Designation: B 197/B 197M – 01

Standard Specification for Copper-Beryllium Alloy Wire[1]

This standard is issued under the fixed designation B 197/B 197M; 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 Department of Defense.

1. Scope *

1.1 This specification establishes the requirements for copper-beryllium alloy wire in coils, spools, or other than straight lengths, of any uniform cross section. Copper Alloy UNS Nos. C17200 and C17300[2] are included.

1.2 Unless otherwise required, Copper Alloy UNS No. C17200 shall be the alloy furnished whenever Specification B 197/B 197M is specified without any alloy designation.

1.3 The values stated in either inch-pounds or SI units are to be regarded separately as the standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.4 *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 in the current issue of the Book of Standards form 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[3]

B 250 Specification for General Requirements for Wrought Copper-Alloy Wire[3]

B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast[3]

B 846 Terminology for Copper and Copper Alloys[3]

E 8 Test Methods for Tension Testing of Metallic Materials[4]

E 8M Test Methods for Tension Testing of Metallic Materials [Metric][4]

E 112 Test Methods for Determining Average Grain Size[4]

E 527 Practice for Numbering Metals and Alloys (UNS)[5]

3. General Requirements

3.1 The following sections of Specification B 250 constitute a part of this specification:

3.1.1 Terminology,
3.1.2 Material and Manufacturer,
3.1.3 Chemical Composition,
3.1.4 Dimensions and Permissible Variations,
3.1.5 Workmanship, Finish, and Appearance,
3.1.6 Sampling,
3.1.7 Number of Tests and Retests,
3.1.8 Specimen Preparation,
3.1.9 Test Methods,
3.1.10 Significance of Numerical Limits,
3.1.11 Inspection,
3.1.12 Rejection and Rehearing,
3.1.13 Certification,
3.1.14 Mill Test Report, and
3.1.15 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 which supplement those appearing in Specification B 250.

4. Terminology

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

4.2 *Definition of Term Specific to This Standard:*

4.2.1 *grain count*—the number of grains per stock thickness.

5. Ordering Information

5.1 Orders for products should include the following information:

5.1.1 ASTM specification designation and year of issue,
5.1.2 Copper (Alloy) UNS No. designation,
5.1.3 Temper (Section 7),
5.1.4 Dimensions, diameter, or distance between parallel

[1] This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.02 on Rod, Bar, Wire, Shapes, and Forgings.

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[2] 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.

[3] *Annual Book of ASTM Standards,* Vol 02.01.

[4] *Annual Book of ASTM Standards,* Vol 03.01.

[5] *Annual Book of ASTM Standards,* Vol 01.01.

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

surfaces, and length if applicable,

5.1.5 Form of material: cross section such as round, hexagonal, octagonal, oval, trapezoidal, and so forth,

5.1.6 How furnished: coils spools, reels, or bucks, and specific lengths with or without ends or stock lengths with or without ends if applicable, and

5.1.7 When material is ordered for agencies of the U.S. Government (see Section 15).

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: square corners, round edge, full-rounded edge (see the Edge Contours section in the Dimensions and Permissible Variations Section of Specification B 250),

5.2.2 Grain size (Section 9.1),

5.2.3 Grain count (Section 9.2),

5.2.4 Mechanical properties (tensile strength and hardness) (Section 10),

5.2.5 Bend test (after precipitation heat treatment) (11.1),

5.2.6 Heat identification or traceability details,

5.2.7 Special packaging requirements,

5.2.8 Certification, and

5.2.9 Mill test report.

6. Chemical Composition

6.1 The material shall conform to the chemical composition requirements prescribed in Table 1 for copper alloy UNS No. designation specified in the ordering information.

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

6.3 Copper is customarily given as remainder, but may be taken as the difference between the sum of all elements analyzed and 100 %.

6.4 When all the elements in Table 1 are determined, the sum of results shall be 99.5 % min.

7. Temper

7.1 The standard tempers available under this specification and as specified in Practice B 601 are TB00 (solution heat treated), or with varying degrees of cold work TD00 to TD04 to be precipitation heat treated by the user. Also available are products already precipitation heat-treated by the manufacturer, tempers TF00 (AT), TH00 to TH04. These products meet property requirements in Tables 2 and 3 and generally do not require further heat treatment by the user.

