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Standard Specification for Seamless Copper-Nickel Pipe and Tube¹

This standard is issued under the fixed designation B 466/B 466M; 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 seamless copper-nickel pipe and tube in straight lengths, suitable for general engineering purposes. The alloys involved are copper alloys UNS Nos. C70400, C70600, C70620, C71000, C71500, C71520, and C72200.

1.1.1 Copper alloys UNS Nos. C70620 and C71520 are intended for product that will be subsequently welded.

1.2 ~~Units—The values—~~Values stated in inch-pound or SI units are to be regarded separately as standard. Within the text, SI units are shown in brackets. The values stated in each system are may not be 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.

1.3 The following safety hazard caveat pertains only to the test methods described in the Test Methods section of 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 ASTM Standards: ²

B 153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing

B 251 Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube

~~B 251M Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube [Metric]~~

~~B 601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast~~ Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube (Metric)

B 846 Terminology for Copper and Copper Alloys

B 950 Guide for Editorial Procedures and Form of Product Specifications for Copper and Copper Alloys

E 8 Test Methods for Tension Testing of Metallic Materials

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

~~E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials—~~ Test Methods for Rockwell Hardness of Metallic Materials

E 54 Test Methods for Chemical Analysis of Special Brasses and Bronzes

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)

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

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys

E 118 Test Methods for Chemical Analysis of Copper-Chromium Alloys

~~E 243 Practice for Electromagnetic (Eddy-Current) Examination of Copper and Copper-Alloy Tubes~~ E 255 Practice for Sampling Copper and Copper Alloys—Determination of Chemical Composition

E 478 Test Methods for Chemical Analysis of Copper Alloys

¹ This specification is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.04 on Pipe and Tube.

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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.

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

3. General Requirements

3.1 The following sections of Specification B 251 or B 251M constitute a part of this specification:

- 3.1.1 Terminology,
- 3.1.2 Materials and Manufacture,
- 3.1.3 Dimensions, Mass, and Permissible Variations,
- 3.1.4 Workmanship, Finish, and Appearance,
- 3.1.5 Sampling,
- 3.1.6 Number of Tests and Retests,
- 3.1.7 Test Specimens,
- 3.1.8 Test Methods,
- 3.1.9 Significance of Numerical Limits,
- 3.1.10 Inspection,
- 3.1.11 Rejection and Rehearing,
- 3.1.12 Certification,
- 3.1.13 Packing and Package Marking, and
- 3.1.14 Mill Test Report.

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 251 or B 251M.

4. Terminology

4.1 *Definitions*— For definitions of terms related to copper and copper alloys, refer to Terminology B 846.

~~4.2 Definitions of Terms Specific to This Standard:~~

~~4.2.1 *capable of, adj*—as used in this specification, the test need not be performed by the manufacturer or the producer; however, should subsequent testing by the purchaser establish that the product does not meet these requirements, the product shall be subject to rejection.~~

5. Ordering Information

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

- 5.1.1 ASTM designation and year of issue,
- 5.1.2 Copper Alloy UNS No. (Scope section),
- 5.1.3 Temper (Temper section),
- 5.1.4 Dimensions; diameter or distance between parallel surfaces, wall thickness, or size (see also Table X1.1).
- ~~5.1.5 Total length, total weight, or number of pieces of each size,~~
- ~~5.1.6 When the product in alloys C71000 or C72200 is to be welded subsequently (Table 1, Footnote A), and~~
- ~~5.1.7 When product is purchased for an agency of the U.S. Government (Purchases for U.S. Government section):~~
- 5.1.5 Total length, total weight, or number of pieces of each,
- 5.1.6 When product is purchased for an agency of the U.S. Government (Purchases for U.S. Government section).

5.2 The following options are available and, when required, are to be specified in the contract or purchase order at the time of placing of the order.

