Designation: B919 – 12

Standard Specification for Welded Copper Heat Exchanger Tubes With Internal Enhancement[1]

This standard is issued under the fixed designation B919; 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.

1. Scope*

1.1 This specification establishes the requirements for welded, internally enhanced copper tube, in straight lengths or coils, suitable for use in refrigeration and air conditioning products or other heat exchangers.

1.2 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The product shall be produced of the following coppers. Unless otherwise specified, tubes made from any one of these coppers may be supplied:

Copper UNS No.	Type of Metal
C10200	Oxygen-free without residual deoxidants
C12200	Phosphorized, high residual phosphorus (DHP)

1.4 The following pertains to the test method described in 18.4 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 requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B153 Test Method for Expansion (Pin Test) of Copper and Copper-Alloy Pipe and Tubing

B577 Test Methods for Detection of Cuprous Oxide (Hydrogen Embrittlement Susceptibility) in Copper

B601 Classification for Temper Designations for Copper and Copper Alloys—Wrought and Cast

B846 Terminology for Copper and Copper Alloys

E3 Guide for Preparation of Metallographic Specimens

E8/E8M Test Methods for Tension Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry

E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[3]

E112 Test Methods for Determining Average Grain Size

E243 Practice for Electromagnetic (Eddy Current) Examination of Copper and Copper-Alloy Tubes

E255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition

E2575 Test Method for Determination of Oxygen in Copper and Copper Alloys

3. Terminology

3.1 For the definition of terms related to copper and copper alloys refer to Terminology B846.

3.2 *Definitions:*

3.2.1 *bottom wall, n*—the wall thickness measured from the base of the enhancement to the outside surface.

3.2.2 *coil, n*—a length of the product wound into a series of connected turns.

3.2.3 *enhancement, n*—a geometrical feature intentionally formed on a tube I.D. surface to improve heat transfer.

3.2.4 *level wound, adj*—a type of coil in which the turns are wound into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *roundness tolerance, n*—the roundness tolerance is defined as the maximum OD at a point minus the minimum OD, at the same plane of intersection of the tube, divided by the specified OD × 100 %.

3.3.2 *squareness of cut, n*—the maximum deviation of one side of a cross section from the opposite side, when measured

[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.

Current edition approved April 1, 2012. Published May 2012. Originally approved in 2001. Last previous edition approved in 2006 as B919 – 01 (2006). DOI: 10.1520/B0919-12.

[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

against the projected perpendicularity of the plane of the projected center of the tube at the ends.

4. Classification

4.1 The following types of welded tube are manufactured under the scope of this specification:

4.1.1 *As-Welded*—Welded tube without subsequent heat treatment or cold work.

4.1.2 *Welded Tube, Subsequently Annealed*—Welded tube annealed to produce a uniform grain size appropriate to the specified annealed temper.

5. Ordering Information

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

5.1.1 ASTM designation number and year of issue,

5.1.2 Copper UNS No.,

5.1.3 Tube type (Section 4),

5.1.4 Temper (Section 8),

5.1.5 Length, diameter, bottom-wall thickness, and enhancement dimensions. Configuration of the enhanced surface shall be as agreed upon between the manufacturer, or supplier, and purchaser,

5.1.6 How furnished: straight or coils,

5.1.7 Quantity,

5.1.8 Cuprous oxide test, if required (12.3 and 16.1.4),

5.1.9 Certification, when required (Section 22), and

5.1.10 Mill test report, if required (Section 23).

6. Materials and Manufacture

6.1 *Material:*

6.1.1 The material of manufacture shall be sheet or strip, of the required alloy, and may be either cold worked or annealed.

6.1.2 The material shall be of such purity and soundness as to be suitable for processing into the product prescribed herein.

6.2 *Manufacture:*

6.2.1 The welded tube shall be manufactured from either cold rolled or annealed sheet or strip. The sheet or strip shall be formed into a tubular shape on a suitable forming mill.

6.2.2 Welding shall be accomplished by any process that produces forge or fusion welds leaving no crevice visible to the unaided eye in the weld seam.

