



Designation: B919 – 19

Standard Specification for Welded Copper Heat Exchanger Tubes With Internal Enhancement¹

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 18.5 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, health, and environmental practices and determine the applicability of regulatory requirements prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

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.

- 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
- 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
- E478 Test Methods for Chemical Analysis of Copper Alloys
- E2575 Standard Test Method for Determination of Oxygen in Copper and Copper Alloys (Withdrawn 2017)³

3. Terminology

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

3.2 Definitions of Terms Specific to This Standard:

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

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

3.2.3 *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.

3.2.4 *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 $\times 100\%$.

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

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

6.1.1 The material of manufacture shall be a form (cast, bar, cake, slab, etc.) of Copper Alloy UNS No. C10200 or C12200 [or other designation] of such purity and soundness as to be suitable for processing into the products 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,

TABLE 1 Chemical Requirements

UNS Alloy Number	Copper, wt % ^A	Phosphorus, wt %
C10200 ^B	99.95 min	...
C12200	99.9 min	0.015–0.040

^A Cu value includes Ag.

^B Oxygen in C10200 shall be 10 ppm max.

(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 The composition limits do not preclude the presence of other elements. By agreement between the manufacturer and purchaser, limits may be established and analysis required for unnamed elements.

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 Grain size shall be the standard requirement for all product in the annealed tempers. Acceptance or rejection based upon grain size shall depend only on the average grain size of a test specimen taken from each of two sample portions, and each specimen shall be within the limits prescribed in Table 2 when determined in accordance with Test Methods E112.

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 %
WM50	...	30 min (205 min)
W060	0.040 min.	30 min (205 min)	6 (40) min	35
W050	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.

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

10. Mechanical Property Requirements

10.1 *Tensile Strength Requirements:*

10.1.1 Product furnished under this specification shall conform to the tensile requirements prescribed in **Table 2**, when tested in accordance with Test Methods **E8/E8M**.

10.1.2 Acceptance or rejection based upon mechanical properties shall depend only on tensile strength.

11. Performance Requirements

11.1 *Expansion Requirements:*

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 3/4 in. (19.05 mm) specified diameter and 0.031 in. (0.785 mm) max. diameter for tubes over 3/4 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, or minor mechanical damage, or combinations thereof, 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 **18.5**, the residue remaining upon evaporation of the solvent shall not exceed 0.0035 g/ft² (0.038 g/m²) 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 **18.5** 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.

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)

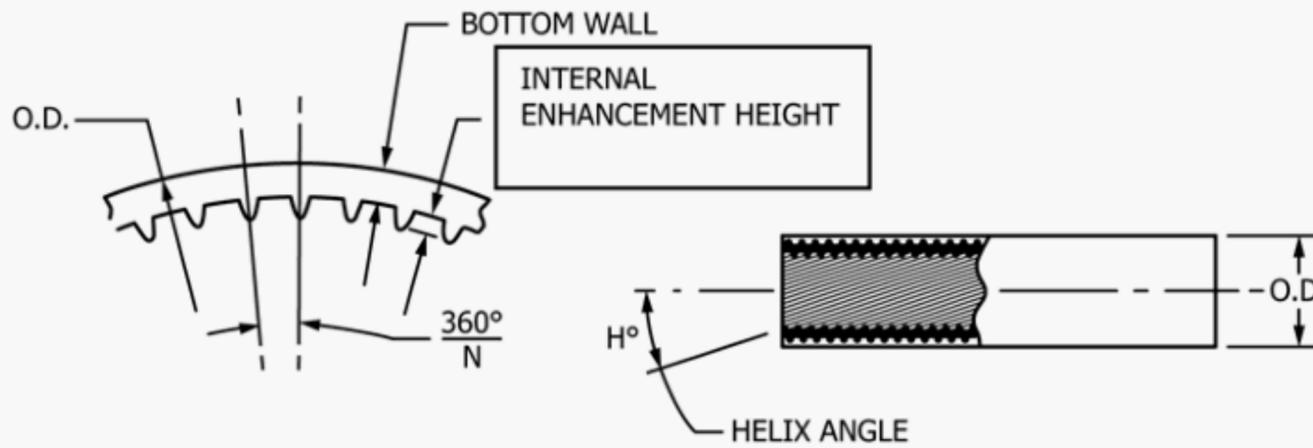


FIG. 1 Bottom-Wall Thickness Tolerances

TABLE 4 Average Diameter Tolerances

Specified Diameter, in. (mm)	Tolerance, Plus and Minus, in. (mm)
0.125 to 0.625 (3 to 16), incl	0.002 (0.050)
Over 0.625 to 1.000 (16 to 25), incl	0.0025 (0.063)

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:

13.6.1 For coil lengths, see Table 5 of this specification. If coils are produced to a specified nominal weight, no coil shall weigh less than 40 % of the nominal weight, and no more than 20 % of the coils in a lot shall weigh less than 65 % of nominal weight unless otherwise agreed upon between the manufacturer or supplier and purchaser.

