



Designation: B 534 – 9601

## Standard Specification for Copper-Cobalt-Beryllium Alloy and Copper-Nickel-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar<sup>1</sup>

This standard is issued under the fixed designation B 534; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This specification ~~covers~~ establishes the requirements for plate, sheet, strip, and rolled bar. The following alloys are ~~covered~~ included:<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee ~~B-5~~ B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

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

Copper Alloy UNS No. <sup>2</sup> UNS No.	Previously Used Designation Designation	Nominal Composition, %		
		Beryllium Beryllium	Cobalt Cobalt	Nickel Nickel
C17500	Alloy 10	0.6	2.5	...
C17510	Alloy 3 or 14	0.4	...	1.8

1.2 The intent is to provide a system of interchangeable alloys.

~~1.3 The values~~

~~1.3 Units—Values stated in inch-pound units are to be regarded as the standard. The values given in parentheses brackets are mathematical conversions to SI units, which are provided for information only.~~

~~1.4 The following safety hazard caveat pertains only to the test methods described in this specification:~~

~~1.5 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 in the current issue in effect on date material purchase of the Book of Standards forms a part of this specification to the extent referenced herein:~~

~~2.2 ASTM Standards:~~

~~B 194 Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar<sup>3</sup>~~

~~B 248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar<sup>3</sup>~~

~~B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast<sup>3</sup>~~

~~B 846 Terminology for Copper and Copper Alloys<sup>3</sup>~~

~~E 8 Test Methods for Tension Testing of Metallic Materials<sup>4</sup>~~

~~E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials<sup>4</sup>~~

~~E 527 Practice for Numbering Metals and Alloys (UNS)<sup>5</sup>~~

## 3. Ordering Information

~~3.1 Orders for material under this specification should include the General Requirements~~

~~3.1 The following information:~~

~~3.1.1 Quantity;~~

~~3.1.2 Copper alloy UNS number (1.1);~~

~~3.1.3 Form sections of material: plate, sheet, strip, or rolled bar;~~

~~3.1.4 Temper (5.1);~~

~~3.1.5 Dimensions: thickness Specification B 248 constitute a part of this specification:~~

~~3.1.1 Terminology,~~

~~3.1.2 Materials and width; Manufacture,~~

~~3.1.3 Dimensions and length if applicable;~~

~~3.1.6 How furnished: rolls, stock lengths with or without ends, specific lengths with or without ends.~~

~~3.1.7 Type Permissible Variations,~~

~~3.1.4 Workmanship, Finish, and Appearance,~~

~~3.1.5 Sampling,~~

~~3.1.6 Number of edge, if required: slit, sheared, sawed, square corners, rounded corners, rounded edges, or full-rounded edges (Section 12);~~

~~3.1.8 Type Tests and Retests,~~

~~3.1.7 Specimen Preparation,~~

~~3.1.8 Test Methods,~~

~~3.1.9 Significance of width Numerical Limits,~~

~~3.1.10 Inspection,~~

~~3.1.11 Rejection and straightness tolerances, if required: slit-metal tolerances, square-sheared-metal tolerances, sawed-metal tolerances, straightened or edge-rolled-metal tolerances (12.3);~~

~~3.1.9 Special thickness tolerances, if required (12.2);~~

<sup>2</sup> The UNS system for copper and copper alloys (see Practice E 527) is a simple expansion of the former standard designation system accomplished by the addition of a prefix "C" and a suffix "00." The suffix can be used to accommodate composition variations of the base alloy.

<sup>3</sup> Annual Book of ASTM Standards, Vol 02.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 04.3.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 01.01.

