



Designation: B 552 – 98<sup>e1</sup>

## Standard Specification for Seamless and Welded Copper–Nickel Tubes for Water Desalting Plants<sup>1</sup>

This standard is issued under the fixed designation B 552; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

<sup>e1</sup> NOTE—Note 1 was editorially deleted in March 2000.

### 1. Scope \*

1.1 This specification establishes requirements for seamless and welded copper-nickel tubes from 0.625 to 1.25 in. (15.9 to 31.8 mm) in diameter for use in heat exchangers in water desalting plants. The following alloys are involved: Copper Alloy UNS Nos. C70600, C71500, C71640, and C72200.

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

1.3 The following safety hazard caveat pertains only to the test methods of Section 16 described in 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 its use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- B 111 Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock<sup>2</sup>
- B 153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing<sup>2</sup>
- B 543 Specification for Welded Copper and Copper-Alloy Heat Exchanger Tube<sup>2</sup>
- B 601 Practice for Temper Designations for Copper and Copper Alloys—Wrought and Cast<sup>2</sup>
- B 846 Terminology for Copper and Copper Alloys<sup>2</sup>
- E 8 Test Methods for Tension Testing of Metallic Materials<sup>3</sup>
- E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)<sup>4</sup>
- E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys<sup>4</sup>

<sup>1</sup> 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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<sup>2</sup> *Annual Book of Standards*, Vol 02.01.

<sup>3</sup> *Annual Book of Standards*, Vol 03.01.

<sup>4</sup> *Annual Book of Standards*, Vol 03.05.

E 118 Test Methods for Chemical Analysis of Copper-Chromium Alloys<sup>4</sup>

E 243 Practice for Electromagnetic (Eddy-Current) Examination of Copper and Copper-Alloy Tubes<sup>5</sup>

E 255 Practice for Sampling Copper and Copper Alloys for Determination of Chemical Composition<sup>4</sup>

E 478 Test Methods for Chemical Analysis of Copper Alloys<sup>6</sup>

### 3. Terminology

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

### 4. Classification

4.1 Tubes furnished to this specification are classified into two types, as follows:

- 4.1.1 Seamless tube and
- 4.1.2 Welded tube.

### 5. Ordering Information

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

- 5.1.1 ASTM designation and year of issue,
- 5.1.2 Copper Alloy UNS number designation,
- 5.1.3 Whether seamless or welded (Section 4),
- 5.1.4 Temper (Section 8),
- 5.1.5 Dimensions: diameter and wall thickness (whether minimum or nominal), and length (Section 12),
- 5.1.6 Total number of pieces of each size, and
- 5.1.7 How furnished, whether in straight lengths or coils.

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

- 5.2.1 Whether further finish processing of welded tube is needed (6.2.2.1),
- 5.2.2 Hydrostatic test (11.2),
- 5.2.3 Pneumatic test (11.3),
- 5.2.4 Certification (Section 20), and

<sup>5</sup> *Annual Book of Standards*, Vol 03.03.

<sup>6</sup> *Annual Book of Standards*, Vol 03.06.

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

5.2.5 Mill test report (Section 21).

## 6. Materials and Manufacture

### 6.1 Material:

6.1.1 The material of manufacture shall be cast billets of Copper Alloys UNS Nos. C70600, C71500, C71640, 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:

6.2.1 *Seamless Tube*— 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.

6.2.2 *Welded Tube*— The product shall be manufactured from cold rolled strip which is subsequently formed and welded by an automatic welding process.

6.2.2.1 As-welded tubes are permitted to have further processing when agreement is established between the manufacturer or supplier and purchaser.

6.2.3 The product shall be cold worked and annealed as necessary to meet properties of the temper specified.

## 7. Chemical Composition

7.1 The product shall conform to the chemical composition requirements specified in Table 1 for the Copper Alloy UNS number designation specified in the ordering information.

7.2 These composition limits do not preclude the presence of other elements. When required, limits for unnamed elements shall be established and analysis required by agreement between the manufacture or supplier and 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 all the elements analyzed and 100 %.