TABLE 1 Chemical Requirements

Element	Composition, %	
	Copper Alloy UNS No. C17200	Copper Alloy UNS No. C17300
Beryllium	1.80–2.00	1.80–2.00
Additive elements:		
Nickel + cobalt, min	0.20	0.20
Nickel + cobalt + iron, max	0.6	0.6
Lead	. . .	0.20–0.60
Aluminum, max	0.20	0.20
Silicon, max	0.20	0.20
Copper	remainder	remainder

TABLE 2 Tensile Strength Requirements for Round, Hexagonal, Octagonal, and Square Wire After Precipitation Heat Treatment (See 11.2)

Temper Designation		Tensile Strength,[A]	
Standard	Former	ksi[B]	MPa
TF00	Precipitation hardened (AT)	160–200[C]	[1105–1380]
TH01	¼ hard and precipitation heat treated (¼ HT)	175–210[C]	[1205–1450]
TH02	½ hard and precipitation heat treated (½ HT)	185–215	[1275–1480]
TH03	¾ hard and precipitation heat treated (¾ HT)[D]	190–230	[1310–1585]
TH04	Hard and precipitation heat treated (HT)	195–230	[1345–1585]

[A] These values apply to mill products (see 11.2).
[B] ksi = 1000 psi.
[C] Corrected editorially.
[D] TH03 (¾ HT) condition is generally available up to 0.080 in. [2.0 mm], inclusive, in diameter or distance between parallel surfaces.

7.2 The pretempered product TL08 shown in Table 4 is prepared by the manufacturer for special applications.

NOTE 1—Special or nonstandard tempers are subject to negotiation between the supplier and the purchaser.

8. Precipitation Heat Treatment

8.1 The precipitation heat treatment is normally performed by the purchaser after forming. The heat treatment specified herein is applicable to mill products. Other treatment times and temperatures may be preferable for end products made from this material.

8.2 Conformance to the TF00 (AT) through TH04 (HT) specification limits shown in Tables 2 and 3 for products supplied in the TB00 (A) through TD04 (H) tempers, shall be determined by testing test specimens heat-treated at a uniform temperature of 600 to 625°F [316 to 329°C] for the times shown in Table 5.

8.3 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 Tables 2 and 3 do not apply to such special heat treatments.

9. Physical Property Requirements

9.1 *Grain Size*—The average grain size of each of two samples of rectangular other than square wire, in thicknesses over 0.010 in. [0.25 mm] taken after precipitation heat treatment (see 8.2), shall not exceed the limits specified in Table 6 when determined in accordance with Test Methods E 112 and taken on a plane perpendicular to the direction of rolling or drawing.

9.2 *Grain Count:*

9.2.1 The grain count of each of two samples of rectangular other than square wire, in thicknesses over 0.004 to 0.010 in. [0.10 to 0.25 mm] inclusive, taken after precipitation heat treatment (see 8.2), shall not be less than the limits specified in Table 7 when tested in accordance with 9.2.2.

TABLE 3 Mechanical Property Requirements[A] for Rectangular Other Than Square Wire After Precipitation Heat Treatment (See 11.2)

NOTE 1—Rockwell hardness values apply only to direct determinations, not converted values.

Temper Designation		Tensile Strength[A]		Rockwell hardness[B]		
Standard	Former	ksi[C]	MPa	C Scale, min	30N Scale, min	15N Scale, min
TF00	Precipitation hardened (AT)	165–190	[1140–1310]	36	56	78
TH01	¼ hard and precipitation heat treated (¼ H)	175–200	[1210–1380]	38	58	79
TH02	½ hard and precipitation heat treated (½ HT)	185–210	[1280–1450]	39	59	79.5
TH04	Hard and precipitation heat treated (HT)	190–215	[1310–1480]	40	60	80

[A]The upper limit in the tensile strength column applies to material thicker than 0.020 in. [0.50 mm].
[B]The thickness of material that may be tested in the case of the Rockwell hardness scales is as follows:

C Scale	0.032 in. and over	[0.80 mm and over]
30N	0.020 to 0.032 in., excl	[0.50 to 0.80 mm, excl]
15N Scale	0.015 to 0.020 in., excl	[0.38 to 0.50 mm, excl]

[C]ksi = 1000 psi.

TABLE 4 Tensile Strength Requirements for Round, Hexagonal, Octagonal, and Square Wire After Mill Hardening (Pretempered TL08-Former Designation XHT)

Diameter or Distance Between Parallel Surfaces, in.	Tensile Strength, ksi[A]	Diameter or Distance Between Parallel Surfaces, mm	Tensile Strength, MPa
Over 0.050 to 0.075, excl	140–165	[Over 1.2 to 1.9, excl]	[965–1140]
0.075 to 0.100, excl	120–140	[1.9 to 2.5, excl]	[830–965]
0.100 to 0.114, incl	115–130	[2.5 to 2.9, excl]	[795–895]

[A]ksi = 1000 psi.