- ~~3.1.10 Tension test or hardness as applicable (Section 6);~~
- ~~3.1.11 Certification if required (see Specification B 248, Section 12);~~
- ~~3.1.12 Mill Rehearing,~~
- ~~3.1.12 Certification,~~
- ~~3.1.13 Mill Test Report, if required (see Specification B 248, Section 14);~~
- ~~3.1.13 Specification number Report,~~
- ~~3.1.14 Packaging and year of issue, Package Marking, and~~
- ~~3.1.14 Special tests or exceptions, if any;~~
- ~~3.2 When material is purchased for agencies of the U.S. Government, this shall be specified in the contract or purchase order, and the material shall conform~~
  - ~~3.1.15 Heat Identification.~~
- ~~3.2 In addition, when a section with a title identical to the Supplementary Requirements as defined that referenced in 3.1 appears in this specification, it contains additional requirement is that supplement those appearing in Specification B 248.~~

#### **4. Terminology**

- 4.1 For terms relating to copper and copper alloys, refer to Terminology B 846.

#### **5. Ordering Information**

- 5.1 Include the following information in orders for products:
  - 5.1.1 ASTM designation and year of issue,
  - 5.1.2 Quantity,
  - 5.1.3 Copper Alloy UNS Number designation (1.1),
  - 5.1.4 Form of material: plate, sheet, strip, or rolled bar,
  - 5.1.5 Temper (8.1),
  - 5.1.6 Dimensions: thickness and width, and length if applicable,
  - 5.1.7 How furnished: rolls, stock lengths with or without ends, specific lengths with or without ends, and
  - 5.1.8 When material is ordered for agencies of the U.S. government.
- 5.2 The following options are available and should be specified in the contract or purchase order when required:
  - 5.2.1 Type of edge, if required: slit, sheared, sawed, square corners, rounded corners, rounded edges, or full-rounded edges (12.6),
  - 5.2.2 Type of width and straightness tolerances, if required: slit-metal tolerances, square-sheared-metal tolerances, sawed-metal tolerances, straightened or edge-rolled-metal tolerances (12.5),
  - 5.2.3 Special thickness tolerances, if required (12.2),
  - 5.2.4 Tension test or hardness as applicable (Section 10),
  - 5.2.5 Certification if required (see Specification B 248),
  - 5.2.6 Mill Test Report, if required (see Specification B 248),
  - 5.2.7 Specification number and year of issue, and
  - 5.2.8 Special tests or exceptions, if any.

#### **6. Materials and Manufacture**

- 6.1 Material:
  - 6.1.1 The material of manufacture shall be Copper Alloy No. C17500 or C17510, cast and worked, and of such purity and soundness as to be suitable for processing into the products prescribed herein.
  - 6.1.2 Heat traceability shall be maintained and reported on the Mill Test Report or Certification.
- 6.2 Manufacture:
  - 6.2.1 The product shall be produced with a combination of hot working, cold working, and thermal processing to produce a uniform wrought structure, and the specified temper.

#### **7. Chemical Composition**

- 47.1 The material shall conform to the chemical requirements specified in Table 1 for the copper alloy UNS No. designation specified in the ordering information.
- 47.2 These specification limits do not preclude the presence of other elements. Limits for unnamed elements may be established by agreement between manufacturer or supplier and purchaser.
- 7.3 Copper may be given as remainder and may be taken as the difference between the sum of all elements analyzed and 100 %.
- 7.4 When all the elements in Table 1 are analyzed, their sum shall be 99.5 % minimum.

#### **58. Temper**

- ~~5.1 Tempers available under~~
  - ~~8.1 Standard tempers for product described in this specification are defined in Practice B 601. The standard tempers of material are as designated in given in Tables 2-6. Tempers are TB00 (solution heat treated), or TD02 and TD04 (varying degrees of cold~~

**TABLE 1 Chemical Requirements**

Element	Composition, %	
	Copper Alloy UNS No. C17500	Copper Alloy UNS No. C17510
Beryllium	0.40–0.7	0.20–0.6
Cobalt	2.4–2.7	0.3 max
Silicon, max	0.20	0.20
Nickel	...	1.4–2.2
Iron, max	0.10	0.10
Aluminum, max	0.10	0.10
Copper	balance	balance