7.2.1.1 When all the elements in Table 1 are analyzed, their sum shall be as shown in the following table:

Copper Alloy UNS No.	Copper Plus Named Elements, % min
C70600	99.5
C71500	99.5
C71640	99.5
C72200	99.8

**TABLE 1 Chemical Requirements**

Element	Composition, %			
	Copper Alloy UNS No.			
	C70600	C71500	C71640	C72200
Copper (incl silver)	remainder	remainder	remainder	remainder
Lead, max	0.05 <sup>A</sup>	0.05 <sup>A</sup>	0.05 <sup>A</sup>	0.05 <sup>A</sup>
Iron	1.0–1.8	0.40–1.0	1.7–2.3	0.5–1.0
Zinc, max	1.0 <sup>A</sup>	1.0 <sup>A</sup>	1.0 <sup>A</sup>	1.0 <sup>A</sup>
Nickel (incl cobalt)	9.0–11.0	29.0–33.0	29.0–32.0	15.0–18.0
Manganese	1.0 max	1.0 max	1.5–2.5	1.0
Chromium	...	...	...	0.30–0.70
Other named elements	A	A	A	A
Copper + elements with specific limits	...	...	...	99.5 min

<sup>A</sup>When the product is for subsequent welding applications and so specified by the purchaser, zinc shall be 0.50 % max, lead 0.02 % max, phosphorus 0.02 % max, sulfur 0.02 % max, and carbon 0.05 % max.

## 8. Temper

8.1 Tempers within this specification are as defined in Practice B 601.

8.1.1 *Seamless Tube*—The product shall be furnished in either the O61 (annealed), or the H55 (light drawn, light cold-worked) temper, as specified in the ordering information.

8.1.2 *Welded Tube*—The product shall be furnished in either the WO61 (welded and annealed) or the WC55 (welded and light cold worked) temper as specified in the ordering information.

8.2 Tubes shall conform to the tensile requirements shown in Table 2.

## 9. Mechanical Property Requirements

### 9.1 Tensile Strength:

9.1.1 The product shall conform with the tensile strength requirements prescribed in Table 2 for the temper, alloy and type specified in the ordering information when tested in accordance with Test Methods E 8.

## 10. Performance Requirements

### 10.1 Expansion Test Requirements:

10.1.1 Tube specimens selected for test shall withstand the expansion shown in Table 3 at one end when tested in accordance with Test Method B 153. The expanded tube shall show no cracking or rupture visible to the unaided eye.

### 10.2 Flattening Test Requirements:

10.2.1 Tube specimens approximately 4 ft (1.22 m) long shall be tested in the annealed condition by flattening on different elements throughout the length. Each element shall be flattened by one stroke of a press. The term “flattened” shall be interpreted as follows: a micrometer set at three times the wall thickness shall pass over the tube freely throughout the flattened part except as the points where the change in element of flattening takes place.

10.2.1.1 For seamless tube the flattened elements shall not show cracking or rupture visible to the unaided eye. Superficial ruptures resulting from surface imperfections shall not be cause for rejection.

10.2.1.2 For seam-welded tube, the weld shall be placed in a position of maximum bend for at least one fourth of the

**TABLE 2 Tensile Requirements**

Copper Alloy UNS No.	Temper		Tensile Strength, min, ksi (MPa)
	Standard	Former	
C70600	O61	annealed	40 (275)
	W061	welded and annealed	40 (275)
	H55	light drawn, light cold worked	45 (310)
C71500	WC55	welded and light cold worked	45 (310)
	O61	annealed	52 (360)
	W061	welded and annealed	52 (360)
C71640	H55	light drawn, light cold worked	54 (370)
	WC55	welded and light cold worked	54 (370)
	O61	annealed	63 (435)
C72200	W061	welded and annealed	63 (435)
	H55	light drawn, light cold worked	75 (515)
	WC55	welded and light cold worked	75 (515)
	O61	annealed	45 (310)
	W061	welded and annealed	45 (310)
	H55	light drawn, light cold worked	50 (345)
	WC55	welded and light cold worked	50 (345)

**TABLE 3 Expansion Test Requirements**

Copper Alloy UNS No.	Temper		Expansion of Tube Outside Diameter, % of Original Outside Diameter
	Standard	Former	
C70600	O61	annealed	30
	W061	welded and annealed	30
	H55	light drawn, light cold worked	15
	WC55	welded and light cold worked	15
C71500	O61	annealed	30
	W061	welded and annealed	30
	H55	light drawn, light cold worked	15
	WC55	welded and light cold worked	15
C71640	O61	annealed	30
	W061	welded and annealed	30
	H55	light drawn, light cold worked	15
	WC55	welded and light cold worked	15
C72200	O61	annealed	30
	W061	welded and annealed	30
	H55	light drawn, light cold worked	15
	WC55	welded and light cold worked	15

flattened elements. The flattened elements shall not show cracking or rupture visible to the unaided eye. If the tube has been further processed after welding and the weld cannot be located, the test shall be performed in accordance with 10.2.1.

