number of plies (6.4.2).

6.6.2 Remove any bitumen absorbed by the insulation (6.2) by solvent extraction. Dry the residue to constant mass and cool to room temperature. Determine the absorbed bitumen per unit area by subtracting the mass of residue from the mass recorded in 6.2 and dividing the result by the specimen area (6.2).

6.6.3 Determine the total applied bitumen by deducting the mass per unit area of surfacing (6.3.3) and of all felt (6.5) from the specimen mass per unit area (6.2); add the absorbed bitumen per unit area determined in 6.6.2, or the estimated bitumen per unit area left on the deck (4.2).

TABLE 1 Weights/Types of Felts

Specification	Type	Material	lb/100 ft	g/m^2
D 226	I	asphalt-organic felt	11.5	560
	II		26	1270
D 227		coal-tar organic felt	13	635
D 249	I	asphalt-organic roll	74	3610
	II	roofing (granule surfaced)	71.5	3490
D 250	I	asphalt-asbestos felt	13	635
	II		28	1370
	III		17	830
	IV		21	1025
D 371	I	asphalt-organic wide-	37	1810
	II	selvage roofing	46.3	2260
	III	(granule surfaced)	35.5	1733
	IV		42.8	2090
D 2178	I	asphalt-glass felt	7.5	366
	II		14	684
	III		9.7	474
	IV		7	342
D 2626		asphalt-organic base felt	37	1810
D 3158		asphalt-asbestos base felt	29	1416
D 3672	I	venting asphalt-inorganic	60	2930
	II	base felt (granule surfaced)	50	2440
D 3909		asphalt-glass roofing felt granule surfaced	83	4050
D 4601	I	asphalt-glass base felt	13.4	654
	II		15.5	756
D 4897	I	asphalt-glass venting	50	2440
	II	base felt	55	2685
D 4990	I	coal-tar glass felt	7	342

6.7 For specimens from smooth surface roofs, omit 6.3.2 and 6.3.3.

6.8 To determine the lapping distance of felts, use the specimen described in 4.4. Delaminate the felts and measure the lap spacing. Report the number of plies and spacing by the representative spacing diagram. (Separation of the plies can be accomplished by warming or by cooling the specimen with dry ice and fracturing the interply moppings.)

7. Calculation

7.1 Carry out all calculations to the following significance:

7.1.1 *Number of Plies*, in the built-up roofing to the nearest hundredth of a ply.

7.1.2 *Mass of Felts*, interply mopping, top coating, total applied bituminous material, and surfacing to the nearest 1 g (0.002 lb).

7.1.3 *Mass per Unit Area*, to the nearest 10 g/m^2(0.2 lb/100 ft^2).

7.1.4 *Dimension of Felts*, to the nearest 1 mm (0.04 in.) and 0.001 m^2(0.01 ft^2).

7.1.5 *Results*—Round mass per unit area to the nearest 50 g/m^2(1 lb/100 ft^2), and number of plies to the nearest tenth.

7.2 A typical computation for a nominal 4-ply, aggregate-surfaced built-up roof mopped to insulation is given in Table 2.

8. Report

8.1 Describe the built-up roof, including the type and class of bituminous material, type of surfacing, type of insulation, type of roof decking, and the type and number of felts or roofing sheets.

8.2 Fully identify the origin and roof location of each specimen.

8.3 Report the mass per unit area of surfacing, average interply bituminous material, top coating bituminous material, total applied bituminous material, and the total specimen (minus insulation). See Table 3 for summary of results and conversion to conventional units of measurement.

8.4 Diagram the felt lapping to show the number of plies and the lap relationship, if determined (6.8).

9. Precision and Bias

9.1 *Precision*—Most of the variance shown between laboratories is due to variations within the samples, and not due to test method variance. Round-robin tests among six laboratories show that differences between laboratories should not be suspect unless they exceed the following values:

9.1.1 *Mass of Adhered Aggregate*—12 lb/100 ft (586 g/m).

9.1.2 *Mass of Top Coating*—12 lb/100 ft (586 g/m).

9.1.3 *Average Interply Bitumen Quality*—6 lb/100 ft (293 g/m).

