Designation: ~~B194 – 15~~ B194 – 22

Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar[1]

This standard is issued under the fixed designation B194; 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 copper-beryllium alloy plate, sheet, strip, and rolled bar. The following alloys are specified:

~~Copper Alloy~~ UNS No.	~~Previously Used Commercial Designations~~
~~C17000~~	~~Alloy 165~~
~~C17200~~	~~Alloy 25~~

Copper Alloy UNS No.	Nominal Beryllium Composition, %
C17000	1.7
C17200	1.9

1.2 Unless otherwise specified in the contract or purchase order, Copper Alloy UNS No. C17200 shall be the alloy furnished.

1.3 *Units*—~~Values~~ 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.

1.4 The following safety hazard caveat pertains only to the test method(s) described in ~~the annex of~~ this specification:

1.4.1 *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~~ safety, health, and ~~health~~environmental practices and to determine the applicability of regulatory limitations prior to use.*

1.5 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

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[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~~standard's Document Summary page on the ASTM website.

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

B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar
B248M Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar (Metric)
B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast
B820 Test Method for Bend Test for Determining the Formability of Copper and Copper Alloy Strip
B846 Terminology for Copper and Copper Alloys
E8/E8M Test Methods for Tension Testing of Metallic Materials
E18 Test Methods for Rockwell Hardness of Metallic Materials
E112 Test Methods for Determining Average Grain Size
~~E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)~~

3. General Requirements

3.1 The following sections of Specification B248 or B248M constitute a part of this specification:

3.1.1 Terminology

3.1.2 Materials and Manufacture

3.1.3 Dimensions, Weights, and Permissible Variations

3.1.4 Workmanship, Finish, and Appearance

3.1.5 Sampling

3.1.6 Number of Tests and Retests

3.1.7 Specimen Preparation

3.1.8 Test Methods

3.1.9 Significance of Numerical Limits

3.1.10 Inspection

3.1.11 Rejection and Rehearing

3.1.12 Certification

3.1.13 Test ~~Report~~Reports

3.1.14 Packaging and Package Marking.

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 or B248M.

4. Terminology

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

5. Ordering Information

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

5.1.1 ASTM designation and year of issue,

5.1.2 Copper ~~[Alloy]~~Alloy UNS No. ~~designation (~~designation,~~1.1),~~

5.1.3 Form of material: plate, sheet, strip, or rolled bar,

5.1.4 Temper ~~(~~(Section ~~7.1~~7),

5.1.5 Dimensions: thickness and width, and length if ~~applicable.~~applicable,

5.1.6 How furnished: ~~rolls,~~coils, stock lengths with or without ends, specific lengths with or without ends,

5.1.7 ~~Quantity: total~~ Quantity—total weight or total length or number of pieces of each size, and

~~5.1.8 Type of edge, if required: slit, sheared, sawed, square corners, rounded corners, rounded edges, or full-rounded edges (Specification B248, Section 5.6),~~

~~5.1.9 Type of width and straightness tolerances, if required: slit-metal tolerances, square-sheared-metal tolerances, sawed-metal tolerances, straightened or edge-rolled-metal tolerances (Specification B248, Section 5.3),~~

~~5.1.10 Special thickness tolerances, if required (Specification B248, Table 3),~~

5.1.8 Tension test or hardness as applicable (Section 8~~),~~).

5.2 The following options are available ~~but may not be included unless~~ and should be specified at the time of placing ~~of~~ the order when required:

5.2.1 Type of edge: slit, sheared, sawed, square corners, rounded corners, rounded edges, or full-rounded edges (Specification B248 or B248M, Subsection 5.6),

5.2.2 Special width and straightness tolerances: slit-metal tolerances, square-sheared-metal tolerances, sawed-metal tolerances, straightened or edge-rolled-metal tolerances (Specification B248 or B248M, Subsection 5.3 or 5.5),

5.2.3 Special thickness tolerances: (Specification B248 or B248M, Table 3),

5.2.4 Bend ~~test, if required~~ test (Section 11),

5.2.5 Grain size ~~or grain count, if required~~ (Section 9 ~~or 10~~),

5.2.6 Grain count (Section 10),

5.2.7 ~~Certification, if required~~Certification (Specification B248 ~~(see Specification~~ or ~~B248~~B248M, Section 14),

5.2.8 Test ~~Report, if required~~Report (Specification B248 ~~(see Specification~~ or ~~B248~~B248M, Section 15),

5.2.9 Special tests or exceptions, if any.

5.3 If the product is purchased for agencies of the U.S. Government, see the Supplementary Requirement of Specification B248 or B248M for additional requirements, if specified.