TABLE 5 Standard Precipitation Heat Treatment Time for Acceptance Test

Temper Designation Before Hardening		Time at 600 to 625°F, h [316–329°C]	
Standard	Former	Round, Hexagonal, Octagonal, and Square Wire	Rectangular Other Than Square Wire
TB00	Solution heat treated (annealed)	3	3
TD01	Quarter-hard	2	2½
TD02	Half-hard	1½	2
TD03	Three-quarter hard	1	2
TD04	Hard	1	2

TABLE 6 Grain Size Requirements for Rectangular Other Than Square Wire

Thickness, in.	Maximum Average Grain Size, mm	Thickness, mm
Over 0.010 to 0.030, incl	0.035	[Over 0.25 to 0.75, incl]
Over 0.030 to 0.090, incl	0.045	[Over 0.75 to 2.30, incl]
Over 0.090 to 0.188, incl	0.060	[Over 2.3 to 4.8, incl]

TABLE 7 Grain Count Requirements for Rectangular Other Than Square Wire

Thickness, in.	Minimum Number of Grains	Thickness, mm
Over 0.004 to 0.006, incl	6	[Over 0.10 to 0.15, incl]
Over 0.006 to 0.008, incl	7	[Over 0.15 to 0.20, incl]
Over 0.008 to 0.010, incl	8	[Over 0.20 to 0.25, incl]

TABLE 8 Tensile Strength Requirements for Round, Hexagonal, Octagonal, and Square Wire

Temper Designation		Tensile Strength,	
Standard	Former	ksi[A]	MPa
TB00	Solution heat treated (annealed) (A)	58–78	[400–540]
TD01	Quarter-hard (¼ H)	90–115	[620–795]
TD02	Half-hard (½ H)	110–135	[760–930]
TD03	Three-quarter hard[B] (¾ H)	130–155	[895–1070]
TD04	Hard (H)	140–165	[965–1140]

[A]ksi = 1000 psi.
[B]TD03 (¾ H) and TD04 (H) tempers are generally available up to 0.080 in. [2.0 mm], inclusive, in diameter or distance between parallel surfaces.

9.2.2 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 direction of rolling or drawing.

10. Property Requirements

10.1 The property requirement basis for acceptance or rejection for product in all forms and tempers is listed in the Tables as follows:

10.1.1 For round, hexagonal, octagonal, and square wire:

10.1.1.1 In the solution heat-treated, and solution heat-treated and cold worked conditioning—Table 8,

10.1.1.2 After precipitation heat-treatment—Table 2,

10.1.1.3 In the pretempered (mill-hardened) condition—Table 4.

10.1.2 For rectangle other than square wire:

10.1.2.1 Rockwell hardness shall be the basis of acceptance or rejection for wire 0.015 in. (0.040 mm) thick or over unless otherwise specified—Table 9.

10.1.2.2 For wire less than 0.015 in. (0.40 mm), or when agreement on hardness tests cannot be reached, the tensile strength requirements shall apply.

10.1.2.3 In the solution heat-treated and solution heat-treated and cold-worked condition—Table 9.

10.1.2.4 After precipitation heat-treatment—Table 3.

11. Performance Requirements

11.1 *Bend Tests Requirements*:

11.1.1 Round, hexagonal, octagonal, and square wire in tempers shown in Table 8 shall withstand being bent cold

TABLE 9 Mechanical Property Requirements for Rectangular Other Than Square Wire

NOTE 1—Hardness values shown apply only to direct determinations, not converted values.

Temper Designation		Tensile Strength		Elongation[A] in 2 in. [50 mm], min, %	Rockwell Hardness[B]		
Standard	Former	ksi[C]	MPa		B Scale	30T Scale	15T Scale
TB00	Solution heat treated (annealed) (A)	60–78	[410–510]	35	45–78	46–67	75–85
TD01	Quarter-hard (¼ H)	75–88	[510–610]	10	68–90	62–75	83–89
TD02	Half-hard (½ H)	85–100	[590–690]	5	88–96	74–79	88–91
TD04	Hard (H)	100–120	[690–830]	2	96–102	79–83	91–94

[A]Elongation requirement applies only to wire 0.004 in. [0.50 mm] and thicker.
[B]The thickness of material that may be tested in the case of the Rockwell hardness scales is as follows:

B Scale	0.032 in. and over	[0.80 mm and over]
30T Scale	0.020 to 0.032 in., excl	[0.50 to 0.80 mm, excl]
15T Scale	0.015 to 0.020 in., excl	[0.38 to 0.50 mm, excl]

[C]ksi = 1000 psi.

through five successive turns on a radius equal to the diameter or distance between parallel surfaces of the wire.

