Designation: B740 – 09 (Reapproved 2015)

Standard Specification for Copper-Nickel-Tin Spinodal Alloy Strip[1]

This standard is issued under the fixed designation B740; 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 requirements for copper-nickel-tin alloy strip in the following alloys:

Copper Alloy UNS No.	Nominal Composition Weight %		
	Copper	Nickel	Tin
C72700	85	9	6
C72900	77	15	8
C72650	87.5	7.5	5

1.2 *Units*—The values stated in inch-pound units and the values stated in SI units in Table 5 are to be regarded as standard, except for grain size which is stated in metric units only. The values given in parentheses are mathematical conversions to SI units and are provided for information only and are not considered standard.

1.3 The following safety hazard caveat pertains only to the test method(s) described in this specification.

1.3.1 *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 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 of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar

B598 Practice for Determining Offset Yield Strength in Tension for Copper Alloys

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

E3 Guide for Preparation of Metallographic Specimens

E8/E8M Test Methods for Tension Testing of Metallic Materials

E75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys (Withdrawn 2010)[3]

E290 Test Methods for Bend Testing of Material for Ductility

E478 Test Methods for Chemical Analysis of Copper Alloys

3. General Requirements

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

3.1.1 Terminology,
3.1.2 Materials and Manufacture,
3.1.3 Dimensions and Permissible Variations,
3.1.4 Workmanship, Finish, and Appearance,
3.1.5 Sampling,
3.1.6 Significance of Numerical Limits,
3.1.7 Inspection,
3.1.8 Rejection and Rehearing,
3.1.9 Certification,
3.1.10 Test Reports, and
3.1.11 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.

4. Terminology

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

5. Ordering Information

5.1 Include the following information when placing orders for product under this specification, as applicable:

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

Current edition approved May 1, 2015. Published June 2015. Originally approved in 1984. Last previous edition approved in 2009 as B740 – 09. DOI: 10.1520/B0740-09R15.

[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 Document Summary page on the ASTM website.

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

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

5.1.1 ASTM designation and year of issue,
5.1.2 Quantity,
5.1.3 Copper Alloy UNS No. (see 1.1),
5.1.4 Form of material: strip,
5.1.5 Temper (see 8.1),
5.1.6 Dimensions: thickness and width, and length if applicable,
5.1.7 How furnished: rolls or coils, stock lengths with or without ends, specific lengths with or without ends,
5.1.8 Type of edge other than slit, for example, rounded corners, rounded edges, or full-rounded edges.
5.1.9 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 Section as defined in the current edition of Specification B248.

5.2 The following options are available and should be specified at the time of placing of the order when required:
5.2.1 Certification, if required.
5.2.2 Mill test report, if required.

6. Chemical Composition

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

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

6.3 Copper may be given as remainder and taken as the difference between the sum of all the elements analyzed and 100%. When all the elements in the table including copper are analyzed, their sum shall be 99.7 % min.

7. Materials and Manufacture

7.1 *Manufacture*—Spinodal Heat Treatment.
7.1.1 Solution-heat-treatment or solution-heat-treated and cold-worked material is normally spinodal hardened by the purchaser after forming or machining.
7.1.2 Mill-hardened products have been spinodal heat treated by the manufacturer. Further thermal treatment is not normally required.

8. Temper

8.1 The standard tempers for products described in this specification are given in Tables 2-4.
8.1.1 TB00 (Solution Heat Treated).
8.1.2 TD01 to TD 12 (Solution Heat Treated with varying degrees of cold working).
8.1.3 TX00 (Spinodal Hardened).
8.1.4 TS01 to TS12 (Hard and Spinodal Hardened).
8.1.5 TM00 to TS08 (mill hardened).

8.2 Other tempers are available and shall be subject to agreement between supplier or manufacturer and purchaser.

9. Grain Size for Annealed Tempers

9.1 Product over 0.010 in. (0.25 mm) in thickness shall have an average grain-size not exceeding the limits prescribed in Table 5. The determinations are made on the separate samples and in a plane perpendicular to the surface.