6. Chemical Composition

6.1 The material shall conform to the chemical composition requirements ~~specified~~ in Table 1 for the ~~copper [alloy]~~Copper Alloy UNS No. designation specified in the ordering information.

6.1.1 Results of analysis on a product (check) sample shall conform to the composition requirements within the permitted analytical variance specified in Table 1.

6.2 These composition limits do not preclude the presence of other elements. By agreement between manufacturer and purchaser, limits may be established and analysis required for unnamed elements.

TABLE 1 Chemical Requirements

Element	Composition, %	
	Copper Alloy UNS No. C17000	Copper Alloy UNS No. C17200
Beryllium	1.60–1.85	1.80–2.00
Additive elements:		
Nickel + cobalt, min	0.20	0.20
Nickel + cobalt + iron, max	0.6	0.6
Aluminum, max	0.20	0.20
Silicon, max	0.20	0.20
Copper	remainder	remainder

6.3 ~~These composition limits do not preclude the presence of other elements. By agreement between manufacturer and purchaser, limits may be established and analysis required for unnamed elements. Copper~~ For alloys in which copper is listed as "remainder," ~~and may be taken as~~ copper is the difference between the sum of results of all elements ~~analyzed~~determined and 100 %. When all elements in Table 1 are determined, the sum of ~~the~~ results shall be 99.5 % minimum.

7. Temper

7.1 The standard tempers for products described in this specification are given in Table 2, Table 3, Table 4, and Table 5.

7.1.1 Solution Heat Treated TB00.

7.1.2 Solution Heat Treated and Cold Worked TD00 to TD04.

7.1.3 Solution Heat Treated and Precipitation Heat Treated TF00.

7.1.4 Solution Heat Treated, Cold Worked and Precipitation Heat Treated TH01 to TH04.

7.1.5 Mill Hardened TM00 to TM08.

7.1.6 Plate is generally available in the TB00, TD04, TF00, and TH04 tempers.

8. Mechanical Property Requirements

8.1 ~~For product less than 0.050 in. (1.27 mm) in thickness:~~*Tensile Strength Requirements:*

8.1.1 Tensile ~~test results~~ strength for product less than 0.050 in. (1.27 mm) in thickness shall be the ~~product acceptance criteria,~~ standard test, when tested in accordance with Test Methods E8/E8M.

TABLE 2 Mechanical Property Requirements for Material in the Solution-Heat-Treated or Solution-Heat-Treated and Cold-Worked Condition

Temper Designation[A]		Material Thickness, in. (mm)		Tensile Strength, ksi[B] (MPa)[C]	Elongation[D] in 2 in. or 50 mm, min,%	Rockwell Hardness[E]		
Code	~~Former~~Name	Over	~~Incl~~To (incl)			B Scale	30T Scale	15T Scale
TB00	A	...	...	60–78 (415–540)	35	45–78	46–67	75–85
TD01	¼ H	...	0.188 (4.78)	75–88 (520–610)	15	68–90	62–75	83–89
TD02	½ H	...	0.188 (4.78)	85–100 (585–690)	9	88–96	74–79	88–91
TD04	H	...	0.188 (4.78)	100–130 (690–895)	2	96–104	79–83	91–94
TD04	H	0.188 (4.78)	0.375 (9.53)	90–130 (620–895)	...	91–103	77 min	90 min
TD04	H	0.375 (9.53)	1.000 (25.4)	90–120 (620–825)	...	90–102	...	...
TD04	H	over 1.000 (25.4)		85–115 (585–790)	8	88–102	...	...