9.1.4 *Number of Felt Plies*—0.1 plies.

9.2 The preferred method for comparing data obtained from different laboratories is to use standard statistical techniques to compare two data sets where the variability is unknown and cannot be assumed to be equal. The steps involve the following:

9.2.1 Select the significance level of the test at 0.05 [95 % probability].

9.2.2 Compute the averages, estimates of the standard deviation, and the variances for each set of data.

9.2.3 Compute the effective number of degrees of freedom from the variances.

9.2.4 Look up Student's *t* (1-05/2) distribution for the calculated degrees of freedom.

9.2.5 Compute the expected variance from the *t* factor and the variances of the data sets.

9.2.6 Accept the data as belonging to the same population if the difference between the averages is less than the computed expected variance.

9.3 *Bias*—The following bias are caused by the assumptions used in this practice:

9.3.1 *Adhered Aggregate Quantity*—The quantity of the adhered aggregate may be reduced significantly by improper packaging and rough handling during shipping.

9.3.2 There are no known biases for the determinations of the top bitumen coating, the average interply bitumen, or the number of felt plies.

10. Keywords

10.1 decking; felts; insulation; interply bituminous material; lap spacing; plies; surfacing; top coating

TABLE 2 Computation Form and Sample Computation for a Nominal 4-Ply, Aggregate Surface, Built-Up Roof Mopped to Insulation

Line	Reference	Identification	Factor Component	Computation	Example	Units
1	6.2	original specimen (minus insulation)	measured mass		2957	g
2	6.2	original specimen size (area)	measured area	0.314 × 0.312	= 0.098	m^2
3	6.2	insulation with absorbed bituminous material	measured mass		131	g
4	6.3.1	surfacing + top coating scrapings	measured mass		2038	g
5	6.3.3	surfacing cleaned of top coating	measured mass		1732	g
6	6.3.3	*approximate* top coating material per unit area	[line(4)-line(5)]/line(2)	(2038 − 1732)/0.098	= 3120	g/m^2
7	6.3.3	surfacing (aggregate) per unit area	line(5)/line(2)	1732/0.098	= 17670	g/m^2
8	6.4	felts and interply bitumen	measured mass		761	g
9	6.4.1	total felt area	measured area of individual felts	0.046 + 3(0.098) + 0.065	= 0.405	m^2
10	6.4.2	number of plies	line(9)/line(2)	0.405/0.098	= 4.13	plies
11	6.5	total unit mass (weight) of all felts	line(10) × assumed felt unit mass	(4.13 × 635)	= 2620	g/m^2
12	6.6	total interply bitumen per unit area	[line(8)/line(2)] − line(11)	(761/0.098) − 2620	= 5150	g/m^2
13	6.6.1	*approximate* interply bitumen per ply	line(12)/[line(10) − 1]	5150/(4.13 − 1.00)	= 1650	g/m^2
14	6.6.2	insulation mass after extraction	measured mass		105	g
15	6.6.2	bitumen absorbed by insulation	[line(3) − line(14)]/line (2)	(131 − 105)/0.098	= 270	g/m^2
16	6.6.3	*approximate* total applied bitumen	[line(1)/line(2)] − line(7) − line(11) + line (15)	(2957/0.098) − 17670 − 2620 + 270	= 10150	g/m^2

TABLE 3 Summary of Results of Table 2 and Conversion to Inch-Pound Units

Line in Table 1	Reference	Identification	Results in Units		Conversion Factor	Results in Inch-Pound Units	
10	6.4.2	number of plies	4.13	plies	...	4.1	plies
6	6.3.3	*approximate* top coating bitumen per unit area	3100	g/m^2	0.02048	63	$lb/100\ ft^2$
13	6.6.1	*approximate* interply mopping bitumen per ply	1650	g/m^2	0.02048	34	$lb/100\ ft^2$
16	6.6.3	*approximate* total applied bitumen per unit area	10150	g/m^2	0.02048	208	$lb/100\ ft^2$
7	6.3.3	surfacing (aggregate) per unit area	17650	g/m^2	0.02048	361	$lb/100\ ft^2$