- 5.2.1 When tension tests are required for large diameter tube (Mechanical Property Requirements section),
- 5.2.2 Hydrostatic Test (Nondestructive Test Requirements section),
- 5.2.2.1 If the product needs to be subjected to a pressure gage reading over 1000 psi [7 MPa].
- 5.2.3 Pneumatic Test (Nondestructive Test Requirements section),
- 5.2.4 Heat identification or traceability requirements, or both,

TABLE 1 Chemical Requirements

Copper Alloy UNS Nos.	Composition, %									
	Copper incl Silver	Nickel incl Cobalt	Lead, max	Iron	Zinc, max	Manganese	Sulfur, max	Phosphorus, max	Chromium	Other Named Elements
C70400	remainder	4.8 to 6.2	0.05	1.3 to 1.7	1.0	0.30 to 0.8	0.02	0.02	...	...
C70600	remainder	9.0 to 11.0	0.05	1.0 to 1.8	1.0	1.0 max	...	...	...	...
C70620	86.5 min	9.0 to 11.0	0.02	1.0 to 1.8	0.50	1.0 max	0.02	0.02	...	Carbon 0.05 max A
C71000	remainder	19.0 to 23.0	0.05 ^A	0.5 to 1.0	1.0 ^A	1.0 max	0.02	0.02	...	...
C71500	remainder	29.0 to 33.0	0.05	0.40 to 1.0	1.0	1.0 max	...	...	...	...
C71520	65.0 min	29.0 to 33.0	0.02	0.40 to 1.0	0.50	1.0 max	0.02	0.02	...	Carbon 0.05 max A,B
C72200	remainder	15.0 to 18.0	0.05 ^A	0.50 to 1.0	1.0 ^A	1.0 max	0.02	0.02	0.30 to 0.7	...

^A When the product is for subsequent welding applications, and so specified by the purchaser, zinc shall be 0.50 % max, lead 0.02 % max, and carbon 0.05 % max.

^B Silicon 0.03 max, titanium 0.03 max.

- 5.2.5 Certification (Specification B 251 or B 251M),
- 5.2.6 Mill test report (Specification B 251 or B 251M), and
- 5.2.7 When product is ordered for ASME Boiler & Pressure Vessel Code Application;³ and
- 5.2.8 When the product in alloys C71000 or C72200 is to be subsequently welded (Table 1, Footnote A).

6. Materials and Manufacture

6.1 *Materials*—The material of manufacture shall be cast billets of copper alloys UNS Nos. C70400, C70600, C70620, C71000, C71500, C71520, and C72200 as specified in the ordering information and shall be of such quality and soundness as to be suitable for processing into finished lengths or coils of tube to meet the properties prescribed herein.—The material of manufacture shall be cast billets of copper alloys UNS Nos. C70400, C70600, C70620, C71000, C71500, C71520, and C72200 of such purity and soundness as to be suitable for processing into the products prescribed herein.

6.2 *Manufacture*— The product shall be manufactured by such hot extrusion or piercing and subsequent cold working and annealing as to produce a uniform, seamless wrought structure in the finished product.

7. Chemical Composition

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

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

7.2.1 For alloys in which copper is specified listed as “remainder,” copper is the difference between the sum of results for of all of the elements determined and 100 %.

7.2.2 When all of the elements in Table 1 are determined, the sum of results shall be as shown below:

Copper Alloy UNS No.	Copper Plus Named Elements, % min
C70400	99.5
C70600 & C70620	99.5
C71000	99.5
C71500 & C71520	99.5
C72200	99.8

8. Temper

8.1 *Annealed Temper*—The product shall be furnished in the O60 (annealed) temper when specified in the ordering information.

8.2

8.1 The standard tempers for products described in this specification are given in Table 2

8.1.1 *Annealed Temper* —O60 (soft annealed).

8.1.2 *Drawn Tempers*—The product shall be furnished in either the H55 (light drawn), H80 (hard drawn), or HE80 (hard drawn and end annealed) temper when specified in the ordering information.— H55 (light drawn), H80 (hard drawn), or HE80 (hard drawn and end annealed).

NOTE 1—The H55 (light drawn) temper is used only when product of some stiffness yet capable of being bent is needed. The H80 (hard drawn) temper is used only when there is a need for material as strong as commercially feasible.

9. Mechanical Property Requirements

9.1 *Tensile Strength Requirements* —Product furnished under this specification shall conform to the tensile and yield strength requirements prescribed in Table 2 when tested in accordance with Test Methods E 8 or E 8M.

9.2 *Yield Strength Requirements* —Product furnished under this specification shall conform to the yield strength requirements prescribed in Table 2 when tested in accordance with Test Methods E8 or E8M.

9.3 *Rockwell Hardness Requirements* —Product furnished under this specification shall conform to the Rockwell hardness requirements prescribed in Table 2 when tested in accordance with Test Methods E 18.