[A] Standard designations defined in Classification B601.
[B] ksi = 1000 psi.
[C] See Appendix X1.
[D] Elongation requirement applies to material 0.004 in. (0.102 mm) and thicker.
[E] The thickness of material that may be tested by use of the Rockwell hardness scales is as follows:
B Scale.....0.040 in. (1.016 mm) and over
30T ~~Scale.....0.020~~Scale.....0.020 in. to 0.040 in. ~~(0.508~~(0.508 mm to 1.016 mm), excl.
15T ~~Scale.....0.015~~Scale.....0.015 in. to 0.020 in. ~~(0.381~~(0.381 mm to 0.508 mm), excl.
Hardness values shown apply only to direct determinations, not converted values.

TABLE 3 Mechanical Property Requirements After Precipitation Heat-Treatment[A]

Temper Designation		Material Thickness, in. (mm)		Tensile Strength, ksi[B] (MPa)[C]	Yield Strength, ksi (MPa), min, 0.2 % Offset	Elongation in 2 in. (50 mm), min, %[D]	Rockwell Hardness,[E] min		
Code	~~Former~~Name	Over	~~Incl~~To (incl)				C Scale	30N Scale	15N Scale
Copper Alloy UNS No. C17000									
TF00	AT	...	0.188 (4.78)	150–180[F] (1035–1240)	130 (895)	3	33	53	76.5
TF00	AT	0.188 (4.78)	...	165–195[F] (1140–1345)	130 (895)	3	36	56	78
TH01	¼ HT	...	...	160–190[F] (1105–1310)	135 (930)	2.5	35	55	77
TH02	½ HT	...	...	170–200[F] (1170–1380)	145 (1000)	1	37	57	78.5
TH04	HT	...	...	180–210[F] (1240–1450)	155 (1070)	1	38	58	79.5
Copper Alloy UNS No. C17200									
TF00	AT	...	...	165–195[F] (1140–1345)	140 (965)	3	36	56	78
TH01	¼ HT	...	0.188 (4.78)	175–205[F] (1205–1415)	150 (1035)	2.5	36	56	79
TH02	½ HT	...	0.188 (4.78)	185–215[F] (1275–1480)	160 (1105)	1	38	58	79.5
TH04	HT	...	0.188 (4.78)	190–220[F] (1310–1520)	165 (1140)	1	38	58	80
TH04	HT	0.188 (4.78)	0.375 (9.53)	180–215[F] (1240–1480)	160 (1105)	1	38	58	80
TH04	HT	0.375 (9.53)	1.000 (25.4)	180–210[F] (1240–1450)	155 (1070)	1	38	...	...
TH04	HT	1.000 (25.4)	2.000 (50.8)	175–205[F] (1205–1415)	150 (1035)	2	37	...	...
TH04	HT	over 2.000 (50.8)		165–200[F] (1140–1380)	130 (895)	2	36	...	...

[A] These values apply to mill products (Section 14). See 12.3 for exceptions in end products.
[B] ksi = 1000 psi.
[C] See Appendix X1.
[D] Elongation requirement applies to material 0.004 in. (0.102 mm) and thicker.
[E] The thickness of material that may be tested by use of the Rockwell Hardness scales is as follows:
C Scale.....0.040 in. (1.016 mm) and over
30N ~~Scale.....0.020~~Scale.....0.020 in. to 0.040 in. ~~(0.508~~(0.508 mm to 1.016 mm), excl.
15N ~~Scale.....0.015~~Scale.....0.015 in. to 0.02 in. ~~(0.381~~(0.381 mm to 0.508 mm), excl.
Hardness values shown apply only to direct determinations, not converted values.
[F] The upper limits in the tensile strength column are for design guidance only.

TABLE 4 Strip Mechanical Property Requirements—Mill-Hardened Condition[A]

