Designation: B 740 – 02

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

This standard is issued under the fixed designation B 740; 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 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. The values given in parentheses are mathematical conversions to SI units and are provided for information only and are not considered standard.

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:*

B 248 Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar[2]

B 598 Practice for Determining Offset Yield Strength in Tension for Copper Alloys[2]

B 601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast[2]

B 820 Test Method for Bend Test for Formability of Copper Alloy Spring Material[2]

B 846 Terminology for Copper and Copper Alloys[2]

E 3 Guide for Preparation of Metallographic Specimens[3]

E 8 Test Methods for Tension Testing of Metallic Materials[3]

E 75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys[4]

E 290 Test Method for Bend Testing of Material for Ductility[3]

E 478 Test Methods for Chemical Analysis of Copper Alloys[4]

3. General Requirements

3.1 The following sections of Specification B 248 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 B 248.

4. Terminology

4.1 For definitions of terms related 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 Specification number and date,
5.1.2 Quantity,
5.1.3 Copper Alloy UNS number (see 1.1),
5.1.4 Form of material: strip,
5.1.5 Temper (see 7.1),
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, and

[1] This specification is under the ASTM Committee B05on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.01 on Plate, Sheet, and Strip.

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[2] *Annual Book of ASTM Standards*, Vol 02.01.
[3] *Annual Book of ASTM Standards*, Vol 03.01.
[4] *Annual Book of ASTM Standards*, Vol 03.05.

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

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 as defined in the current edition of Specification B 248.

5.2 The following options are available and should be specified at the time of placing of the order when required:

5.2.1 Width and straightness tolerances, if different from those required in Specification B 248.

5.2.2 Special thickness tolerances if required,

5.2.3 Certification if required,

5.2.4 Mill test report if required, and

5.2.5 Special tests or exceptions, if any.

6. Chemical Composition

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

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

7. Temper

7.1 The standard tempers of material are as designated in Table 2, Table 3, and Table 4. Tempers are as follows: TB00 (solution heat treated), or with varying additional degrees of cold rolling TD01 to TD12 (solution heat treated with varying degrees of cold rolling); spinodal hardened from these appropriate tempers TX00 or TS01 to TS12 (spinodal hardened from the appropriate solution heat treated or solution heat treated and cold rolled temper); or Mill Hardened TM00 to TM08 (mill hardened).

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

8. Grain Size for Annealed Tempers

8.1 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.

9. Mechanical Property Requirements

9.1 *Tensile Strength Requirements*:

9.1.1 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 E 8.

9.1.2 The spinodal heat-treated material shall conform to the tensile property requirements specified in Table 3. Spinodal heat-treatment parameters are given in 11.1.

9.1.3 The mill-hardened material shall conform to the tensile property requirements specified in Table 4.

10. Performance Requirements

10.1 *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.

10.1.1 Material in tempers TM00, TM02, TM04, and TM06 shall conform to the bend test requirements specified in Table 4 when tested in accordance with 14.2.1.

11. Spinodal Heat Treatment

11.1 Solution-heat-treated or solution-heat-treated and cold-worked material is normally spinodal hardened by the purchaser after forming or machining. For the purpose of determining conformance to the mechanical properties of Table 3, a sample of the as-supplied strip of alloys C72700 and C72900 material shall be heat treated at 662 ± 9°F (350± 5°C) for 1½ h ± 5 min and a sample of the as-supplied strip of alloy C72650 shall be heat treated at 725 ± 9°F (385 ± 5°C) for 2 h ± 5 min. Other heat-treating temperatures and times may be preferred for end products of this material.

11.2 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.

11.3 Mill-hardened products have been spinodal heat treated by the manufacturer. Further thermal treatment is not normally required.

12. Retests

12.1 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.

12.2 If any lot of material fails to conform to the bend test requirements of this specification, one retest is permitted if

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., %
	Standard[E]	Former			
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 B 598.
[E] As per Classification B 601.

only one of the three specimens fails the test. No retest is permitted if two or more specimens fail this test.

13. Specimen Preparation

13.1 Tension test specimens shall be prepared as specified in Test Methods E 8. The longitudinal axis of the specimen shall be parallel to the direction of rolling unless otherwise specified.

13.2 Specimens for the determination of grain size shall be prepared in accordance with Guide E 3.

13.3 For bend testing, three specimens, ½ ± 1⁄16 in. (12.70 ± 1.59 mm) in width of any convenient length, with the rolling direction perpendicular to the ½ in. dimension, shall be prepared and tested in accordance with Test Method B 820.

14. Test Methods

14.1 *Chemical Analysis*:

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

Element	Test Methods
Copper	E 75
Nickel	E 478
Tin	E 75
Lead	E 75
Iron	E 75
Zinc	E 75
Manganese	E 75

14.2 *Other Tests*:

14.2.1 *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. To pass the test, all three specimens tested from a lot must withstand the 90° bend without visible cracks or fracture when observed on the convex surface of the bend at a magnification

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., %
	Standard[F]	Former			
C72650	TX00	Spinodal HT	120–140 (825—965)	60—95 (415–655)	6
C72650	TS01	¼Hard and Spinodal HT	130–140 (900–965)	90–115 (620–790)	8
C72650	TS02	½Hard and Spinodal HT	135–145 (930—1000)	100–125 (690–860)	6
C72650	TS03	¾Hard 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	¼Hard + Spinodal HT	115–140 (790–970)	85–112 (590–770)	10
C72700	TS02	½Hard + 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	¼Hard + Spinodal HT	130–160 (895–1105)	105–130 (725–895)	4
C72900	TS02	½Hard + 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 1½h ± 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 B 598.
[F] As per Classification B 601.

of 10×. 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. Keywords

15.1 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]
	Standard[G]	Former					
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 B 598.
[E] Max for reference.
[F] As per Practice B 820. The “t” equals the measured average strip thickness to be tested. The “R” equals the bend radius.
[G] As per Classification B 601.

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 B 601.

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 location of selected changes to this standard since the last issue (B 740 – 96) that may impact the use of this standard.

(*1*) In Table 1, the correction of iron and zinc limits for UNS 72650, and manganese range for C 72700. Also, the substitution of the chemical symbol Nb, for the obsolete Cb, in footnote *A* of the table.

(*2*) The addition of minimum bend test ratios to Table 4.

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