



Designation: B 466/B 466M – 98

Standard Specification for Seamless Copper-Nickel Pipe and Tube¹

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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, C71000, C71500, and C72200.

1.2 The values stated in inch-pound or SI units are to be regarded separately as standard. The values 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.

1.3 The following safety hazard caveat pertains only to the test methods described Section 15 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 153 Test Method for Expansion (Pin Test) of Copper and Copper Alloy Pipe and Tubing²
- B 251 Specification for General Requirements for Wrought Seamless Copper and Copper/Alloy Tube²
- B 251M Specification for General Requirements for Wrought Seamless Copper and Copper/Alloy Tube [Metric]²
- B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast²
- B 846 Terminology for Copper and Copper Alloys²
- E 8 Test Methods for Tension Testing of Metallic Materials³
- E 8M Test Methods for Tension Testing of Metallic Materials [Metric]³
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials³
- E 62 Test Methods for Chemical Analysis of Copper and

- Copper Alloys (Photometric Methods)⁴
- E 75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys⁴
- E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys⁴
- E 118 Test Methods for Chemical Analysis of Copper-Chromium Alloys⁴
- E 243 Practice for Electromagnetic (Eddy-Current) Examination of Copper and Copper/Alloy Tubes³
- E 255 Practice for Sampling Copper and Copper Alloys Determination of Chemical Composition⁴
- E 478 Test Methods for Chemical Analysis of Copper Alloys⁵

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *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.

3.2.2 *unaided eye, n*—without visual enhancement, however, corrective lenses necessary to obtain normal visual shall be permitted.

4. Ordering Information

4.1 Orders for products under this specification shall include the following information:

- 4.1.1 ASTM designation and year of issue,
- 4.1.2 Copper Alloy UNS No. (Section 1),
- 4.1.3 Temper (Section 8),
- 4.1.4 Dimensions; diameter or distance between parallel surfaces, wall thickness, or size (see also Table X1.1).
- 4.1.5 Total length, total weight, or number of pieces of each size,
- 4.1.6 When the product is to be welded subsequently (Table 1, Footnote A), and
- 4.1.7 When product is purchased for an agency of the U.S. Government (Section 11).

¹ This specification is under the jurisdiction of ASTM Committee B-5 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.04 on Pipe and Tube.

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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.

⁵ *Annual Book of ASTM Standards*, Vol 03.06.

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

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TABLE 1 Chemical Requirements

Copper Alloy UNS Nos.	Composition, %									
	Copper	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 ^A	1.0 to 1.8	1.0 ^A	1.0 max	0.02	0.02	...	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	...	A
C71500	remainder	29.0 to 33.0	0.05 ^A	0.40 to 1.0	1.0 ^A	1.0 max	0.02	0.02	...	A
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

^AWhen 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.

4.2 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.

- 4.2.1 Hydrostatic Test (12.2),
- 4.2.2 Pneumatic Test (12.3),
- 4.2.3 Heat identification or traceability requirements,
- 4.2.4 Certification (Section 14 of Specification B 251 or B 251M), and
- 4.2.5 Mill test report (Section 16 of Specification B 251 or B 251M).

5. General Requirements

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

- 5.1.1 Terminology,
- 5.1.2 Materials and Manufacture,
- 5.1.3 Dimensions, Mass, and Permissible Variations,
- 5.1.4 Workmanship, Finish, and Appearance,
- 5.1.5 Sampling,
- 5.1.6 Number of Tests and Retests,
- 5.1.7 Test Specimens,
- 5.1.8 Test Methods,
- 5.1.9 Significance of Numerical Limits,
- 5.1.10 Inspection,
- 5.1.11 Rejection and Rehearing,
- 5.1.12 Certification,
- 5.1.13 Packing and Package Marking, and
- 5.1.14 Mill Test Report.

5.2 In addition, when a section with a title identical to that referenced in 5.1, above, appears in this specification, it contains additional requirements which supplement those appearing in Specification B 251 or B 251M.

6. Materials and Manufacture

6.1 *Materials*—The material of manufacture shall be cast billets of copper alloys UNS Nos. C70400, C70600, C71000, C71500, 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.