Temper Designation		Tensile Strength, ksi[B] (MPa)[C]	Yield Strength, ksi (MPa), 0.2 % Offset	Elongation in 2 in. (50 mm), min, %[D]	Rockwell Hardness,[E] min		
Code	~~Former~~Name[B]				C Scale	30N Scale	15N Scale
Copper Alloy UNS No. C17000							
TM00	AM	100–110[F] (690–760)	70–95 (485–655)	18	18	37	67.5
TM01	¼ HM	110–120[F] (760–825)	80–110 (550–760)	15	20	42	70
TM02	½ HM	120–135[F] (825–930)	95–125 (655–860)	12	24	45	72
TM04	HM	135–150[F] (930–1035)	110–135 (760–930)	9	28	48	75
TM05	SHM	150–160[F] (1035–1100)	125–140 (860–965)	9	31	52	75.5
TM06	XHM	155–175[F] (1070–1205)	135–165 (930–1140)	3	32	52	76
Copper Alloy UNS No. C17200							
TM00	AM	100–110[F] (690–760)	70–95 (485–660)	16	R_B95	37	67.5
TM01	¼ HM	110–120[F] (760–825)	80–110 (550–760)	15	20	42	70
TM02	½ HM	120–135[F] (825–930)	95–125 (655–860)	12	23	44	72
TM04	HM	135–150[F] (930–1035)	110–135 (760–930)	9	28	48	75
TM05	SHM	150–160[F] (1035–1105)	125–140 (860–965)	9	31	52	75.5
TM06	XHM	155–175[F] (1070–1210)	135–170 (930–1170)	4	32	52	76
TM08	XHMS	175–190[F] (1210–1310)	150–180 (1035–1240)	3	33	53	76.5

[A] These values apply to mill products (Section 14). See 12.3 for exceptions in end products.
[B] ksi = 1000 psi.
[C] See Appendix X1.
[D] Elongation requirement applies to material 0.004 in. (0.102 mm) and thicker.
[E] The thickness of material that may be tested by use of the Rockwell Hardness scales is as follows:
C Scale.....0.040 in. (1.016 mm) and over
30N ~~Scale.....0.020~~Scale.....0.020 in. to 0.040 in. ~~(0.508~~(0.508 mm to 1.016 mm), excl.
15N ~~Scale.....0.015~~Scale.....0.015 in. to 0.020 in. ~~(0.381~~(0.381 mm to 0.508 mm), excl.
Hardness values shown apply only to direct determinations, not converted values.
[F] The upper limits in the tensile strength column are for design guidance only.

8.1.2 The tensile strength requirements are given in Table 2, Table 3, and Table 4.

8.1.3 Acceptance or rejection for products less than 0.050 in. (1.27 mm) in thickness shall depend only on tensile properties.

8.2 ~~For product 0.050 in. (1.27 mm) and greater in thickness.~~*Rockwell Hardness Requirements:*

~~8.2.1 Rockwell hardness is the product acceptance criteria, when tested in accordance with Test Methods E18.~~

TABLE 5 Grain-Size Requirements for TB00 (Solution-Heat-Treated) Material

Thickness, in. (mm)	~~Grain Size Specified~~	Maximum Average Grain Size, mm
~~Over 0.010 to 0.030 (0.254 to 0.762), incl~~	~~OS035~~	~~0.035~~
~~Over 0.030 to 0.090 (0.762 to 2.29), incl~~	~~OS045~~	~~0.045~~
~~Over 0.090 to 0.188 (2.29 to 4.78), incl~~	~~OS060~~	~~0.060~~

TABLE 5 Grain-Size Requirements for TB00 (Solution-Heat-Treated) Material

Thickness, in. (mm)	Maximum Average Grain Size, mm
Over 0.010 to 0.030 (0.254 to 0.762), incl	0.035
Over 0.030 to 0.090 (0.762 to 2.29), incl	0.045
Over 0.090 to 0.188 (2.29 to 4.78), incl	0.060

8.2.1 ~~The referee product rejection criteria shall be tensile test results,~~Rockwell hardness for product 0.050 in. (1.27 mm) and greater in thickness shall be the standard test, when tested in accordance with Test Methods ~~E8/E8M~~E18.

8.2.2 The Rockwell hardness ~~and tensile strength~~ requirements are given in Table 2, Table 3, and Table 4.

8.2.3 Acceptance or rejection for product 0.050 in. (1.27 mm) and greater in thickness shall depend only on Rockwell hardness.

8.3 ~~Product, as specified in~~In cases of disagreement ~~7.1, shall conform to the requirements specified in~~ with Rockwell results, the acceptance ~~Table 2, in the solution heat-treated, or solution heat-treated and cold-worked conditions, and in~~ or rejection shall be ~~Table 3, after precipitation heat-treatment or Table 4 in the mill-hardened condition. Precipitation heat-treatment parameters for~~ the tensile properties, when tested ~~Table 2 and Table 3 are shown in Section~~accordance ~~12~~with Test Methods E8/E8M.