13.6.2 The tolerances for tubes furnished in straight lengths shall be in accordance with Table 6.

13.7 Roundness:

13.7.1 The roundness tolerance for material in straight lengths shall be 1.5 % of the OD expressed to the nearest 0.001 in. (0.025 mm).

13.7.2 The roundness tolerance for material in coils shall be 6.5 % of the OD expressed to the nearest 0.001 in. (0.025 mm).

13.8 Squareness of Cut:

13.8.1 For tube in straight lengths, the departure from squareness of the end of any tube shall not exceed the following:

Specified Outside Diameter, in. (mm)	Tolerance
Up to 0.625 (15.9 mm), incl.	0.010 in. (0.25 mm)
Over 0.625 (15.9 mm)	0.016 in./in. (0.406 mm/mm)

13.9 Straightness:

13.9.1 For tubes in any as-welded temper, the straightness tolerance shall be in accordance with Table 7.

TABLE 5 Coil Length Tolerances (Specific Lengths)

Tube Outside Diameter, in. (mm)	Nominal Length, ft (m)	Shortest Permissible Length, % of Nominal Length	Maximum Permissible Weight of Ends, % of Lot Weight	Tolerance All Plus, ft (m)
All sizes	up to 100 (30.5), incl.	100	0	1 (0.3)
All sizes	over 100 (30.5)	40	20	...

TABLE 6 Length Tolerances for Straight Lengths

NOTE 1—Tolerances are all plus; if all minus tolerances are desired, use the same values; if tolerances of plus and minus are desired, halve the values given.

Length	Tolerance, in. (mm)
Up to 6 in (152 mm), incl.	0.063 in. (1.6)
Over 6 in. (152 mm) to 2 ft (610 mm), incl.	0.063 in. (1.6)
Over 2 ft (610 mm) to 6 ft (1.83 m), incl.	0.094 in. (2.38)
Over 6 ft (1.83 m) to 14 ft (4.27 m)	0.250 in. (6.3)
Over 14 ft (4.27 m)	0.500 in. (12.7)

TABLE 7 Straightness Tolerance

Length, ft (m)	Maximum Curvature (Depth of Arc), in. (mm)
Over 3 (0.914) to 6 (1.83), incl.	0.188 in. (4.8)
Over 6 (1.83) to 8 (2.44), incl.	0.313 in. (7.9)
Over 8 (2.44) to 10 (3.05), incl.	0.500 in. (13)
Over 10 (3.05)	0.500 in. (13) in any 10 ft (3.05 m) section

14. Workmanship, Finish, and Appearance

14.1 The product shall be free of defects, but blemishes of a nature that do not interfere with the intended application are acceptable.

15. Sampling

15.1 The lot size and portion size of the finished product shall be as follows:

15.1.1 Lot Size—An inspection lot shall be 10 000 lb (4540 kg) or fraction thereof, subject to inspection at one time.

15.1.2 Portion Size—A portion shall be taken for test purposes from each lot according to the following schedule:

Number of Tubes in Lot	Number of Pieces to be Taken
1 to 50	1
51 to 200	2
201 to 1500	3
Over 1500	0.2 % of the total number of pieces in the lot, but not to exceed ten pieces

15.2 Chemical Analysis:

15.2.1 Sampling for chemical analysis by the manufacturer shall be performed by one of the following methods:

15.2.1.1 The sample shall be taken in approximately equal weight from each portion piece selected in 15.1.2 and in

accordance with Practice E255. The minimum weight of the composite sample shall be 150 g.

15.2.1.2 Instead of sampling in accordance with Practice E255, the manufacturer shall have the option of determining composition by analyzing samples taken at the time castings are poured or taken from semifinished product. When the manufacturer determines chemical composition during the course of manufacture, sampling of the finished product is not required.

15.2.1.3 In case of compositional dispute, the sample shall be taken in accordance with 15.2.1.1.

15.2.2 The number of samples taken for determining composition shall be as follows:

15.2.2.1 When samples are taken at the time the castings are poured, at least two samples shall be taken for each group of castings poured simultaneously from the same source of molten metal.

15.2.2.2 When samples are taken from the semifinished product, a sample shall be taken to represent each 10 000 lb (4540 kg) or fraction thereof, except that not more than one sample per piece is required.