6.2.2.1 *Forge—Welded Tube*—The edges of the strip shall be heated to the required welding temperature, usually by a high frequency electric current, and be pressed firmly together causing a forged-type joint to be formed with internal and external flash.

6.2.2.2 *Fusion—Welded Tube*—The edges of the tube shall be brought together and welded, usually by a GTAW welding process, without the addition of filler metal, causing a fusion-type joint to be formed with no internal or external flash.

6.2.2.3 *Flash Removal*—The external flash of forge welded tubes, if present, shall be removed by scarfing. The internal flash shall be treated by one of the following techniques: (*1*) IFI—internal flash to remain in the as-welded condition, (*2*) IFR—internal flash to be removed by scarfing, and (*3*) IFD—internal flash displaced by rolling or drawing.

6.2.3 The internal enhancement shall be produced by cold forming.

6.2.4 The longitudinal seam from welding shall be free of filler metal.

7. Chemical Composition

7.1 The material shall conform to the requirements in Table 1 for the copper specified in the contract or purchase order.

7.2 These compositional limits do not preclude the possible presence of other unnamed elements. When required, limits and analysis for unnamed elements shall be established by agreement between the manufacturer and the purchaser.

8. Temper

8.1 Tempers, as defined in Classification B601, of the various tube types are as follows:

8.1.1 *As-Welded:*

8.1.1.1 Annealed strip WM50, subsequently internally enhanced by cold working and welded.

8.1.2 *Welded and Annealed:*

8.1.2.1 Annealed strip, internally enhanced by cold working, welded and soft annealed W060, and

8.1.2.2 Annealed strip, internally enhanced by cold working, welded and light annealed W050.

NOTE 1—By agreement with the purchaser and manufacturer, product in special tempers may be supplied with properties as agreed upon between the purchaser and the manufacturer.

9. Grain Size for Annealed Tempers

9.1 Samples of annealed temper tubes shall be examined at a magnification of 75 diameters. The grain size shall be determined in the wall beneath the internal enhancement. The microstructure shall show complete recrystallization and shall have an average grain size within the limits specified in Table 2.

9.2 The surface of the test specimen for the microscopical examination shall approximate a radial longitudinal section of the tube.

10. Mechanical Properties

10.1 WM (as-welded) and WO (annealed) temper shall conform to the mechanical properties as specified in Table 2.

10.2 If disagreement arises between the grain size requirement and the mechanical property requirements for annealed tempers, the mechanical property requirements take precedent.

11. Performance Requirements

11.1 *Expansion Requirements:*

TABLE 1 Chemical Requirements

UNS Alloy Number	Copper, wt %	Phosphorus, wt %
C10200[A]	99.95 min	
C12200	99.9 min	0.015 - 0.040

[A] Oxygen in C10200 shall be 10 ppm max.

TABLE 2 Mechanical Property Requirements of As-Fabricated and Annealed Tube

Temper	Average Grain Size, mm	Tensile Strength, ksi[A] (MPa)	Yield Strength, ksi[B] (MPa)	Elongation in 2 in. (51 mm), min %
WM	. . .	30 min (205 min)	. . .	. . .
WO60	0.040 min.	30 min (205 min)	6 (40) min	35
WO50	0.040 max	30 min (205 min)	9-15 (60 - 105)	35

[A] ksi = 1000 psi.
[B] Yield strength to be determined at 0.5 % extension under load.

11.1.1 The annealed material shall be capable of being expanded in accordance with Test Method B153 with an expansion of the outside diameter in the following percentage:

Outside Diameter, in. (mm)	Expansion of Outside Diameter, %
0.750 in. (19.0) and under	30
Over 0.750 in. (19.0)	20

11.1.2 The expanded tube shall show no cracking or rupture visible to the unaided eye.

12. Other Requirements

12.1 *Nondestructive Examination for Defects:*

12.1.1 Each tube shall be subjected to an eddy-current test. Tubes shall normally be tested in the fabricated temper; however, they may be tested in the annealed temper at the option of the manufacturer.