9. Grain Size

9.1 Acceptance or rejection based upon grain size shall depend on the average grain size of a test specimen from each of two sample portions, and each specimen shall be within the limits prescribed in Table 5 when determined in accordance with Test Methods E112.

9.2 ~~Material over 0.010 in. (0.254 mm) in thickness shall have an average grain size in accordance with Test Methods E112, not exceeding the limits specified in Table 5.~~ The determinations ~~are~~ shall be made on ~~the separate~~ samples ~~and~~ in a plane perpendicular to the surface and perpendicular to the direction of rolling.

10. Grain Count

10.1 The grain count of a sample of material, in any temper, over ~~0.004~~0.004 in. to 0.010 in. ~~(0.102~~(0.102 mm to 0.254 mm), inclusive, in thickness shall not be less than the limits specified in Table 6.

10.2 Grain count is the number of grains per stock thickness, averaged for five locations one stock thickness apart. Grain count shall be determined in a plane perpendicular to the surface and perpendicular to the direction of rolling.

11. Bend-Test Requirements

11.1 When specified in the contract or purchase order (see 5.2.4), the material shall conform to requirements agreed upon between manufacturer or supplier and purchaser when tested in accordance with Test Method B820.

TABLE 6 Grain-Count Requirements

Thickness, in. (mm)	Minimum Number of Grains
Over 0.004 to 0.006 (0.102 to 0.152), incl	6
Over 0.006 to 0.008 (0.152 to 0.203), incl	7
Over 0.008 to 0.010 (0.203 to 0.254), incl	8

11.2 The ~~optional~~ bend test is a method for evaluating ~~the ductility of precipitation heat-treated copper-beryllium strip in thin~~formability. It applies to the product 0.004 in. to 0.020 in. thick (0.102 mm to 0.508 mm) inclusive in Table 2 ~~gages.~~and Table 4.

~~11.2 When specified in the order (see 5.1.6), material in any temper 0.004 to 0.020 in. (0.102 to 0.508 mm), inclusive, in thickness shall conform to the requirements specified in Table 7, when tested in accordance with 14.2.~~

~~11.3 Five specimens, ⅜ ± 1⁄16 in. (9.53 ± 1.59 mm) in width, of any convenient length, with the rolling direction parallel to the ⅜-in. dimension, shall be precipitation heat-treated in accordance with 12.2. To pass the bend test, at least four specimens out of five, and at least 80 % of the total specimens tested from a lot shall withstand the 90° bend without visible crack or fracture, when tested in accordance with 15.3.~~

12. Precipitation Heat-Treatment

12.1 Solution-heat-treated or solution-heat-treated and cold-worked material is normally precipitation hardened by the purchaser after forming or machining. For the purpose of determining conformance to specified mechanical properties of Table 3, a sample of the as-supplied material shall be heat treated as shown in Table 87. Other heat treating temperatures and times may be preferred for end products of this material.

12.2 The solution-heat-treated and cold-worked test specimens shall be heat treated at a uniform temperature of ~~600~~600 °F to ~~675°F (316~~675 °F (316 °C to ~~357°C)~~357 °C) for the time shown in Table 87.

12.3 Special combinations of properties such as increased ductility, electrical conductivity, dimensional accuracy, endurance life, and resistance to elastic drift and hysteresis in springs may be obtained by special precipitation-hardening heat treatments. The mechanical requirements of Table 3 do not apply to such special heat treatments.

12.4 Mill-hardened products have been precipitation heat-treated by the manufacturer. Further thermal treatment is not normally required.

13. Sampling

13.1 ~~Sampling shall be in accordance with~~ Refer to sampling section in Specification B248 or B248M, Section 7, except that the heat size is defined as ~~12 000 lbs (5455 kg)~~ 12 000 lb (5455 kg) or fraction thereof.

14. Specimen Preparation

14.1 The tension specimen direction shall have the longitudinal test-axis parallel to the rolling direction, unless mutually agreed upon between the supplier and purchaser at the time the order is placed.