15.3 Other Tests:

15.3.1 Specimens for all other tests shall be taken from two of the sample pieces taken in 15.1.2 and be of a convenient size to accommodate the test(s) and comply with the requirements of the product specification and test method(s).

15.3.2 In the event only one sample piece is required, all specimens shall be taken from the piece selected.

15.3.3 In the case of tube furnished in coils, a length sufficient for all necessary tests shall be cut from each coil selected for purpose of testing. The remaining portion of these coils shall be included in the shipment, and the permissible variations in length on such coils shall be waived.

16. Number of Tests and Retests

16.1 Tests:

16.1.1 Chemical Analysis—Chemical composition shall be determined in accordance with the element mean of the results from at least two replicate analyses of the sample(s).

16.1.2 Grain Size—The average grain size of each specimen shall be the arithmetic average of at least three different fields.

16.1.3 Mechanical Properties—Mechanical properties shall be reported as individual test results from each of two pieces selected in 15.1.2, and each specimen must meet the requirements of the product specification.

16.1.4 Cuprous Oxide Requirement:

16.1.4.1 When specified, one test of each sample selected in 15.1.2 shall be performed and each specimen must meet the requirement in 12.3.

16.1.5 When only one piece is to be sampled, all specimens shall be taken from the piece selected.

16.2 Retest:

16.2.1 When requested by the manufacturer or supplier, a retest shall be performed when results of tests obtained by the purchaser fail to conform to the requirements of the product specification.

16.2.2 The retest shall be as directed in the product specification for the initial test, except the number of test specimens shall be twice that normally required for the specified test.

16.2.3 All test specimens shall conform to the product specification requirement(s) in retest. Failure to conform shall be cause for rejection.

17. Specimen Preparation

17.1 Chemical Analysis:

17.1.1 Preparation of the analytical test specimen shall be the responsibility of the reporting laboratory.

17.2 Grain Size:

17.2.1 Test specimen shall be prepared in accordance with Guide E3.

17.3 Tensile Test:

17.3.1 The test specimen shall be of the full section of the tube and shall conform to the requirements of the section titled Specimens for Pipe and Tube in Test Methods E8/E8M.

17.3.2 Because some internal enhancement configurations may cause breakage of the specimen in the grips, specimen ends may be flattened and tested using wedge or sheet metal grips.

17.4 Electromagnetic (Eddy-Current) Test:

17.4.1 Specimen preparation shall be in accordance with Practice E243.

17.5 Cleanness Test:

17.5.1 A section of a straight tube specimen, or a straightened tube specimen from the outside end of a coil not less than 5 ft (1.5 m) shall be selected.

17.6 Cuprous Oxide Requirement:

17.6.1 Sample preparation shall be in accordance with Test Methods B577.

18. Test Methods

18.1 Chemical Analyses:

18.1.1 In cases of disagreement, test methods for chemical analysis shall be subject to agreement between the manufacturer or supplier and the purchaser. The following table is a list of published methods, some of which may no longer be viable, which along with others not listed, may be used subject to agreement.

Element	Test Method
Copper	E478
Phosphorus	E62
Oxygen ^A	E2575

^A Oxygen in C10200 shall be 10 ppm max.

18.1.2 Test method(s) to be followed for the determination of element(s) resulting from contractual or purchase order agreement shall be as agreed upon between the manufacturer or supplier and the purchaser.

18.2 Other Tests:

18.2.1 The product furnished shall conform to specified requirements when subjected to test in accordance with Table 8.

TABLE 8 Methods of Test

Test	ASTM Designation
Cuprous oxide requirement	B577, Method C
Tension	E8/E8M
Grain size	E112
Expansion (pin test)	B153
Eddy current	E243

18.3 Tension Tests:

18.3.1 Tensile specimens shall normally be tested as shown in Fig. 11 of Test Methods E8/E8M. Tension test specimens shall be of the full section of the tube unless the limitations of the testing machine preclude the use of such specimens. Determination of cross-sectional area shall be determined by using the weight of the tube as described in Test Methods E8/E8M.

18.3.2 Whenever different tension test results are obtained from both full-size and from machined test specimens, the results obtained from full-size test specimens shall be used to determine conformance to the requirements of this specification.

18.3.3 Tension test results on product within the scope of this specification are not seriously affected by variations in speed of testing. A considerable range of testing speed is permissible; however, the rate of stressing to the yield strength shall not exceed 100 ksi/min (690 MPa/min). Above the yield strength, the movement per minute of the testing-machine head under load should not exceed 0.5 in./in. (0.5 mm/mm) of gage length (or distance between grips for full-section specimens).