9.4 *The 9.3 The mechanical property requirements for tubes of all alloys in the H80 temper are only applicable to the following sizes:*

Outside Diameter, in. [mm]	Wall Thickness, in. [mm]
Up to 1 [25] incl	0.020-0.120 [0.5-3.0] incl
Over 1-2 [25-50] incl	0.035-0.180 [0.9-4.5] incl
Over 2-4 [50-100] incl	0.060-0.250 [1.5-6.5] incl

² Available from the American Society of Mechanical Engineers, (ASME International), Three Park Ave., New York, NY 10016-5990.

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

TABLE 2 Mechanical Requirements

Standard Temper	Former Temper	Copper Alloy UNS Nos.	Tensile Strength, ^A min		Yield Strength, ^A min	Rockwell ^B Hardness- 30-T	Yield Strength min
			Temper Code	Temper Name			
			ksi	MPa	ksi	MPa		Copper Alloy UNS Nos.	Tensile Strength, min
O60	Soft anneal ^C	C70400	37	255	12	85	45 max
		C70600 & C70620	38	260	13	90	45 max
		C71000	45	310	16	110	48 max
		C71500 & C71520	52	345	18	125	51 max
		C72200	40	275	14	95	45 max
H55	Light drawn	C70400	40	275	30	205	41 to 65
		C70600 & C70620	45	310	35	240	45 to 70
		C72200	48	330	42	290	55 to 70
H80	Hard drawn	C70400	45	310	35	240	60 min
		C70600 & C70620	50	345	40	275	63 min
		C71000	55	380	43	295	67 min
		C71500 & C71520	70	485	45	310	70 min
		C72200	55	380	44	305	67 min

^A At 0.5 % extension under load.

^B Rockwell hardness values shall apply only to tube or pipe having a wall thickness of 0.020 in. [0.5 mm] or over and an outside diameter of 5/16 in. [8 mm] or over. For all other tube no Rockwell hardness values shall apply. Rockwell hardness tests shall be made on the inside surface of the tube. When suitable equipment is not available for determining the specified Rockwell hardness, other Rockwell scales and values may be specified subject to agreement between the manufacturer and the purchaser.

^C Although no minimum grain size is specified, the product must nevertheless have fully recrystallized grain structure.

9.4.1 For 9.3.1 For other sizes in the H80 (hard drawn) temper, the mechanical property requirements shall be established by agreement between the manufacturer and the purchaser.

9.5 The 9.4 The mechanical property requirements for tubes of the HE80 (hard drawn and end annealed) temper shall be established by agreement between the manufacturer or supplier and the purchaser.

9.6.5 Tension tests are required to be performed for products having a wall thickness under 0.020 in. [0.5 mm] and an inside diameter of 0.312 [0.8 mm] or smaller.

9.6.5.1 Tension tests for other sizes need not be performed except when indicated in the contract or purchase order at the time of placing the order.

10. Performance Requirements

10.1 Expansion Test Requirements :

10.1.1 Tube furnished in the O60 (annealed)(soft anneal) temper and the HE80 (hard drawn and end annealed) shall withstand an expansion to 30 % of the outside diameter when tested in accordance with Test Method B 153.

10.1.1.1 The expanded sample shall show no cracking or other defect visible to the unaided eye.

10.1.1.2 The expansion test is not required for tube furnished in tempers other than O60 and HE80.

10.2 Flattening Test Alternative :

10.2.1 As an alternate to the expansion test for product over 4 in. [100 mm] in diameter, the flattening test described in the Test Method section in 15.2.2 may be performed.

10.2.2 During inspection, the flattened areas of the test specimen shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

11. Other Requirements

11.1 Purchases for U.S. Government Agencies

11.1.1 Agencies — If the product ordered is for an agency of the U.S. Government, when specifically stipulated in the contract or purchase order, the product furnished shall conform to the conditions specified in the Supplementary Requirements section of Specification B 251 or B 251M.

12. Nondestructive Test Requirements

12.1

11.2 Nondestructive Test Requirements

11.2.1 Electromagnetic (Eddy Current) Test:

12.1.1 Each Each tube up to and including 3.125-in. [80-mm] nominal outside diameter shall be subjected to an eddy current test. Testing shall follow the procedures of Practice E 243 and the Test Methods section of this specification.

12.1.1.1 The 11.2.1.1 The provisions for the determination of “end-effect” in Practice E 243 shall not apply.

12.1.1.2 Hydrostatic Test Alternative