~~14.2 When required, five bend-test specimens per test set shall be cut ⅜ ± 1⁄16 in. (9.53 ± 1.59 mm) in width and any convenient length. Specimens shall be precipitation heat-treated after cutting and prior to testing. Precipitation heat-treatment parameters for these bend tests shall be in accordance with 12.2.~~

TABLE 87 Precipitation-Heat-Treatment Time for Acceptance Tests

Temper Designation (Before Precipitation Heat Treatment)		Time at ~~600~~600 °F to ~~675°F~~675 °F (~~316~~(316 °C to ~~357°C),~~357 °C), h
Standard	Former	
TB00	A	3
TD01	¼ H	2
TD02	½ H	2
TD04	H	2

15. Test Methods

~~15.1 The method for determining chemical analysis for compliance and preparation of certifications and test reports shall be at the discretion of the reporting laboratory.~~

15.1 ~~In case of dispute, the test methods found in the Annex shall be used for determining chemical requirements for the elements and ranges shown in Table 1.~~*Chemical Analysis:*

15.1.1 The method for determining chemical analysis for compliance and preparation of certifications and test reports shall be at the discretion of the reporting laboratory.

15.1.2 In case of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer and the purchaser. The methods found in the Annex to this specification contain methods, some of which may no longer be viable, which along with others not listed, may be used subject to agreement.

15.1.3 When analysis for unnamed or residual elements is required in the purchase order, the method of analysis shall be ~~mutually~~ agreed upon between manufacturer ~~or supplier~~ and purchaser.

15.2 ~~Bend-test specimens, shall be tested by clamping them firmly between a flat jaw and the test radius, as shown in Fig. 1. The test specimen shall be bent approximately 90° around the test radius, using a tangential wiping motion with adequate radial pressure to ensure continuous contact between the specimen and the test radius. Test specimens shall be bent to the full 90° bend position. The test radius shall be within ±6 % of the nominal radius up to 0.010 in. (0.254 mm), exclusive, and within ±4 % for radii 0.010 in. (0.254 mm) and over.~~*Other Tests:*

15.2.1 The product furnished shall conform to specified requirements when subjected to test in accordance with the following table:

Test	Method
Formability	B820
Tension Properties	E8/E8M
Hardness	E18
Grain Size	E112

15.2.2 In case of dispute, the intercept method of Test Methods E112 shall be followed

16. Keywords

16.1 C17000; C17200; copper-beryllium; ~~flat products;~~ copper plate; copper rolled bar; copper ~~strip~~strip; flat products

ANNEX

(Mandatory Information)

A1. TEST METHODS FOR DETERMINATION OF COMPLIANCE WITH COPPER-BERYLLIUM ALLOYS—CHEMICAL COMPOSITION REQUIREMENTS

A1.1. Scope

A1.1.1 These test methods establish the procedure(s) for the determination of chemical composition of copper-beryllium alloys.

A1.1.2 The analytical procedures appear in the following order:

Procedure	Sections
Test Method A—Copper by the Electrolytic Method	A1.8 to A1.15
Test Method B—Aluminum, Beryllium, Cobalt, Iron, and Nickel by the Flame Atomic Absorption Spectrophotometric Method	A1.16 to A1.24
Test Method C—Silicon by the Ammonium Molybdate Spectrophotometric Method	A1.25 to A1.35

A1.2. Referenced Documents

A1.2.1 *ASTM Standards:*

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

~~E50-00~~E50 Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials

E60 Practice for Analysis of Metals, Ores, and Related Materials by Spectrophotometry

E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

E663 Practice for Flame Atomic Absorption Analysis (Withdrawn 1997)[3]
E1024 Guide for Chemical Analysis of Metals and Metal Bearing Ores by Flame Atomic Absorption Spectrophotometry (Withdrawn 2004)[3]

A1.3. Significance and Use

A1.3.1 These test methods are primarily intended to test for compliance with composition specifications. It is assumed that all who use these test methods will be trained analysts capable of performing common laboratory procedures skillfully and safely. It is expected that work will be performed in a properly equipped laboratory.

A1.4 Apparatus, Reagents, and Photometric Practice

A1.4.1 Apparatus and reagents required for each determination are listed in separate sections preceding the procedure. The apparatus, standard solutions, and certain other reagents are referred to by number and shall conform to the requirements prescribed in Practices ~~E50-00~~E50.

