



## Designation: B 412 – 95

AMERICAN SOCIETY FOR TESTING AND MATERIALS  
100 Barr Harbor Dr., West Conshohocken, PA 19428  
Reprinted from the Annual Book of ASTM Standards. Copyright ASTM

# Standard Specification for Copper-Nickel-Silicon Alloy Wire<sup>1</sup>

This standard is issued under the fixed designation B 412; 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 round, hexagonal, octagonal, rectangular, and square wire of copper alloy C64700.

1.2 The values stated in inch-pound units are the standard. Values given in parentheses are for information only.

1.3 The following safety hazard caveat pertains only to Section 9 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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

B 193 Test Method for Resistivity of Electrical Conductor Materials<sup>2</sup>

B 250 Specification for General Requirements for Wrought Copper-Alloy Wire<sup>3</sup>

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

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

E 54 Test Methods for Chemical Analysis of Special Brasses and Bronzes<sup>5</sup>

E 255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition<sup>5</sup>

E 478 Test Methods for Chemical Analysis of Copper Alloys<sup>5</sup>

## 3. Terminology

3.1 For definition of terms related to copper and copper alloys refer to Terminology B 846.

## 4. Ordering Information

4.1 Orders for product under this specification should include the following information:

<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 B05.02 on Rod, Bar, Wire Shapes and Forgings.

Current edition approved Sept. 10, 1995. Published November 1995. Originally published as B 412 – 64. Last previous edition B 412 – 93.

<sup>2</sup> Annual Book of ASTM Standards, Vol 02.03.

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

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 03.05.

4.1.1 ASTM designation and year of issue (for example, B 412 – XX),

4.1.2 Copper alloy designation (for example, C64700),

4.1.3 Temper designation (Section 6),

4.1.4 Form: round, hexagonal, octagonal, rectangular, or square,

4.1.5 Edge contours,

4.1.6 Length required,

4.1.7 Quantity; total weight, footage, or number of pieces, each size and type, and

4.1.8 When product is purchased for agencies of the U.S. Government.

4.2 The following options are available under this specification and should be included in the contract or purchase order when required:

4.2.1 Certification,

4.2.2 Mill Test Reports.

## 5. Chemical Composition

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

5.1.1 Copper, listed as “remainder”, is the difference between the sum of results for the elements determined and 100 %.

5.1.2 When all elements listed in Table 1 are determined, the sum of results shall be 99.5 % minimum.

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

## 6. Temper

6.1 The product is available in the following tempers as defined by Practice B 601:

6.1.1 Solution heat treated (A) TB00,

6.1.2 Solution heat treated and cold worked (1/8 hard) TD00,

6.1.3 Solution heat treated and cold worked (1/4 hard) TD01,

6.1.4 Solution heat treated and cold worked (1/2 hard) TD02,

6.1.5 Solution heat treated and cold worked (3/4 hard) TD03,

6.1.6 Solution heat treated and cold worked (hard) TD04,

and

6.1.7 Precipitation hardened (AT) TF00.

6.2 Solution heat treated and cold worked tempers are suitable for cold forming and subsequent precipitation heat

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

**TABLE 1 Chemical Requirements**

| Element             | Composition, % |
|---------------------|----------------|
| Nickel, incl cobalt | 1.6–2.2        |
| Silicon             | 0.40–0.8       |
| Lead, max           | 0.10           |
| Iron, max           | 0.10           |
| Zinc, max           | 0.50           |
| Copper, incl silver | remainder      |

treatment by the fabricator.

## 7. Physical Property Requirements

### 7.1 Electrical Resistivity:

7.1.1 The electrical mass resistivity for product in all forms and tempers shall be 0.34836 to 0.58954 ohm·g/m<sup>2</sup> (44.00 to 26.00 % International Annealed Copper Standard (ICAS)) at 20°C (68°F) when tested in accordance with Test Method B 193.

## 8. Mechanical Property Requirements

### 8.1 Tensile Requirements:

8.1.1 The product shall conform to the requirements prescribed in Table 2 for the form and size designated in the ordering information after precipitation heat treatment when tested in accordance with Test Methods E 8.