18.4 Grain Size—In case of dispute, the intercept method of Test Methods E112 shall be followed.

18.5 Cleanness Test:

18.5.1 One end of the tube specimen, selected in accordance with 17.5 shall be closed and the tube specimen shall be filled with solvent to one-eighth of capacity. The opposite end shall be sealed and the tube shall be rolled back and forth on horizontal supports to thoroughly wash the inside surface. The seal shall be removed and the solvent shall be poured into a suitable weighed-container. The solvent in the container shall be evaporated to dryness on a low-temperature hot plate or sand bath. Overheating of the container shall be avoided to prevent charring of the residue. The container shall then be dried in an oven at 100 to 110 °C for 10 min, cooled in a desiccator, and weighed. A blank determination shall be run on the determined quantity of solvent and the gain in weight for the blank shall be subtracted from the weight of the residue sample. The corrected weight shall then be calculated in grams of residue per internal area of the tube in square feet (g/m²).

18.5.2 The quantity of the solvent used will vary with the size of the tube being examined. The quantity of solvent used for the blank run shall be the same as that discharged from the tube specimen.

18.5.3 The specimen must be prepared in such a manner as to prevent the inclusion in the residue of copper chips or dust resulting from the cutting of the sample.

19. Significance of Numerical Limits

19.1 For purpose of determining compliance with the specified limits for requirements of the properties listed in Table 9, an observed or calculated value shall be rounded as indicated, in accordance with the rounding method of Practice E29.

20. Inspection

20.1 The manufacturer or supplier shall inspect and make tests necessary to verify the furnished product conforms to specification requirements.

20.2 Source inspection of the product by the purchaser may be agreed upon between the manufacturer or supplier and the purchaser as part of the purchase order. In such case, the nature of the facilities needed to satisfy the inspector, representing the purchaser, that the product is being furnished in accordance with the specification shall be included in the agreement. All testing and inspection shall be conducted so as not to interfere unnecessarily with the operation of the works.

20.3 When mutually agreed upon, the manufacturer or supplier and the purchaser shall conduct the final inspection simultaneously.

21. Rejection and Rehearing

21.1 Rejection:

21.1.1 Product that fails to conform to the specification requirements when tested by the purchaser or purchaser’s agent shall be subject to rejection.

21.1.2 Rejection shall be reported to the manufacturer or supplier promptly. In addition, a written notification of rejection shall follow.

21.1.3 In case of dissatisfaction with results of the test upon which rejection is based, the manufacturer or supplier shall have the option to make claim for a rehearing.

21.2 Rehearing:

21.2.1 As a result of product rejection, the manufacturer or supplier shall have the option to make claim for a retest to be conducted by the manufacturer or supplier and the purchaser. Samples of the rejected product shall be taken in accordance with the product specification and subjected to test by both parties using the test method(s) specified in the product specification or alternately, upon agreement of both parties, an independent laboratory may be selected for the test(s) using the test method(s) specified in the product specification.

TABLE 9 Rounding Units

Property	Rounded Unit for Observed or Calculated Value
Chemical composition and hardness	Nearest unit in the last right-hand place of figures of the specified limit
Tensile strength	Nearest ksi (nearest 5 MPa)
Expansion	Nearest 1 %
Grain size	
Under 0.060 mm	Nearest multiple of 0.005 mm
0.060 mm and over	Nearest 0.01 mm

22. Certification

22.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been tested and inspected as directed in this specification and requirements have been met.

23. Test Report

23.1 When specified in the contract or purchase order, a report of test results shall be furnished.

24. Packaging and Package Marking

24.1 Packaging:

24.1.1 The product shall be separated by size, composition, and temper and prepared for shipment by common carrier, in such a manner as to afford protection from the normal hazards of transportation.

24.2 Package Marking:

24.2.1 Each shipping unit shall be legibly marked with the purchase order number, metal or alloy designation, temper, size, gross and net weight, total length or piece count, or both, and name of supplier. When specified in the contract or purchaser order, the product specification number shall be shown.

25. Keywords

25.1 C10200; C12200; coils; copper tubes; heat exchanger; internally enhanced; straight lengths; tube; welded

APPENDIX

(Nonmandatory Information)

X1. METRIC EQUIVALENTS

X1.1 The SI unit for strength is shown in accordance with the International System of Units (SI). The derived SI unit for force is the Newton (N), which is defined as the force that when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ($N = \text{kg}\cdot\text{m}/\text{s}^2$).

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 $1 \text{ ksi} = 6\,894\,757 \text{ Pa}$, the metric equivalents are expressed as megapascals (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 (B919–12) that may impact the use of this standard. (Approved April 1, 2019.)

(1) Made editorial changes in accordance with Guide B950.

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