A1.4.2 Flame atomic-absorption spectrophotometric practice prescribed in these test methods shall conform to the requirements prescribed in Practice E663 and Guide E1024.

A1.4.3 Spectrophotometric practice prescribed in these test methods shall conform to requirements prescribed in Practice E60.

A1.5. Hazards

A1.5.1 ~~For precautions to be observed in these test methods,~~This test method involves the use of concentrated acids. Read and follow all label precautions and Safety Data Sheet (SDS) information. Also refer to Practices ~~E50-00~~E50~~.~~ for handling nitric acid and the use of certain other reagents in this test method.

A1.5.2 ~~Both~~Processing beryllium ~~metal and its compounds may be toxic. Exercise care to prevent contact of beryllium-containing solutions with the skin. Especially avoid the inhalation of any beryllium-containing substance, either as a volatile compound or as a finely divided powder. The proper precautions are to be observed in the disposition of beryllium-containing residues, especially ignited oxide.~~and beryllium-containing materials poses a health risk if safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in some individuals. Occupational safety and health regulatory agencies have set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the SDS before working with these materials.

A1.6. Sampling

A1.6.1 Sampling shall conform to the requirements of Practice E255.

A1.7 Rounding Off Calculated Values

A1.7.1 Calculated values shall be rounded off to the proper number of places in accordance with the method given in 3.4 and 3.5 of Practice E29.

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

TEST METHOD A—COPPER BY ELECTROLYTIC DEPOSITION AND ATOMIC-ABSORPTION SPECTROPHOTOMETRY

A1.8 Scope

A1.8.1 This test method establishes a procedure for the determination of copper in copper-beryllium alloys with silver reported as copper.

A1.9 Summary of Test Methods

A1.9.1 The sample is dissolved in an acid mixture. A small amount of fluorohydric acid (HF) is added to minimize possible interferences. Copper is electrolytically deposited on a tared platinum cathode. Copper remaining in the electrolyte is determined by atomic absorption spectrophotometry.

A1.10 Interferences

A1.10.1 Elements normally present do not interfere.

A1.11 Apparatus

A1.11.1 *Electrodes for Electrolysis*—Apparatus No. 9, in Practices ~~E50-00~~E50.

A1.11.2 *Atomic Absorption Spectrophotometer*—Determine the instrument to be suitable for use as directed in Guide E1024. Instrument response must permit estimation of copper concentration to within 1 ~~mg/Litre.~~mg/L.

A1.11.3 *Operating Parameters*—Wavelength, fuel/oxidant, and flame conditions are as follows:

Wavelength, nm	Fuel/Oxidant	Flame Condition
Copper 327.5	Acetylene/air	Oxidizing

A1.12 Reagents

A1.12.1 *Sulfuric-Nitric Acid Mixture*—While stirring, slowly add 500 mL of sulfuric acid (H_2SO_4) to 1 L of water. Cool and transfer to a ~~2-L~~2 L volumetric flask. Add 300 mL of nitric acid (HNO_3). Cool, dilute to volume, and mix.

A1.12.2 *Copper Standard Solution*(1 mL = 1.0 mg ~~Cu)— Transfer~~ Cu)—Transfer 1.000 g of copper metal (purity, 99.9 % min) into a ~~250-mL~~250 mL beaker. Add 20 mL of the acid mixture. Cover the beaker and allow to stand until dissolution is nearly complete. Heat at ~~80~~80 °C to ~~90°C~~90 °C until dissolution is complete and brown fumes have been expelled. Cool, transfer into a ~~1-L~~1 L volumetric flask, dilute to volume, and mix.

A1.12.3 *Calibration Solutions*—Pipet ~~5, 10, 15, 20, and 25-mL~~5 mL, 10 mL, 15 mL, 20 mL, and 25 mL portions of the copper standard solution into individual ~~1-L~~1 L volumetric flasks. Add 50 mL of the acid mixture to each flask, dilute to volume, and mix. These solutions are equivalent to ~~0.005, 0.010, 0.015, 0.020,~~0.005 g, 0.010 g, 0.015 g, 0.020 g, and 0.025 g of copper respectively.