



Designation: B101 – 22

Standard Specification for Lead-Coated Copper Sheet and Strip for Building Construction¹

This standard is issued under the fixed designation B101; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification establishes the requirements for lead-coated copper sheet and strip in flat lengths (or in coils) in ounce-weight thicknesses for roofing, flashing, gutters, downspouts, and for the general sheet metalwork for outside building construction. The lead coating is applied by hot dipping.

1.1.1 Products produced to this specification are not intended for electrical applications.

1.1.2 This product is not designed to be used for decorative, ornamental, or wall panel applications.

1.2 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

NOTE 1—A companion specification for copper sheet and strip for building construction is Specification B370.

1.3 The following hazard caveat pertains to the test method portion, Section 17, of this specification. *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This specification is under the jurisdiction of Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

Current edition approved May 1, 2022. Published May 2022. Originally approved in 1935. Last previous edition approved in 2019 as B101–12 (2019). DOI: 10.1520/B0101-22.

2. Referenced Documents

2.1 ASTM Standards:²

B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar

B370 Specification for Copper Sheet and Strip for Building Construction

B846 Terminology for Copper and Copper Alloys

B950 Guide for Editorial Procedures and Form of Product Specifications for Copper and Copper Alloys

E8/E8M Test Methods for Tension Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E37 Test Methods for Chemical Analysis of Pig Lead (Withdrawn 2020)³

E46 Test Methods for Chemical Analysis of Lead- and Tin-Base Solder (Withdrawn 1994)³

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)³

E112 Test Methods for Determining Average Grain Size

E478 Test Methods for Chemical Analysis of Copper Alloys

3. General Requirements

3.1 The following sections of Specification B248 constitute a part of this specification:

3.1.1 Significance of numerical limits,

3.1.2 Inspection,

3.1.3 Rejection and rehearing,

3.1.4 Certification,

3.1.5 Test reports, and

3.1.6 Packaging and package marking.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

*A Summary of Changes section appears at the end of this standard

3.2 In addition, when a section with a title identical to that referenced in 3.1, above, appears in this specification, it contains additional requirements that supplement those appearing in Specification B248.

4. Terminology

4.1 For definitions of terms related to copper and copper alloys, refer to Terminology B846.

4.2 Definitions of Terms Specific to This Standard:

4.2.1 *coil*—a length of the product wound into a series of connected turns.

4.2.1.1 *Discussion*—The unqualified term “coil” as applied to “flat product” usually refers to a coil in which the product is spirally wound, with the successive layers on top of one another. (Sometimes called a “roll.”)

4.2.2 *flashing, n*—an impervious lead-coated copper sheet or strip used in a building envelope to create a barrier to prevent water penetration or direct the flow of moisture.

4.2.2.1 *Discussion*—This can include, but is not limited to, the heads of windows and doors, the edge components of roof systems, changes in building planes, around chimneys, roof vents, skylights, decks and other penetrations, and other conditions requiring a watertight or water-shedding solution.

4.2.3 *lead-coated copper sheet (for building construction), n*—a rolled flat product over 24 in. (610 mm) in width and of ounce-weight thickness from 8 oz (227 g) to 48 oz (1361 g).

4.2.4 *lead-coated strip (for building construction), n*—a rolled flat product up to and including 24 in. (610 mm) in width and of ounce-weight thickness from 8 oz (227 g) to 48 oz (1361 g).

4.2.5 *lengths, mill, n*—straight lengths, including ends, that are conveniently manufactured in the mills.

4.2.5.1 *Discussion*—Full length pieces are usually 8 ft, 10 ft, or 12 ft (2.44 m, 3.05 m, or 3.66 m) and subject to established length tolerances.

4.2.6 *ounce-weight*—the weight of uncoated copper sheet or strip expressed in ounces per square foot.

4.2.7 *thickness, ounce-weight, n*—the metal thickness that corresponds to the ounce weight.