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

Temper Designation	Tensile Strength		Elongation <sup>A</sup> in 2 in. (50 mm), %	Rockwell Hardness <sup>B</sup>			
	Standard <sup>C</sup>	Former		ksi <sup>D</sup>	MPa <sup>E</sup>	B	30T
TF00	–A		35–55	240–380	20–35	45 max	45 max
TB00	A		35–55		20–35	45 max	45 max
TD02	–½ H		60–75	415–520	5–10	65–77	60–68
TD02	½ H		60–75		5–10	65–77	60–68
TD04	–H		70–85	480–585	2–8	78–88	69–75
TD04	H		70–85		2–8	78–88	69–75

<sup>A</sup> Elongation requirement applies only to material 0.004 in. (0.102 mm) and thicker.

<sup>B</sup> The thickness that may be tested in the case of the Rockwell hardness scales is as follows:

B Scale 0.045 in. (1.14 mm) and over.

30 T Scale 0.032 to 0.045 in. (0.812 to 1.14 mm), excl.

Hardness values shown apply only to direct determinations, not converted values.

<sup>C</sup> Standard designations defined in Practice B 601.

<sup>D</sup> ksi = 1000 psi.

<sup>E</sup> See Appendix X1.

**TABLE 3 Mechanical Property Requirements After Precipitation Heat Treatment<sup>A</sup>**

Temper Designation		Tensile Strength		Yield Strength, ksi min, 0.2 % Offset		Elongation <sup>B</sup> in 2 in. (50 mm), % min	Rockwell Hardness <sup>C</sup>	
Standard	Former	ksi <sup>D</sup>	MPa <sup>E</sup>	ksi <sup>D</sup>	MPa <sup>E</sup>		B	30T
TF00	–AF	400–130	690–895	80	550	40	92–100	77–82
TF00	AT	100–130		80		10	92–100	77–82
TH02	–½ HT	110–140	760–965	95	655	8	95–102	79–83
TH02	½ HT	110–140	[760–965]	95	[655]	8	95–102	79–83
TH04	–HT	110–140	760–965	95	655	8	95–102	79–83
TH04	HT	110–140	[760–965]	95	[655]	8	95–102	79–83

<sup>A</sup> These values apply to mill products (Section 147). See 147.3 for exceptions in end products.

<sup>B</sup> Elongation requirement applies only to material 0.004 in. (0.102 mm) and thicker.

<sup>C</sup> The thickness that may be tested in the case of the Rockwell hardness scales is as follows:

B Scale 0.045 in. (1.14 mm) and over.

30 T Scale 0.032 to 0.045 in. (0.812 to 1.14 mm) excl.

Hardness values shown apply only to direct determinations, not converted values.

<sup>D</sup> ksi = 1000 psi.

<sup>E</sup> See Appendix X1.

work), TF00 or TH02 and TH04 (precipitation heat treated from the appropriate tempers), or TM02 and TM04 (mill hardened). Note 1—Plate is generally available in the TB00 solution heat treated and TD04 (hard) tempers.

## 6. Mechanical Requirements

6.1 The material shall conform to the requirements specified in Table 2 in the solution-heat-treated, and solution-heat-treated and cold-worked condition, in Table 3 after precipitation heat treatment or in Table 4 in the mill-hardened conditions. Precipitation heat treatment parameters are shown in Section 10.

6.2 Tension tests are required for material equal to or less than 0.050 in. (1.27 mm) in thickness. Hardness is used for thicker material except when the tension test is specified by the purchaser at the time the order is placed or when agreement cannot be reached on hardness values.

**TABLE 4 Mechanical Property Requirements—Mill-Hardened Condition<sup>A</sup>**

Temper Standard	Designation Former	Tensile Strength		Yield Strength		Elongation <sup>B</sup> in 2 in. (50 mm) min. %
		ksi <sup>C</sup>	MPa <sup>D</sup>	ksi <sup>C</sup>	MPa <sup>D</sup>	
TM02	½ HM	95–120	655–827	85–110	586–758	10
TM02	½ HM	95–120		85–110		10
TM04	HM	110–135	758–931	100–125	689–862	6
TM04	HM	110–135		100–125		6

<sup>A</sup> These values apply to mill products (Section 147). See 147.3 for exceptions in end products.