10. Mechanical Property Requirements

10.1 *Tensile Strength Requirements:*
10.1.1 The solution heat-treated or solution heat-treated and cold-worked material shall conform to the tensile property requirements specified in Table 2, when tested in accordance with Test Methods E8/E8M.
10.1.2 The spinodal heat-treated material shall conform to the tensile property requirements specified in Table 3.
10.1.2.1 Special combinations of properties such as increased ductility, electrical conductivity, dimensional accuracy, endurance life, improved stress relaxation resistance, resistance to elastic drift, and hysteresis in springs may be obtained by special spinodal-hardening treatments. The mechanical requirements of Table 3 do not apply to such special heat treatments.
10.1.3 The mill-hardened material shall conform to the tensile property requirements specified in Table 4.

11. Performance Requirements

11.1 *Bend Testing*—The bend test is a method for evaluating the ductility of mill-hardened copper-nickel-tin spinodal alloy strip in thicknesses of 0.004 to 0.020 in. (0.102 to 0.508 mm), inclusive.
11.1.1 Material in tempers TM00, TM02, TM04, and TM06 shall conform to the bend test requirements specified in Table 4 when tested in accordance with 15.2.1.
11.1.2 To pass the test, all three specimens tested from a lot must withstand the 90° bend without visible cracks of fracture when observed of the convex surface of the bend at a magnification of ×10.

TABLE 1 Chemical Requirements

		Composition, %								
Copper Alloy UNS No.	Previous Designation	Copper, incl. Silver	Lead,[A] max	Iron,[A] max	Zinc,[A] max	Nickel, incl. Cobalt	Tin	Manganese,[A] max	Niobium,[A] max	Magnesium,[A] max
C72650	Cu-7.5Ni-5Sn	remainder	0.01	0.10	0.10	7.0–8.0	4.5–5.5	0.10	...	...
C72700	Cu-9Ni-6Sn	remainder	0.02[B]	0.50	0.50	8.5–9.5	5.5–6.5	0.05-0.30	0.10	0.15
C72900	Cu-15Ni-8Sn	remainder	0.02[B]	0.50	0.50	14.5–15.5	7.5–8.5	0.30	0.10	0.15

[A] The total of the elements Pb, Fe, Zn, Mn, Nb, and Mg not to exceed 0.7 %.
[B] 0.005 % Pb, max for hot rolling.

TABLE 2 Tensile Property Requirements

Tempers: Solution Heat-Treated
Solution Heat-Treated and Cold Worked

Copper Alloy UNS No.	Temper Designations		Tensile Strength, ksi[A] (MPa)[B] min–max[C]	Yield[D] Strength (0.05 % Offset), ksi[A] (MPa)[B] min–max[C]	Elongation in 2 in., %
	Code	Name			
C72650	TB00	Solution HT	55–70 (380—480)	21—32 (145–220)	32
C72650	TD01	Solution HT and Cold Worked ¼ Hard	60–75 (415–515)	45–60 (310–415)	18
C72650	TD02	Solution HT and Cold Worked ½ Hard	75—85 (515—585)	55–75 (380–515)	5
C72650	TD03	Solution HT and Cold Worked ¾ Hard	80–90 (550–620)	68–82 (470–565)	4
C72650	TD04	Solution HT and Cold Worked Hard	85–95 (585–655)	77–90 (530–620)	2
C72700	TB00	Solution HT	60–80 (410–550)	23–33 (160–230)	30
C72700	TD01	Solution HT and Cold Worked ¼ Hard	72–95 (500–660)	48–64 (330–440)	12
C72700	TD02	Solution HT and Cold Worked ½ Hard	82–108 (570–740)	57–80 (390–550)	6
C72700	TD04	Solution HT and Cold Worked Hard	97–125 (670–860)	77–100 (530–690)	3
C72700	TD08	Solution HT and Cold Worked Spring	110–140 (760–970)	95–115 (660–790)	2
C72700	TD12	Solution HT and Cold Worked Special Spring	115–150 (790–1030)	105–125 (720–860)	...
C72900	TB00	Solution HT	64–85 (440–585)	24–40 (165–275)	32
C72900	TD01	Solution HT and Cold Worked ¼ Hard	75–100 (515–690)	50–66 (345–455)	18
C72900	TD02	Solution HT and Cold Worked ½ Hard	85–110 (585–760)	65–84 (450–580)	8
C72900	TD03	Solution HT and Cold Worked ¾ Hard	95-120 (655-825)	80-100 (550-690)	3
C72900	TD04	Solution HT and Cold Worked Hard	100–130 (690–895)	85–108 (585–745)	...
C72900	TD08	Solution HT and Cold Worked Spring	122–145 (840–1000)	100–125 (690–860)	...
C72900	TD12	Solution HT and Cold Worked Special Spring	135–155 (930–1070)	110–130 (760–895)	...