11.1.1.1 The specimens shall not develop cracks visible to the unaided eye.

11.2 When specified (see 5.2.5), rectangular other than square wire after precipitation heat treatment, according to Table 5 and having dimensions of 0.004 to 0.020 in. [0.10 to 0.50 mm], inclusive in thickness, and having a width of at least four times its thickness, shall conform to the requirements specified in Table 10 when tested in accordance with 14.2.

12. Dimensions and Permissible Variations

12.1 The dimensions and tolerances for material covered by this specification shall be as specified in the current edition of Specification B 250, with particular reference to the Dimensions and Permissible Variations Section and the following tables of that specification:

12.2 *Diameter or Distance Between Parallel Surfaces*—See 6.2, Table 2.

12.3 *Thickness*[6] —See 6.3, Table 4,

12.4 *Width*[6] —See 6.4, Table 6,

12.5 *Length*[6] —See 6.5, Tables 7 and 8,

12.6 *Straightness*[6] —See 6.6, Table 9.

13. Specimen Preparation

13.1 Tension test specimens, when required, shall be prepared in a full cross-section area if practicable. Full cross-section or machined specimens shall be as specified in Test Methods E 8 and E 8M.

[6] Applicable to flat (rectangular and square) wire only.

TABLE 10 Bend Test Requirements for Rectangular Other Than Square Wire

Temper Designation		Test Radius[A]
Standard	Former	
TF00	Precipitation hardened (AT)	5*t*
TH01	¼ hard and precipitation heat treated (¼ HT)	6*t*
TH02	½ hard and precipitation heat treated (½ HT)	9*t*
TH04	Hard and precipitation heat treated (HT)	15*t*

[A]The *t* refers to the measured average stock thickness to be tested.

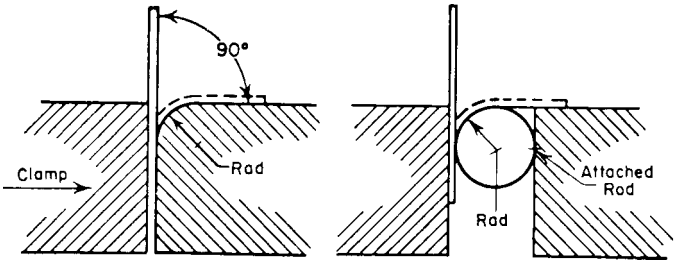

FIG. 1 Methods for Clamping Specimen to Radius for Bend Test

NOTE 2—Mechanical property data determined on other than round cross section, for sizes under 0.125 in. [3.2 mm], may be compromised and be inaccurate due to the stress riser effect on the corner.

14. Test Methods

14.1 *Chemical Analysis*—In case of dispute, the test method in Specification B 194 Annex shall be used for determining chemical requirements for the elements and ranges shown in Table 1.

14.2 *Bend Test*—Five specimens of any convenient length that have been precipitation heat treated in accordance with Table 5, shall be clamped firmly between a flat jaw and test radius, as shown in Fig. 1. The test radius shall be within ±6 % of the specimen thickness up to 0.010 in. [0.25 mm], and within ±4 % of the specimen thickness 0.010 in. [0.25 mm] and over. The test specimen shall be bent approximately 90 degrees around the test radius, using a tangential wiping motion with adequate radial pressure to ensure continuous contact between the specimen and the test radius. To pass the bend test, at least four out of five, and at least 80 % of the total specimens tested from a lot must withstand the 90 degree bend without visible cracks or fractures when observed in the full 90 degree bend position.

15. Orders for U.S. Government Agencies

15.1 Orders for agencies of the U.S. Government shall conform to the special government requirements stipulated in the Supplement Requirements Section in Specification B 250.

16. Keywords

16.1 copper-beryllium; wire

SUMMARY OF CHANGES

This section identifies the principle changes to B 197/B 197M that have been incorporated since the 1999 version.

(*1*) Section 10, Property Requirements, has been changed.
(*2*) Paragraph 11.2 was changed.
(*3*) Section 12, Dimensions and Permissible Variations, was changed.
(*4*) Paragraph 14.2 was changed.