Designation: E 252 – 84 (Reapproved 1999)

Standard Test Method for Thickness of Thin Foil and Film by Weighing[1]

This standard is issued under the fixed designation E 252; 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 This test method covers the determination of the thickness of metallic foils 0.002 in. (0.05 mm) and less in thickness by weighing a specimen of known area and density. The test method is applicable to other foils and films as indicated in Annex A3.

1.2 The values stated in inch-pound units are to be regarded as the 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 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 The following documents of the issue in effect on the date of material purchase, unless otherwise noted, form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique[2]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[3]

3. Apparatus

3.1 *Precision Blanking Press*—to cut foil circles that are 8.000 ± 0.008 in.^{2} (51.613± 0.051 cm^2) in area or 3.1915 ± 0.0015 in. (81.06 ± 0.04 mm) in diameter. Other size specimens may be used with the recognition that the accuracy stated in 6.1 is no longer applicable. See Annex A1 for the selection of other specimen sizes and the resulting change in accuracy of the test method.

3.2 *Balance*—capable of measuring to the nearest 0.1 mg of thickness for the 8.000-in.^{2} (51.613-cm^2) circle.

4. Procedure

4.1 Blank an 8.000 ± 0.008-in.^{2} (51.613 ± 0.051-cm^2) circle representative of the foil swab with acetone or other suitable solvent to ensure a surface free of soil, and weigh the clean, dry specimen to the nearest 0.1 mg. Use a suitable solvent to remove any coating known to exceed 0.005 mg/ft^2 (4.645 mg/cm^2) of surface area.

5. Calculation

5.1 Determine the thickness from the relationship:

$$T = W/AD$$

where:

T = thickness of the foil or film, in. (or cm),
W = weight of the circle, g,
A = area of the circle, in.^{2} (or cm^2), and
D = density of the foil, g/in.^{3} (or Mg/m^3).

5.2 *Densities of Aluminum Alloys*:

5.2.1 Calculate the density of aluminum foil from chemical composition limits of the alloy by the method described in Annex A2. The densities of foil alloys determined in this manner are accurate to within ± 0.3 %.

5.2.2 Table 1 lists densities computed for some of the common foil alloys. A column headed "Mils/g for 8.000-in.^{2} Area" is added for convenience in determining thickness of the 8.000-in.^{2} (51.613-cm^2) specimens. The weight of the specimen in grams multiplied by this factor is equal to the thickness of the foil in mils.

6. Precision and Bias

6.1 Following the procedure outlined in this test method, repeated weighings of the same specimen on different balances should result in agreement within 1 mg. It is outside of the scope of this test method to describe maintenance and calibration procedures for balances, but disagreement larger than 1 mg warrants attention to maintenance or recalibration of the balance.

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[1] This test method is under the jurisdiction of ASTM Committee B-7 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.05 on Testing.

Current edition approved Aug. 31, 1984. Published November 1984. Originally published as E 252–64T. Last previous edition E 252–78.

[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

TABLE 1 Densities of Aluminum Foil Alloys Applicable to the Determination of Foil Thickness by the Weight Method

Alloy	Density		mils/g for 8.000-in.^{2} Area
	g/in.^{3}	Mg/m$^{3\,A}$	
1100	44.41	2.71	2.815
1145	44.24	2.700	2.826
1188	44.24	2.700	2.826
1199	44.24	2.700	2.826
1235	44.33	2.705	2.820
3003	44.74	2.73	2.794
5052	43.92	2.68	2.846
5056	43.26	2.64	2.890
8079	44.57	2.72	2.805
8111	44.41	2.71	2.815

^{A} *Registration Record of Aluminum Association Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys*, Aluminum Assoc., Washington, DC.

ANNEXES

(Mandatory Information)

A1. SPECIMEN SIZE AND SHAPE AND ITS EFFECT ON ACCURACY

A1.1 General

A1.1.1 Specimens of sizes and shapes other than the 8.000-in.^{2} (51.613-cm^2) circle maybe used provided consideration is given to controllable factors affecting the accuracy of the method. Specifically, the area of the specimen shall be known and controlled to an accuracy of ±0.1 % and the minimum weight of specimen shall be 70 mg. Specimens ranging in size from 8 to 32 in.^{2} (52 to 206 cm^2) are convenient to handle and can be prepared to meet the aforementioned requirements.

A1.2 Source of Error

A1.2.1 Inherent errors in determining thickness by the weight method result from the limits on the accuracy of the density value assigned to the alloy, the accuracy with which a specimen can be cut and its area determined, and the accuracy of weighing. Much time could be devoted to a discussion of refinement of errors but it shall suffice here to draw on experience as a guide for determining the accuracy of the method.

A1.3 Error from Uncertainty of the Densities of the Specimen (E_D)

A1.3.1 The density of aluminum foil alloys shall be those listed in Table 1 or shall be determined by the method described in Annex A2. Values so obtained are accurate to ±0.3 % of the true density. The error imposed by uncertainty of the density then is $E_D = \pm 0.3$ % of the thickness determined.

A1.4 Error from Control of the Area of the Specimen (E_A)

A1.4.1 A precision blanking press can cut a specimen whose area is known and reproducible to an accuracy of ±0.1 %. If d is the specific diameter required to provide the area used in the thickness computation, then the error in area resulting from a small error, Δd, in the diameter is 200 $\Delta d/d$ %. It follows then that to maintain an area accurate to ±0.1 %, the tolerance on the diameter of the blanked circle shall be ±0.0005 times the circle diameter. The fact that the tolerance on diameter loosens in direct proportion to the diameter is a factor to consider in selecting the specimen size to use in the method. Compliance with this tolerance limits the area error to $E_A = \pm 0.1$ % of the thickness determined.

A1.5 Error from Weighing the Specimen (E_W)

A1.5.1 The accuracy of weighing a foil specimen has been found to be 0.7 mg. This imposes a maximum error on the method of ± 0.07/*TAD*% of the thickness determined. Since *D*, density of the foil, is fixed, it is seen that the magnitude of the weighing error is a function of the thickness, *T*, of the foil and the area, *A*, of the specimen. The area, *A*, is a controllable factor in the method, and the importance of selecting a large area to minimize the overall percentage error in the method for thin foil is apparent from a few simple calculations. The product *TAD* is the weight of the specimen in grams, so to prevent the weighing error from introducing errors in excess of ±1.0 %, it is necessary that the weight of the minimum thickness specimen be larger than 70 mg. The maximum error in the method due to weighing then is $E_W = \pm$ 0.07/*TAD* % of the thickness determined.