5. Ordering Information

5.1 Include the following specified choices when placing orders for product under this specification, as applicable:

- 5.1.1 ASTM designation and year of issue.
- 5.1.2 Temper (Section 8 and Table 2),
- 5.1.3 How furnished: flat lengths or in coils,
- 5.1.4 Quantity: total weight or sheets of each size,
- 5.1.5 Ounce-weight or ounce-weight thickness of the uncoated copper sheet or strip (Table 3),
- 5.1.6 Dimensions: width and length (Section 12),

5.2 The following options are available and, when required, shall be specified at the time of placing of the order:

- 5.2.1 Heat identification or traceability details.
- 5.2.2 Certification, where required (see 5.1.4),
- 5.2.3 Test report, where required (see 5.1.5), and

5.2.4 If the material being purchased is intended for use by agencies of the U.S. government, refer to Section 11.

5.2.5 Other variations in coating or texture shall be furnished by agreement in writing between the purchaser and the manufacturer or supplier.

6. Materials and Manufacture

6.1 Materials:

6.1.1 The material of manufacture shall be in the form of copper strip or sheet that conforms to the requirements of Specification B370.

6.1.2 The lead coating shall conform to the chemical requirements of Table 1.

NOTE 2—Due to the discontinuous nature of the processing of castings into wrought products, it is not always practical to identify a specific casting analysis with a specific quantity of finished material.

6.2 Manufacture:

6.2.1 The product shall be manufactured by hot dipping the copper sheet or strip in a bath of molten lead to produce the finished product.

6.2.2 Unless otherwise specified, the lead coating shall be applied to the copper sheet after slitting and cutting to the specified length.

6.2.3 Unless otherwise specified, the lead coating shall be applied to the copper strip before slitting.

7. Chemical Composition

7.1 The copper sheet or strip shall have a minimum copper, including silver, content of 99.5 %.

7.2 Any copper that complies with 7.1 shall be acceptable.

7.3 If limits for unnamed elements are required, they shall be established and analysis required by agreement between the manufacturer or supplier and purchaser.

7.4 The lead coating shall conform to the chemical requirements of Table 1.

8. Temper

8.1 The standard tempers of the uncoated copper sheet and strip described in this specification are given in Table 2.

8.1.1 Annealed Temper O60.

8.1.2 Cold rolled tempers H00 (eighth hard, cold-rolled); and H01 (quarter hard, cold-rolled high yield).

TABLE 1 Chemical Requirements for Lead Used to Coat Copper Sheet

Element	Composition, % (Maximum unless shown as range or remainder)
Silver	0.02
Copper	0.08
Arsenic plus antimony	0.10
Zinc	0.005
Iron	0.01
Bismuth	0.08
Lead	remainder
Tin	3.0-4.0
Phosphorus	0.03

TABLE 2 Mechanical Properties of Uncoated Sheet

Temper Designation		Tensile Strength, ksi ^A (MPa)		Yield Strength, at 0.5 % Extension Under Load, min, ksi (MPa)	Approximate Rockwell Hardness ^B (for Information Only)			
Standard	Former	Min	Max		F Scale		Superficial 30 T	
					Min	Max	Min	Max
O60	soft	30 (205)	38 (260)	65	...	31
H00	cold-rolled	32 (220)	40 (275)	20 (140)	54	82	15	49
H01	cold-rolled (high yield)	34 (235)	42 (290)	28 (195)	60	84	18	51

^A ksi = 100 psi.

^B Rockwell hardness values apply as follows: The F scale applies to metal 0.020 in. (0.508 mm) and over in thickness; the superficial 30T scale applies to metal 0.012 in. (0.305 mm) to 0.020 in. (0.508 mm) in thickness.

9. Grain Size for Annealed Temper

9.1 Grain Size Requirement:

9.1.1 The soft annealed temper uncoated product furnished under this specification shall have a minimum grain size of 0.010 mm when tested to Test Methods E112.

9.1.2 Acceptance or rejection for the soft temper based upon the physical properties shall depend on the grain size.

10. Mechanical Property Requirements

10.1 Tensile and Yield Strength Requirements:

10.1.1 The uncoated product furnished under this specification shall conform to the tensile and yield strength requirements prescribed in Table 2 when tested in accordance with Test Methods E8/E8M. Tension test specimens shall be taken so that the longitudinal axis of such specimens is parallel to the direction of rolling.