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. Limits may be established and analysis required for unnamed elements by agreements between the manufacturer or supplier and the purchaser.

7.2.1 For copper alloys in which copper is specified as the remainder, copper may be taken as the difference between the sum of results for 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	99.5
C71000	99.5
C71500	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 *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.

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 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 E 8 or E 8M.

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 mechanical 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

TABLE 2 Mechanical Requirements

Standard Temper	Former Temper	Copper Alloy UNS, Nos.	Tensile Strength, min ksi [MPa]	Yield Strength ^A , min ksi [MPa]	Rockwell ^B Hardness 30 T
O 60	Soft anneal ^C	C70400	37 [255]	12 [85]	45 max
		C70600	38 [260]	13 [90]	45 max
		C71000	45 [310]	16 [110]	48 max
		C71500	52 [345]	18 [125]	51 max
		C72200	40 [275]	14 [95]	45 max
H 55	Light drawn	C70400	40 [275]	30 [205]	41 to 65
		C70600	45 [310]	35 [240]	45 to 70
		C72200	48 [330]	42 [290]	55 to 70
H 80	Hard drawn	C70400	45 [310]	35 [240]	60 min
		C70600	50 [345]	40 [275]	63 min
		C71000	55 [380]	43 [295]	67 min
		C71500	70 [485]	45 [310]	70 min
		C72200	55 [380]	44 [305]	67 min

^AAt 0.5 % extension under load.

^BRockwell 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.

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

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

9.5 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 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.

9.6.1 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) 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 rupture 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*—As an alternative to the expansion test of 10.1, tube of the O60 and HE80 tempers above 4 in. [100 mm] in diameter shall be capable of passing a flattening test performed per the test method prescribed in 15.2.2.

11. Purchases for U.S. Government Agencies

11.1 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 Electromagnetic (Eddy Current) Test:

12.1.1 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 15.2.

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

12.1.1.2 *Hydrostatic Test Alternative*—As an alternative to the eddy current test for tubes of diameters above 1.25 in. [32 mm], the manufacturer shall have the option to perform the hydrostatic test to the requirements of 12.2.

12.1.2 The tested tubes, which do not actuate the signaling device of the testing unit, shall be considered as conforming to the requirements of the test.

12.1.3 Either notch depth or drilled hole standards shall be used.

12.1.3.1 Notch depth standards shall be 22 % of the wall thickness.

12.1.3.2 The sizes of drilled hole standards shall in accordance with Table X1.2 of Practice E 243.

12.2 Hydrostatic Test:

12.2.1 When specified in the contract or purchase order, or as an alternate to the eddy current test for tubes above 1.25 in. [32 mm] in diameter (see 12.1.1.2), each tube shall stand, without showing evidence of leakage, an internal hydrostatic pressure sufficient to produce a fiber stress of 7000 psi [48 MPa] as determined by the following equation for thin hollow cylinders under tension:

$$P = 2St/(D - 0.8t) \quad (1)$$

where:

- P = hydrostatic pressure, psi [MPa];
- t = wall thickness of the material, in. [mm];
- D = outside diameter of the material, in. [mm]; and
- S = allowable stress of the material, psi [MPa].

12.2.1.1 The tube need not be subjected to a pressure gage reading over 1000 psi [7 MPa] unless specifically stipulated in the contract or purchase order.

12.2.2 When the hydrostatic test is specified for tubes of less than 0.50 in. [12 mm] in outside diameter and less than 0.060 in. [1.5 mm] in wall thickness, the manufacturer shall have the option to perform either the hydrostatic test to the requirements specified in 12.2 or the pneumatic test to the requirements specified in 12.3.

12.3 *Pneumatic Test*—When specified in the contract or purchase order, each tube shall be subjected to a minimum internal air pressure of 60 psig [415 kPa] for 5s without showing evidence of leakage.

13. Dimensions, Mass, and Permissible Variations

13.1 *Wall Thickness Tolerances*—The wall thickness tolerances shall be in accordance with Table 3.

13.2 *Diameter Tolerances*—The diameter tolerances shall be in accordance with Table 4.