[A] 1 ksi = 1000 psi.
[B] See Appendix X1.
[C] Max for reference.
[D] As per Practice B598.

12. Dimensions and Permissible Variations

12.1 The dimensions and tolerances for product described by this specification shall be as specified in Specification B248 with particular reference to the following tables and related paragraphs:

12.1.1 *Thickness*—Table 2

12.1.1.1 *Special Thickness*—Table 3

12.1.2 Width

12.1.3 Length

12.1.4 Straightness

12.1.4.1 Slit Metal or Slit Metal Either Straightened or Edge Rolled

13. Retests

13.1 If any lot of material fails to conform to the requirements of this specification due to inadequate heat treatment, new samples of material may be resubmitted for test after heat treatment. Only two such reheat treatments shall be permitted.

13.2 If any lot of material fails to conform to the bend test requirements of this specification, one retest is permitted if only one of the three specimens fails the test. No retest is permitted if two or more specimens fail the test.

14. Specimen Preparation

14.1 For the purpose of determining conformance to the mechanical properties of Table 3, a sample of the non-spinodally hardened strip of alloys C72700 and C72900 material shall be heat treated at 662 ± 9°F (350 ± 5°C) for 1 ½ h ± 5 min and a sample of the as-supplied strip of alloy C72650 shall be heat treated at 725 ± 9° (385 ± 5°C) for 2 h ± 5 min. Other heat-treating temperatures and times may be preferred for end products of this material.

14.2 Specimens for the determination of grain size shall be prepared in accordance with Guide E3.

14.3 For bend testing, three specimens, ½ ± 1⁄16 in. (12.70 ± 1.59 mm) in width of any convenient length, with the rolling

TABLE 3 Tensile Property Requirements

Tempers: Solution Heat Treated and Spinodally Hardened;[A]
Solution Heat Treated, Cold Worked and Spinodally Hardened[A]

Copper Alloy UNS No.	Temper Designations		Tensile Strength, ksi[B] (MPa)[C] min–max[D]	Yield[E] Strength (0.05 % Offset), ksi[B] (MPa)[C] min–max[D]	Elongation in 2 in., %
	Code	Name			
C72650	TX00	Spinodal HT	120–140 (825—965)	60—95 (415–655)	6
C72650	TS01	¼ Hard and Spinodal HT	130–140 (900–965)	90–115 (620–790)	8
C72650	TS02	½ Hard and Spinodal HT	135–145 (930—1000)	100–125 (690–860)	6
C72650	TS03	¾ Hard and Spinodal HT	140–150 (965–1035)	105–130 (725–895)	6
C72650	TS04	Hard and Spinodal HT	140–155 (965–1070)	110–135 (760–930)	4
C72700	TX00	Spinodal HT	100–130 (690–900)	55–99 (380–680)	15
C72700	TS01	¼ Hard + Spinodal HT	115–140 (790–970)	85–112 (590–770)	10
C72700	TS02	½ Hard + Spinodal HT	125–150 (860–1030)	100–123 (690–850)	6
C72700	TS04	Hard + Spinodal HT	135–160 (930–1100)	115–135 (790–930)	4
C72700	TS08	Spring + Spinodal HT	145–179 (1000–1230)	125–150 (860–1030)	3
C72700	TS12	Special Spring + Spinodal HT	150–180 (1030–1240)	130–160 (900–1100)	2
C72900	TX00	Spinodal HT	120–150 (825–1035)	95–120 (655–825)	6
C72900	TS01	¼ Hard + Spinodal HT	130–160 (895–1105)	105–130 (725–895)	4
C72900	TS02	½ Hard + Spinodal HT	145–175 (1000–1205)	125–150 (860–1035)	3
C72900	TS03	¾ Hard + Spinodal HT	155–185 (1070–1275)	135–160 (930–1105)	2
C72900	TS04	Hard + Spinodal HT	165–195 (1140–1345)	145–170 (1005–1170)	2
C72900	TS08	Spring + Spinodal HT	175–205 (1205–1415)	155–185 (1070–1275)	...
C72900	TS12	Special Spring + Spinodal HT	180–225 (1240–1550)	160–200 (1105–1380)	...