10.1.2 Acceptance or rejection based upon mechanical properties shall depend on the tensile and yield strength.

10.2 Rockwell Hardness:

10.2.1 The approximate Rockwell hardness values given in Table 2 are for general information and assistance in testing and shall not be used as a basis for product rejection.

NOTE 3—The Rockwell hardness test offers a quick and convenient method of checking for general conformity to the specification requirements for temper and tensile strength.

11. Purchases for the U.S. Government

11.1 When specified in the contractor purchase order, product purchased for an agency of the U.S. government shall conform to the special government requirements specified in the Supplementary Requirements section of Specification B248.

12. Dimensions, Mass, and Permissible Variations

12.1 *Weight*—The weight of the lead-coated sheet and strip copper shall conform to the minimum requirements of Table 3.

12.2 *Width*—The tolerances for width of sheets shall be as shown in Table 4.

12.3 *Length*—Sheets ordered to exact lengths shall be permitted to have a variation of +1/4 in. (+6.5 mm) in length.

12.4 *Straightness*—The tolerances on straightness or edge-wise curvature (depth of arc) in any 72 in. (2 m) portion of the total length shall be as specified in Table 5 for slit metal and Table 6 for square-sheared metal.

TABLE 3 Sheet Weights

Nominal Weights and Thickness of Bare Copper Sheets		Minimum Weight of Lead-Coated Copper Sheet
Ounce-Weight, oz/ft ²	Ounce-Weight Thickness, ^A in. (mm)	oz/ft ² (g/m ²)
24	0.0323 (0.820)	25.0 (7625)
20	0.0270 (0.686)	21.2 (6466)
16	0.0216 (0.549)	17.3 (5276)
12	0.0162 (0.411)	13.2 (4026)

^A Based upon a density of 0.322 lb/in.³ (8.91 g/cm³).

TABLE 4 Width Tolerances

Width, in. (mm)	Tolerances, in. (mm)
5 (125) and under	+0.025 (0.6)–0
Over 5–14 (125–355), incl	+0.050 (1.3)–0
Over 14 (355)	+0.125 (3.2)–0

TABLE 5 Straightness Tolerances for Slit Metal

Width, in. (mm)	Straightness Tolerance, in. (mm)
Over 4 to 24 (102 to 610), incl	1/2 (13)

TABLE 6 Straightness Tolerances for Square-Sheared Metal

NOTE 1—Maximum edgewise curvature (depth of arc) in any 72 in. (1.83 m) portion of the total length (not applicable to metal over 120 in. (3.05 m) in length).

	Straightness Tolerances, in. (mm)	
	Up to 10 in. (254 mm) incl. in Width	Over 10 in. (254 mm) in Width
All thicknesses	1/16 (1.6)	1/32 (0.8)

13. Workmanship, Finish, and Appearance

13.1 Lead Coating:

13.1.1 The lead coating shall cover both surfaces, edges, and ends for sheet product.

13.1.2 The lead coating shall cover at least both surfaces for strip products.

13.1.3 The coating shall be smooth and free from pinholes, voids, or unwetted areas, but blemishes of a nature that do not interfere with the intended application are acceptable.

13.1.4 The weight of the lead coating shall conform to the requirements of Table 7.

14. Sampling

14.1 Refer to Specification B248 for chemical and mechanical properties.

TABLE 7 Weight of Lead Coating, lb (kg)^A

Min	Max
12 (5.4)	15 (6.8)

^A The weight of coating specified is the total weight of lead applied to two sides of 100 ft² (9.3 m²) of copper sheet, approximately one half of the coating to be on each side of the sheet.

14.2 Weight of Coating Tests:

14.2.1 *Method A*—Test ten sheets selected at random.

14.2.2 *Methods B and C*—Test four representative samples cut from the diagonal of one sheet selected at random.

15. Number of Tests and Retests

15.1 Tests:

15.1.1 Refer to the section of Specification **B248** for chemical and mechanical tests.

15.1.2 A test on each specimen taken in **14.2.1** or **14.2.2**, as applicable, shall be made for the determination of lead.

15.2 Retests:

15.2.1 When a specimen fails to meet the requirements of a test, one retest shall be made under the conditions of the original test.