8.1.2 When furnished as solution heat treated or solution heat treated and cold worked, the product shall conform to the requirements of Table 2 after precipitation heat treatment as advised by the manufacture or as indicated in Table 3.

## 9. Precipitation Heat Treatment

9.1 For acceptance test purposes only, the procedure given in Table 3 shall be considered as suitable heat treatment.

## 10. Purchases for U.S. Government

10.1 Product purchased for agencies of the U.S. Government shall conform to the special government requirements prescribed in the Supplemental Requirements section of Specification B 249. (Section 4.1.6)

## 11. Dimensions and Permissible Variations

11.1 The dimensions and tolerances for product produced under this specification shall be as specified in following tables, related, and specified paragraphs in Specification B 250:

11.1.1 *Diameter or Distance Between Parallel Surfaces*—

11.1.2 *Thickness*—Table 4.

11.1.3 *Width*—Table 6.

11.1.4 *Length*:

**TABLE 3 Precipitation Heat Treatment Parameters**

| Forms | Size, <sup>A</sup> in. (mm)         | Temperature |     | Time at Temperature, minutes |
|-------|-------------------------------------|-------------|-----|------------------------------|
|       |                                     | °F          | °C  |                              |
| All   | under 0.050 (1.27)                  | 800         | 427 | 90                           |
|       | 0.050 to 1.000 (1.27 to 25.4), incl | 850         | 454 | 90                           |
|       | over 1.000 (25.4)                   | 850         | 454 | 120                          |

<sup>A</sup> For rectangular wire, the thickness dimension applies.

11.1.4.1 *Round, Hexagonal, and Octagonal*—Paragraph titled “Length”.

11.1.4.2 *Rectangular and Square*—Tables 7 and 8.

11.1.5 *Edge Contours*—Paragraph titled “Edge Contours”.

## 12. Analytical Methods

12.1 Chemical composition shall, in case of dispute, be determined as follows:

| Element         | ASTM Test Method    |
|-----------------|---------------------|
| Copper          | E 478               |
| Nickel & cobalt | E 478 (gravimetric) |
| Silicon         | E 62                |
| Lead            | E 478 (AA)          |
| Iron            | E 478               |
| Zinc            | E 478 (AA)          |

12.2 Test method(s) to be followed for the determination of element(s) required by contractual or purchase order agreement shall be as agreed upon between the supplier and the purchaser.

## 13. General Requirements

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

13.1.1 Terminology,

13.1.2 Materials and Manufacture,

13.1.3 Workmanship, Finish and Appearance,

13.1.4 Sampling,

13.1.5 Number of Tests and Retests,

13.1.6 Specimen Preparation,

13.1.7 Test Methods,

13.1.8 Significance of Numerical Limits,

13.1.9 Inspection,

13.1.10 Rejection and Rehearing,

13.1.11 Certification,

13.1.12 Test Reports,

13.1.13 Packaging and Package Marking, and

13.1.14 Supplementary Requirements

13.2 In addition, when a section with a title identical to those referenced in 3.1 above appears in this specification, it contains additional information which supplements those appearing in Specification B 250. In case of conflict, this specification shall prevail.

**TABLE 2 Mechanical Property Requirements After Precipitation Heat Treatment**

| Form                    | Size, in. (mm)                                          | Tensile Strength, min |                  | Yield Strength <sup>A</sup> min |                  | Elongation in 2 in. (50.8 mm), % |
|-------------------------|---------------------------------------------------------|-----------------------|------------------|---------------------------------|------------------|----------------------------------|
|                         |                                                         | ksi <sup>B</sup>      | MPa <sup>C</sup> | ksi <sup>B</sup>                | MPa <sup>C</sup> |                                  |
| Round, hexagon, octagon | 0.040 to 0.750 (1.02 to 19.0), incl                     | 90                    | 620              | 75                              | 515              | 5                                |
| Square                  | up to 0.188 (4.78) incl                                 | 90                    | 620              | 75                              | 515              | 5                                |
| Rectangular             | up to 0.188 (4.775) thick<br>up to 1 (31.75) wide, incl | 90                    | 620              | 70                              | 485              | 5                                |

<sup>A</sup> Yield strength at 0.5 % extension under load.

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

<sup>C</sup> See Appendix.