12.1.2 *Electromagnetic (Eddy-Current) Test:*

12.1.2.1 The testing shall follow the procedures specified in Practice E243. Unless otherwise agreed upon between the manufacturer, or supplier, and the purchaser, the manufacturer shall have the option of calibrating the test equipment using either notches or drilled holes. Notch depth standards rounded to the nearest 0.001 in. (0.025 mm) shall be 22 % max. of the nominal, bottom-wall thickness. Drilled hole standards shall be 0.025-in. (0.635-mm) max. diameter for tubes up to and including ¾-in. (19.05-mm) specified diameter and 0.031-in. (0.785-mm) max. diameter for tubes over ¾-in. (19.05-mm) specified diameter.

12.1.2.2 Tubes that do not actuate the signaling device on the eddy-current tester shall be considered in conformance to the requirements of this test.

12.1.2.3 Tubes, rejected for irrelevant signals because of moisture, soil, and or minor, mechanical damage, shall, at the option of the manufacturer, be reconditioned and retested.

12.1.2.4 Tubes that are reconditioned and retested (see 12.1.2.3) shall be considered to conform to the requirements of this specification, if they do not cause output signals beyond the acceptable limits.

12.1.2.5 Unless otherwise specified, eddy-current discontinuities will be identified on coils in excess of 200 ft. (6096 cm) in length for subsequent removal by the purchaser.

12.1.2.6 When required, the customer shall specify the permissible number of identified eddy-current discontinuities.

12.2 *Cleanness Requirements:*

12.2.1 The tube shall be capable of meeting the following cleanness requirement:

12.2.1.1 The inside of the tube with closed ends shall be sufficiently clean so that when tested in accordance with the method given in 18.4, the residue remaining upon evaporation of the solvent shall not exceed 0.0035 g/ft^2 (0.038 g/m^2) of interior surface.

12.2.1.2 The term “capable of” in the context of this requirement shall mean that the testing and reporting of individual lots need not be performed by the producer of the product, if capability of the manufacturing process to meet this requirement has previously been established. However, should subsequent testing by either the producer or purchaser establish that the product does not meet this requirement, the product shall be subject to either rejection, or recall or both. See 18.4 for the test method.

12.3 *Cuprous Oxide Requirement:*

12.3.1 Product manufactured from Copper UNS Alloy C10200 shall be significantly free of cuprous oxide as determined by Procedure A of Test Methods B577.

13. Dimensions, Mass, and Permissible Variations

13.1 The standard method for specifying tube diameters and walls shall be decimal fractions of an inch.

13.2 Tolerances on a given tube are permitted to be specified with respect to any two but not all three of the following: outside diameter, inside diameter, and bottom-wall thickness.

13.3 For the purposes of determining conformance with the dimensional requirements in this specification, any measured value outside the specified limiting values for any dimension shall be cause for rejection.

13.4 *Bottom-Wall Thickness Tolerances:*

13.4.1 Bottom-wall thickness tolerances shall conform to the tolerances listed in Table 3 (See Fig. 1).

13.4.2 The wall thickness tolerances, listed in Table 3 for tube furnished IFI, shall not apply to that portion of the tube wall that contains the interior flash and weld upset.

NOTE 2—The weld thickness shall not exceed the summation of the bottom- wall thickness and the enhancement height.

13.4.3 The tolerances of Table 3 shall be increased by 100 % for tube furnished IFR and IFD for the portion of the tube wall that contains the weld zone.

13.5 *Diameter Tolerances:*

13.5.1 The average diameter tolerances in Table 4 shall apply to both coils and straight lengths of product:

13.5.2 For product furnished IFI, IFD, or IFR, the inside diameter shall not be taken so as to include the flash or flash-treated areas.

13.6 *Lengths:*

TABLE 3 Bottom-Wall Tolerance

Bottom-Wall Thickness, in. (mm)	Tolerance (Plus and Minus) Outside Diameter, in. (mm)	
	0.125 to 0.625 (3 to 16), incl	Over 0.625 to 1.000 (16 to 25), incl
Up to 0.017 (0.43), incl.	0.001(0.025)	0.0015 (0.038)
Over 0.017 to 0.024 (0.43 to 0.61), incl	0.002 (0.050)	0.002 (0.050)