[A] 662 ± 9°F (350 ± 5°C) for 1½ h ± 5 min (C72700, C72900); 725 ± 9°F (385 ± 5°C) for 2 h ± 5 min (C72650).
[B] 1 ksi = 1000 psi.
[C] See Appendix X1.
[D] Max for reference.
[E] As per Practice B598.

direction perpendicular to the ½ in. dimension, shall be prepared and tested in accordance with Test Method B820.

15. Test Methods

15.1 *Chemical Analysis:*

15.1.1 Composition shall be determined, in case of disagreement, as follows:

Element	Test Methods
Copper	E75
Nickel	E478
Tin	E75
Lead	E75
Iron	E75
Zinc	E75
Manganese	E75

15.1.2 Test methods to be followed for the determination of elements not listed above or elements resulting from contractual or purchase order agreement, shall be as agreed upon between the manufacturer or supplier and purchaser.

15.2 *Other Tests:*

15.2.1 *Bend Test*—The axis of the bend shall be at an angle of 90° to the direction of rolling, unless otherwise specified. The test specimens shall be bent 90 ± 5° around the test radius.

15.2.2 The test radius shall be within ±6 % of the nominal radius up to 0.010 in. (0.254 mm), and within ±4 % for radii 0.010 in. (0.254 mm) and over.

15.2.3 The determinations are made on the separate samples and in a plane perpendicular to the surface.

16. Keywords

16.1 age hardening; copper-nickel-tin; spinodal; strip; UNS C72650; UNS C72700; UNS C72900

TABLE 4 Mechanical Property Requirements Copper Alloy UNS Nos. C72650 and C72900—Mill Hardened Tempers

Copper Alloys UNS No.	Temper Designations		Tensile Strength, ksi[A] (MPa)[B] min–max	Yield Strength (0.2 % offset)[C], ksi[A] (MPa)[B] min–max	Yield Strength[D] (0.05 % offset) ksi[A] (MPa)[B] min–max[E]	Elongation in 2 in., % min	Minimum 90° Bad Way Bend Ratio (R/t)[F]
	Code	Name					
C72650	TM00	AM	100–120 (690–825)	70–90 (480–620)	65–85 (450–555)	18	1
C72650	TM02	½ HM	115–135 (790–930)	90–110 (620–760)	85–105 (585–725)	10	2.5
C72650	TM04	HM	115–135 (790–930)	100–120 (690–830)	95–115 (655–790)	10	3.7
C72650	TM06	XHM	120–140 (825–965)	105–125 (725–860)	100–120 (690–825)	10	5
C72650	TM08	XHMS	130–145 (895–1000)	115–135 (790-930)	105–125 (725-860)	6	5.5
C72900	TM00	AM	95–115 (655–790)	75–95 (515–655)	70–90 (480–620)	22	0
C72900	TM02	½ HM	105–125 (725–860)	90–110 (620–760)	80–105 (550–725)	15	0.5
C72900	TM04	HM	115–135 (790–930)	105–125 (725–860)	95–120 (655–825)	10	1
C72900	TM06	XHM	130–150 (895–1035)	120–145 (825–1000)	105–130 (725–895)	6	6
C72900	TM08	XHMS	150–180 (1035–1225)	140–170 (965–1170)	125–150 (860–1035)	2	...

[A] 1 ksi = 1000 psi.
[B] See Appendix X1.
[C] For reference.
[D] As per Practice B598.
[E] Max for reference.
[F] As per Test Method B820. The "t" equals the measured average strip thickness to be tested. The "R" equals the bend radius.

TABLE 5 Grain Size Requirements for Copper Alloy UNS Nos. C72700 and C72900—Tempers TB00, TX00, and TM00

Thickness, in. (mm)[A]	Maximum Average Grain Size, mm[B]
Up to 0.030 (0.762)	0.035
Over 0.030 to 0.090 (0.762 to 2.28)	0.045
Over 0.090 to 0.188 (2.28 to 4.78)[C]	0.060

[A] See Appendix X1.
[B] Although no minimum grain size is required, this material must be fully recrystallized.
[C] As per Classification B601.

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 ksi = 6 894 757 Pa, the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2.

SUMMARY OF CHANGES

Committee B05 has identified the principle changes to this specification that have been incorporated since the last issue (B740–02) as follows. (Approved Aug. 15, 2009.)

(1) Editorial and format changes as required for a 5-year review.