15.2.2 All specimens must conform to test requirements when retested or the material may be rejected.

16. Specimen Preparation

16.1 Refer to Specification **B248** for the chemical and mechanical property test specimen preparation.

16.2 Weight of Coating Tests:

16.2.1 Refer to **17.4.2** of this specification for Method A.

16.2.2 Refer to **17.4.3** of this specification for Method B.

16.2.3 Refer to **17.4.4** of this specification for Method C.

17. Test Methods

17.1 Chemical Analysis:

17.1.1 In case of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer or supplier and the purchaser. The following table is a list of published methods, some of which may no longer be viable, which along with others not listed, may be used subject to agreement. The methods listed are for both the lead coating and the copper substrate.

Element	Range, %	Test Method
Copper	99.0 min	E478
	0.001 to 0.1	E37
Lead	95.0 to 100	by difference
Tin	0.001 to 0.02	E37
	1 to 4	E46
Silver	0.001 to 0.03	E37
Arsenic	0.0005 to 0.02	E37
Antimony	0.001 to 0.03	E37
Zinc	0.001 to 0.005	E37
Iron	0.0005 to 0.005	E37
Bismuth	0.002 to 0.2	E37
Phosphorous	0.001 to 0.03	E62

17.1.2 Test method(s) used for the determination of element(s) required by contractual or purchase order agreement shall be agreed upon between the manufacturer and the purchaser.

17.2 Physical Requirements:

17.2.1 *Grain Size*—Grain size shall be determined in accordance with Test Methods **E112**.

17.3 Mechanical Requirements:

17.3.1 *Tensile Strength*—Tensile strength shall be determined in accordance with Test Methods **E8/E8M**.

17.3.2 *Yield Strength*—Yield strength shall be determined at 0.5 % extension-underload of Test Methods **E8/E8M**.

17.3.3 Test results are not seriously affected by variations in speed or testing. A considerable range of testing speed is permitted; however, the rate of stressing to the yield strength should not exceed 100 ksi/min. Above the yield strength, the movement per minute of the testing machine head under load should not exceed 0.5 in./in. of gauge length (or distance between grips for full-section specimens).

17.4 Other Tests:

17.4.1 *Weight of Coating Test*—When testing is specified, the determination of the lead coating shall be made in accordance with one of the three following methods:

17.4.2 *Method A*—Select at random ten sheets from those being coated. Weigh these ten sheets before and after coating and calculate the weight of the coating from the difference in weight on the basis of the ordered size.

17.4.3 *Method B*—Select at random one sheet from the lead-coated sheets furnished. Cut four representative samples 2¼ in. by 2¼ in. (60 mm by 60 mm) from each sheet, uniformly spaced along a diagonal, the end samples being taken not less than 1 in. (25 mm) from the edge. Weigh and then completely dissolve the four samples of sheet obtained. Determine the copper by electrolytic assay in accordance with Test Methods **E478**. Calculate the weight of the lead coating as the difference between the total weight of the samples and the weight of copper found.

17.4.4 *Method C*—Select at random one sheet from the lead-coated sheets furnished. Cut four representative samples 2¼ in. by 2¼ in. (60 mm by 60 mm) from the sheet, uniformly spaced along a diagonal, the end samples being taken not less than 1 in. (25 mm) from the edge. After removing the burrs, clean each sample and rinse with alcohol and ether. Obtain the weight of the specimens and the weight of the coating from measurements taken of the specific gravity or density of these samples as determined by the usual method of weighing in air and in water.

17.4.5 Calculations are as follows:

$$\text{Weight of lead coating, lb/100 ft}^2 = (29.1 - 259/D)W \quad (1)$$

$$\text{Weight of bare copper sheet, oz/ft}^2 = (41.5/D - 3.66)W \quad (2)$$

where:

W = weight of the sample in air, g;

D = density of the sample = $(W \times D_t)/(W - M)$;

D_t = density of water at room temperature; and

M = weight of the sample in water, g.

NOTE 4—To convert lb/100 ft² to kg/m², multiply by 0.0488. To convert oz/ft² to kg/m², multiply by 0.305.

17.4.6 In case of dispute, the weight of the coating shall be determined by Method B.