<sup>B</sup> Elongation requirement applies only to material 0.004 in. (0.102 mm) and thicker.

<sup>C</sup> ksi = 1000 psi.

<sup>D</sup> See Appendix X1.

**TABLE 5 Electrical Conductivity**

Temper	IACS, min, %
TF00 (AT)	45
TH02 (1/2 HT)	48
TH04 (HT)	48
TM02	50
TM04	50

**TABLE 6 Precipitation-Heat-Treatment Time for Acceptance Tests**

Standard (Before Precipitation Heat Treatment)	Former	At 850°F (454°C) to 900°F (482°C) <sup>A</sup> , h
TB00	A	3
TD02	½ H	2
TD04	H	2

<sup>A</sup> Specific temperature used must conform with supplier's certification.

## 7. Electrical Conductivity

7.1 The electrical conductivity of this material after precipitation heat treatment in accordance with Section 7 shall conform to Table 5.

## 8. Precipitation Heat Treatment

8.1 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 this material shall be heat treated as shown in Table 6. Other heat-treating temperatures and times may be preferred for end products of this material.

8.2 Special combinations of properties may be obtained by special precipitation heat-treating techniques. Mechanical property requirements of Table 3 do not apply to material so treated.

## 9. Sampling

### 9.1 Sampling Precipitation Heat Treatment

9.1 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 this material shall be in accordance with Specification B 248 Section 6, except that the heat size is defined as 12 000 lb (5455 kg) or fraction thereof, shown in Table 6. Other heat-treating temperatures and times may be preferred for end products of this material.

9.2 Special combinations of properties may be obtained by special precipitation heat-treating techniques. Mechanical property requirements of Table 3 do not apply to material so treated.

## 10. Specimen Preparation

### 10.1 Specimen Preparation Property Requirements

#### 10.1 Tensile Strength Requirements:

10.1.1 When specified, product furnished under this specification shall conform to the tensile requirements prescribed in Tables 2-4 when tested in accordance with Specification B 248 Test Method E 8. Values in Table 2 are in the solution-heat-treated, and solution-heat-treated and cold-worked condition, in Table 3 after precipitation heat treatment and in Table 4 in the mill-hardened conditions. Precipitation heat treatment parameters are specified in Section 8, with 9.

10.1.2 Tension tests are required for material equal to or less than 0.050 in. (1.27 mm) in thickness.

10.2 Rockwell Hardness Requirements:

10.2.1 For material thicker than 0.050 in. (1.27 mm), and except when the preferred tension test specimen direction having its longitudinal axis parallel is specified by the purchaser at the time the order is placed or when agreement cannot be reached on hardness values, products furnished under this specification shall conform to the Rockwell hardness requirements prescribed in Tables 2 and 3, when tested in accordance with Test Methods E 18.

## **11. Test Method**

~~11.1 The test methods for determining the mechanical and physical properties are detailed in the general flat product standard, Specification B 248.~~

~~11.2 The test method for determining chemical analysis for compliance and preparation~~Performance Requirements

~~11.1 Electrical Conductivity:~~

~~11.1.1 The electrical conductivity of certifications and test reports shall be at the discretion of the reporting laboratory.~~

~~11.2.1 In case of dispute, the test method found this material after precipitation heat-treatment in Specification B 194, Annex 1, accordance with Section 9 shall be used for determining chemical requirements in conform to Table 1.~~

~~11.3 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. 5.~~

## **12. Dimensions and Permissible Variations**

12.1 The dimensions and tolerances for material covered by this specification shall be as prescribed in the current edition of Specification B 248, with particular reference to Section 5 and the following tables of that specification:

12.2 *Thickness*—See 5.2.2; Table 2, and for special tolerances, Table 3.

12.3 *Width:*

12.3.1 *Slit Metal and Slit Metal with Rolled Edges*—See 5.3.1; Table 4.

