



# 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 plate, sheet, strip, and rolled bar. The following alloys are covered:

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

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

1.3 The values stated in inch-pound units are to be regarded as the standard. The values in parentheses are for information only.

1.4 *This standard does not purport to address 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 date material purchase 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>

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

Current edition approved Sept. 10, 1996. Published November 1996. Originally published as B 534 – 70. Last previous edition B 534 – 95.

<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.

E 527 Practice for Numbering Metals and Alloys (UNS)<sup>4</sup>

## 3. Ordering Information

3.1 Orders for material under this specification should include the following information:

3.1.1 Quantity,

3.1.2 Copper alloy UNS number (1.1),

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

3.1.4 Temper (5.1),

3.1.5 Dimensions: thickness and width, 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 of edge, if required: slit, sheared, sawed, square corners, rounded corners, rounded edges, or full-rounded edges (Section 12),

3.1.8 Type of width and straightness tolerances, if required: slit-metal tolerances, square-sheared-metal tolerances, sawed-metal tolerances, straightened or edge-rolled-metal tolerances (12.3),

3.1.9 Special thickness tolerances, if required (12.2),

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 Test Report, if required (see Specification B 248, Section 14),

3.1.13 Specification number and year of issue, 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 to the Supplementary Requirements as defined in the current issue of Specification B 248.

## 4. Chemical Composition

4.1 The material shall conform to the chemical requirements specified in Table 1.

4.2 These specification limits do not preclude the presence of other elements. Limits for unnamed elements may be established by agreement between manufacturer or supplier

<sup>4</sup> Annual Book of ASTM Standards, Vol 01.01.

**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                     |
| Nickel    | ...                         | 1.4–2.2                     |
| Iron, max | 0.10                        | 0.10                        |
| Copper    | balance                     | balance                     |

and purchaser. Copper may be given as remainder and may be taken as the difference between the sum of all elements analyzed and 100 %. When all the elements in Table 1 are analyzed, their sum shall be 99.5 % minimum.

## 5. Temper

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

## 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.

**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> |        |
|------------------------|------------------|---|--------------------------------|--------|
|                        |                  |   | B                              | 30T    |
| Stand-ard <sup>C</sup> |                  |   |                                |        |
|                        | Former           | ksi <sup>D</sup>                            | MPa <sup>E</sup>               |        |
| TB00                   | A                | 35–55                                       | 240–380                        | 20–35  |
| TD02                   | ½H               | 60–75                                       | 415–520                        | 5–10   |
| TD04                   | H                | 70–85                                       | 480–585                        | 2–8    |
|                        |                  |   |                                | 45 max |
|                        |                  |   |                                | 65–77  |
|                        |                  |   |                                | 60–68  |
|                        |                  |   |                                | 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.

## 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 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.

## 10. Specimen Preparation

10.1 Specimen preparation shall be in accordance with Specification B 248 Section 8, with the preferred test specimen direction having its longitudinal axis parallel to the rolling direction.

## 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 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 in Specification B 194, Annex 1, shall be used for determining chemical requirements in 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.

## 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.

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

| Temper Designation |        | Tensile Strength |                  | Yield Strength, ksi<br>min, 0.2 % Offset |                  | Elongation <sup>B</sup> in<br>2 in. (50 mm),<br>% min | Rockwell<br>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               | AT     | 100–130          | 690–895          | 80                                       | 550              | 10  | 92–100                            | 77–82 |
| 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 |

<sup>A</sup>These values apply to mill products (Section 11). See 11.3 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.

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

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

<sup>A</sup>These values apply to mill products (Section 11). See 11.3 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           |

**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.

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

| Standard<br>(Before Precipitation Heat Treatment) | Former | At 850°F (454°C) to<br>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.

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 shall conform to the applicable requirements of the current edition of Specification B 248.

**14. Keywords**

14.1 copper-beryllium; flat product; copper plate; copper rolled bar; copper strip

**APPENDIX**

**(Nonmandatory Information)**

**X1. 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 ( $N = kg \cdot m/s^2$ ). The derived SI unit for pressure or

stress is the newton per square metre ( $N/m^2$ ), 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  $MN/m^2$  and  $N/mm^2$ .

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