



Designation: B170 – 24

Standard Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes¹

This standard is issued under the fixed designation B170; 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 reappraisal. A superscript epsilon (ε) indicates an editorial change since the last revision or reappraisal.

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

1. Scope

1.1 This specification covers the requirements for two grades of oxygen-free electrolytic copper wire bars, billets, and cakes produced without the use of metallic or metaloidal deoxidizers.

1.2 Oxygen-free copper, as described herein, is defined as copper containing oxygen not in excess of 0.0010 % (10 ppm).

1.2.1 Grade 1 copper (UNS C10100) corresponds to the designation OFE in Classification [B224](#).

1.2.2 Grade 2 copper (UNS C10200) corresponds to the designation OF in Classification [B224](#).

1.2.3 Grade 2 copper may be used to produce OFS designation coppers corresponding to UNS C10400, C10500, and C10700.

1.3 Although this specification includes certain UNS designations as described in Practice [E527](#), these designations are for cross reference only and are not specification requirements. In case of conflict, Specification B170 shall govern.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only, except for analytical measurements where SI units are the norm.

1.5 The following hazard caveat pertains only to Section [13](#) and [Annex A1](#) 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.*

1.6 *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 ASTM Committee [B05](#) on Copper and Copper Alloys and is the direct responsibility of Subcommittee [B05.07](#) on Refined Copper.

Current edition approved July 1, 2024. Published July 2024. Originally approved in 1942. Last previous edition approved in 2020 as B170 – 99 (2020). DOI: 10.1520/B0170-24.

2. Referenced Documents

2.1 *ASTM Standards:*²

[B5](#) Specification for High Conductivity Tough-Pitch Copper Refinery Shapes

[B193](#) Test Method for Resistivity of Electrical Conductor Materials

[B224](#) Classification of Coppers

[B577](#) Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper

[B846](#) Terminology for Copper and Copper Alloys

[E29](#) Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

[E50](#) Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials

[E53](#) Test Method for Determination of Copper in Unalloyed Copper by Gravimetry (Withdrawn 2022)³

[E76](#) Test Methods for Chemical Analysis of Nickel-Copper Alloys (Withdrawn 2003)³

[E255](#) Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

[E527](#) Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

3. Terminology

3.1 *Definitions:*

3.1.1 Definition of terms used shall be that found in Classification [B224](#) and Terminology [B846](#).

3.1.2 *impurity total, n*—defined as the sum of antimony, arsenic, bismuth, cadmium, iron, lead, manganese, nickel, oxygen, phosphorus, silver, selenium, sulfur, tellurium, tin, and zinc.

4. Ordering Information

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

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. 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.

4.1.1 ASTM designation and year of issue.

4.1.2 Grade.

4.1.2.1 Grade 1 copper, (UNS C10100), corresponds to the designation OFE in Classification **B224**.

4.1.2.2 Grade 2 copper (UNS C10200), corresponds to the designation OF in Classification **B224**.

4.1.3 Shape and size.

4.1.4 Quantity.

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

4.2.1 Certification.

4.2.2 Test report.

4.2.3 Piece identification.

4.2.4 The amount of silver required in troy oz/short ton for silver bearing (OFS) coppers.

4.2.4.1 The addition of silver up to an average of 30 troy oz/short ton (0.102 %) will be considered within the specification, with no individual silver analysis to exceed 35 troy oz/short ton (0.12 %).

4.2.4.2 Copper with added silver corresponds to the designation OFS as shown in Classification **B224** and to coppers UNS C10400, C10500, and C10700 as defined by the agreed silver content.

5. Chemical Composition

5.1 The composition of each grade shall be in accordance with the requirements of **Table 1**.

5.2 By agreement between purchaser and supplier, analysis may be required and limits established for elements not specified in **Table 1**.

6. Physical Properties

6.1 *Electrical Resistivity:*

6.1.1 The maximum mass resistivity for Grade 1 is 0.15176 Ω g/m² (conductivity 101 %, minimum, International Annealed Copper Standards, IACS).

6.1.2 The maximum mass resistivity for Grade 2 is 0.15328 Ω g/m² (conductivity 100 %, minimum, IACS).

6.2 *Embrittlement Test:*

6.2.1 Grade 1 shall withstand ten *reverse* bends without breaking, in accordance with Test Method D of Test Methods **B577**.

6.2.2 Grade 2 shall withstand eight *reverse* bends without breaking in accordance with Test Method D of Test Methods **B577**.

7. Dimensions, Mass, and Permissible Variations

7.1 *Standard Shapes and Sizes*—The copper shall be supplied in the form of wire bars, cakes, and billets (**Note 1**).

NOTE 1—For available shapes and sizes consult the manufacturer's published list.

7.1.1 Wire bars covered by this specification do not conform in dimension to Specification **B5**.

7.2 *Wire Bars:*

7.2.1 A variation of 5 % in weight, or

7.2.2 A variation of ¼ in. (6.4 mm) in height, or width, or both, or

7.2.3 A variation of 1 % in length from the purchaser's specification shall be considered good delivery.

7.3 *Cakes:*

7.3.1 A variation of 5 % in weight, or

7.3.2 A variation of ¼ in. (6.4 mm) in height or width, or both, from the purchaser's specification shall be considered good delivery.

7.3.3 Cakes may vary by 3 % from any listed or specified dimension greater than 8 in. (203.2 mm).

7.4 *Billets:*

7.4.1 For billets up to 6 in. (152.4 mm) in diameter, a variation of 5 % in weight and $\pm 1/16$ in. (1.6 mm) in diameter from the purchaser's specification shall be considered good delivery.

7.4.2 For billets 6 in. (152.4 mm) and over in diameter, the diameter tolerance shall be $+1/16$ in., $-1/8$ in. (+1.6 mm, -3.2 mm) for good delivery.

7.4.3 By agreement between the manufacturer and the purchaser a diameter tolerance of $+0$ in., $-3/16$ in. ($+0$ mm, -4.8 mm) may be specified for billets 6 in. (152.4 mm) and over in diameter.

7.4.4 Billets varying in length by ± 2 % from the listed or specified length shall be considered good delivery.

7.4.5 Billets shall be straight within ¼ in. (6.4 mm) in 4 ft (1.22 m) as measured at the center of the billet.

7.4.6 Billets shall not be cupped except by specific agreement at time of purchase.

8. Workmanship, Finish, and Appearance

8.1 *Wire Bars, Billets, and Cakes*—Shall be substantially free of shrink holes, porosity, cracks, cold sets, pits, inclusions, and similar defects.

9. Sampling

9.1 For routine sampling, the method of sampling shall be at the discretion of the sampler.

TABLE 1 Chemical Composition^A

Element	Grade 1	Grade 2
Copper, min %	99.99 ^B	...
Copper (including silver), min %	...	99.95
	ppm, max	ppm, max
Antimony	4	...
Arsenic	5	...
Bismuth	1	...
Cadmium	1	...
Iron	10	...
Lead	5	...
Manganese	0.5	...
Nickel	10	...
Oxygen	5	10
Phosphorus ^C	3	...
Selenium	3	...
Silver	25	...
Sulfur	15	...
Tellurium	2	...
Tin	2	...
Zinc	1	...

^A Analytical uncertainty is not incorporated into the specified limits.

^B Copper is determined by the difference of impurity total from 100.

^C Refer to Section **13**.