**10.3 Weld Quality Test Requirements:**

10.3.1 *Seam Welds*—Conformance to the quality requirements of 13.3 shall be demonstrated at the welding job site by a 180° reverse-bend test. Specimens approximately 1½ in. (38.1 mm) long containing the weld shall be sectioned along the longitudinal axis of the tube with the seam weld centered in one of the test sections. The sections containing the seam weld shall be flattened in a vise or equivalent tool before bending, and then bent 180° over a radius equal to three times the nominal tube wall thickness. The root of the weld shall be located on the outside surface of the knuckle of the bend. There shall be no evidence of cracks or lack of penetration in the weld. In cases in which the seam-welded tube is further processed, it may be difficult or impossible to locate the weld, and then this paragraph will not be a requirement.

**11. Nondestructive Test Requirements**

**11.1 Electromagnetic (Eddy-Current) Test:**

11.1.1 Each tube shall be subjected to an eddy-current test. Testing shall follow the procedures of Practice E 243.

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

11.1.3 When tested in accordance with Practice E 243, tubes that do not actuate the signaling device of the testing unit shall be considered as conforming to the requirements of the test.

11.1.4 Either notch depth or drilled hold standards shall be used.

11.1.4.1 Notch depth standards shall be 10 % of the wall thickness.

11.1.4.2 Drilled hole standards shall be per Table X1.2 of Practice E 243.

**11.2 Hydrostatic Test:**

11.2.1 When specified in the contract or purchase order, 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. 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.

$$P = 2St/(D - 0.8t) \tag{1}$$

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).

**11.3 Pneumatic Test:**

11.3.1 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 5 s without showing evidence of leakage.

**12. Dimensions, Mass, and Permissible Variations**

12.1 *Diameter*—Tubes to be furnished shall range in outside diameter, as specified, from 5/8 to 1¼ in. (15.9 to 31.8 mm) inclusive. The diameter of the tubes shall not vary from that specified by more than the following amount as measured by “go” and “no go” gages:

Specified Diameter, in. (mm)	Tolerance, Plus and Minus in. (mm)
To 1 (25.4) incl	0.004 (0.10)
Over 1 to 1.250 (25.4 to 31.8) incl	0.005 (0.13)

12.1.1 When tubes are supplied in coils for straightening at jobsite the above tolerances apply to the finished straightened tubes.

12.2 *Wall Thickness*—Tubes shall be furnished as specified, with wall thicknesses in the range of 0.035 to 0.065 in. (0.889 to 1.65 mm), inclusive.

12.2.1 The wall thickness at any point shall not be less than that specified except when tubes are specifically ordered to a “nominal” wall thickness. When tube is ordered to a “nominal” wall thickness the deviation of the wall thickness from “nominal” shall not exceed ± 10 % of the nominal wall thickness, expressed to the nearest 0.0005 in. (0.013 mm).

12.2.2 The residual inner-bead reinforcement after removal at seam-weld areas shall not exceed 0.006 in. (0.15 mm) in height.

12.3 *Length*—The lengths of the straight tubes shall not be less than that specified when measured at a temperature of 20°C but may exceed the specified value by the amounts given in Table 4. For tube ordered in coils, the length may not be less than that specified.

12.4 *Squareness of Cut*—The departure from squareness of the end of any straight tube shall not exceed 0.016 in./in. (0.016 mm/mm) of diameter.

**TABLE 4 Length Tolerance**

Specified Length	Tolerance, All Plus	
	ft	(m)
Up to 15	(4.9) incl	3/32 ( 2.4)
Over 15 to 20, incl	(4.9–6.6) incl	1/8 ( 3.2)
Over 20 to 30, incl	(6.6–9.8) incl	5/32 ( 4.0)
Over 30 to 60, incl	(9.9–19.7) incl	3/8 ( 9.5)
Over 60 to 100, incl	(19.7–32.8) incl	1/2 (12.7)