12.3.2 *Square-Sheared Metal*—See 5.3.2 and Table 5.

12.3.3 *Sawed Metal*—See 5.3.3 and Table 6.

12.4 *Length:*

12.4.1 *Specific and Stock Lengths With and Without Ends*—See 5.4.1 and Table 7.

12.4.2 *Schedule of Lengths (Specific and Stock) With Ends*—See 5.4.2 and Table 8.

12.4.3 *Length Tolerances for Square-Sheared Metal*—See 5.4.3 and Table 9.

12.4.4 *Length Tolerances for Sawed Metal*— See 5.4.4 and Table 10.

12.5 *Straightness:*

12.5.1 *Slit Metal or Edge-Rolled Metal*— See 5.5.1 and Table 11.

12.5.2 *Square-Sheared Metal*—See 5.5.2; Table 12.

12.5.3 *Sawed Metal*—See 5.5.3 and Table 13.

12.6 *Edges*—See 5.6.:

12.6.1 *Square Edges*—See 5.6.1 and Table 14.

12.6.2 *Rounded Corners*—See 5.6.2 and Table 15.

12.6.3 *Rounded Edges*—See 5.6.3 and Table 16.

12.6.4 *Full-Rounded Edges*—See 5.6.4 and Table 17.

## **13. General Requirements**

~~13.1 Material furnished under this specification~~Workmanship, Finish and Appearance

~~13.1 The product shall conform to the applicable requirements be free of the current edition defects, but blemishes of Specification B 248—a nature that do not interfere with the intended application are acceptable.~~

## **14. Sampling**

14.1 Sampling shall be in accordance with Specification B 248 Section 7, except that the heat size is defined as 12 000 lb (5455 kg) or fraction thereof.

14.2 Sample pieces shall be taken from a heat and lot of material processed simultaneously in the same equipment, as follows:

14.2.1 *Heat*—A heat shall be the result of castings poured simultaneously from the same source of molten metal.

14.2.2 *Lot*—The lot shall be a heat or fraction thereof.

## **15. Number of Tests and Retests**

15.1 Specification B 248 constitutes a part of this specification.

15.2 Test specimens shall be taken from sample pieces selected in accordance with 14.1.

## **16. Specimen Preparation**

16.1 Specimen preparation shall be in accordance with Specification B 248 Section 9, with the preferred test specimen direction having its longitudinal axis parallel to the rolling direction.

## **17. Test Method**

17.1 Section 10 of Specification B 248 constitutes a part of this specification.

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

17.2.1 10.2 of Specification B 248 is amended to include in the group of chemical analysis techniques found in Specification B 194, Annex.

17.3 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.

## **18. Keywords**

14.1 copper-beryllium; flat product;

18.1 C17500; C17510; copper-beryllium; copper plate; copper rolled bar; copper strip; flat product

## **APPENDIX**

**(Nonmandatory Information)**

### **XI. METRIC EQUIVALENTS**

X1.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the newton (N), which is defined as that force which when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ( $N = \text{kg}\cdot\text{m}/\text{s}^2$ ). The derived SI unit for pressure or stress is the newton per square metre ( $\text{N}/\text{m}^2$ ), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since  $1 \text{ ksi} = 6\,894\,757 \text{ Pa}$ , the metric equivalents are expressed as megapascal (MPa), which is the same as  $\text{MN}/\text{m}^2$  and  $\text{N}/\text{mm}^2$ .

## **SUMMARY OF CHANGES**

Committee B05 has identified the location of selected changes to this standard since the last issue (B 534 – 96) that may impact the use of this standard.

- (1) A comprehensive five-year review was conducted. No technical changes were made to temper and property requirements. Some sections were rearranged, renumbered, and in some cases reworded to conform to the new *Outline of Form and Style* and the *Form and Style for ASTM Standards* (Blue Books).
- (2) Silicon and Aluminum maximum limits were added to Table 1 to match the UNS registered alloy composition.
- (3) Heat and Lot size were more specifically defined.
- (4) A General Requirements section was added.

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