Designation: B758 – 00 (Reapproved 2016)

Standard Specification for Nickel-Chromium-Molybdenum-Tungsten Alloys (UNS N06110) Welded Tube[1]

This standard is issued under the fixed designation B758; 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 covers welded UNS N06110[2] tube in the annealed condition (temper) for general corrosion applications.

1.2 This specification covers outside diameter and nominal wall tube.

1.2.1 The tube sizes covered by this specification are ⅛ to 5 in. (3.2 to 127 mm) in outside diameter and 0.015 to 0.148 in. (0.4 to 3.8 mm), inclusive, in wall thickness.

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI units in parentheses are provided for information only.

1.4 The following precautionary caveat pertains only to the test method portion, Section 13, 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 become familiar with all hazards including those identified in the appropriate Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

E8 Test Methods for Tension Testing of Metallic Materials

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

E38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys (Withdrawn 1989)[4]

E213 Practice for Ultrasonic Testing of Metal Pipe and Tubing

E354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

E571 Practice for Electromagnetic (Eddy-Current) Examination of Nickel and Nickel Alloy Tubular Products

3. Classification

3.1 *Class 1*—Welded, cold-worked, annealed, and nondestructively tested in accordance with 11.5.1.

3.2 *Class 2*—Welded, cold-worked, annealed, and nondestructively tested in accordance with 11.5.2.

4. Ordering Information

4.1 Orders for material conforming to this specification shall include the following information:

4.1.1 *Alloy name or UNS number.*

4.1.2 *ASTM designation and year of issue.*

4.1.3 *Dimensions:*

4.1.3.1 Outside diameter and nominal wall thickness.

NOTE 1—Tube produced to outside diameter and minimum wall may be furnished upon agreement between the manufacturer and the purchaser.

4.1.3.2 *Length* (specific or random).

4.1.4 *Class* (see 11.5).

4.1.5 *Quantity* (feet or number of pieces).

4.1.6 *Certification*—State if certification is required (Section 16).

4.1.7 *Samples for Product (Check) Analysis*—State whether samples for product (check) analysis should be furnished (10.2).

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt and Their Alloys.

Current edition approved June 1, 2016. Published June 2016. Originally approved in 1986. Last previous edition approved in 2011 as B758 – 00 (2011). DOI: 10.1520/B0758-00R16.

[2] New designation established in accordance with Practice E527 and SAE J1086, Recommended Practice for Numbering Metals and Alloys (UNS).

[3] 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.

[4] The last approved version of this historical standard is referenced on www.astm.org.

4.1.8 *Purchaser Inspection*—If purchaser wishes to witness tests or inspection of material at place of manufacture, the purchase order must so state indicating which tests or inspections are to be witnessed (Section 14).

5. Material and Manufacture

5.1 Tube shall be made from flat-rolled alloy by an automatic welding process with no addition of filler metal. Subsequent to welding and prior to final annealing, the material shall be cold-worked in either the weld metal only or both weld and base metal.

5.2 Tube shall be furnished with oxide removed. When bright annealing is used, descaling is not necessary.

6. Chemical Composition

6.1 The material shall conform to the composition limits specified in Table 1.

6.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Table 2.

7. Mechanical and Other Properties

7.1 *Mechanical Properties*—The material shall conform to the mechanical properties specified in Table 3.

7.2 *Flattening Test*—A section of tube not less than 4 in. (102 mm) in length shall be capable of withstanding, without cracking, flattening under a load applied gradually at room temperature until the distance between the platens is five times the wall thickness. The weld shall be positioned 90° from the direction of the applied flattening force.

7.2.1 Superficial ruptures resulting from surface imperfections shall not be a cause for rejection.

7.3 *Flange Test*—A section of tube shall be capable of having a flange turned over at a right angle to the body of the tube without through-wall cracking. The width of the flange shall not be less than 15 % of the tube diameter.

TABLE 1 Chemical Requirements

Element	Composition Limits, %	Product (Check) Analysis Variations under min or over max, of the Specified Limit of Element
C	0.15 max	0.01
Mn	1.0 max	0.05
Si	1.0 max	0.05
P	0.015 max	0.005
S	0.015 max	0.003
Cr	28.0 min	0.25
	33.0 max	0.25
Cb	1.0 max	0.05
Co (if determined)	1.0 max	0.05
Mo	9.0 min	0.15
	12.0 max	0.15
Fe	1.0 max	0.07
Al	1.0 max	0.05
Ti	1.0 max	0.05
W	1.0 min	0.10
	4.0 max	0.10
Ni[A]	51.0 min	0.35
Cu	0.5 max	0.03

[A] Element shall be determined arithmetically by difference.

TABLE 2 Product (Check) Analysis Chemical Composition Variations

Element	Specified Limit of Element %	Variation under min or over max of the Specified Limit of Element
Nickel	over 20.00 to 30.00, incl	0.25
	over 30.00 to 40.00, incl	0.30
Tungsten	over 1.00 to 4.00, incl	0.04
Iron	over 0.75 to 2.50, incl	0.05
Manganese	up to 1.00, incl	0.03
Carbon	up to 0.20, incl	0.01
Silicon	over 0.25 to 0.50, incl	0.03
	over 0.50 to 1.00, incl	0.05
Sulfur	up to 0.02, incl	0.003
Chromium	over 25.00 to 35.00, incl	0.25
Aluminum	over 0.10 to 0.50, incl	0.05
	over 0.50 to 1.00, incl	0.10
Titanium	over 0.10 to 0.50, incl	0.03
	over 0.50 to 1.00, incl	0.04
Columbium + Tantalum	up to 1.0, incl	0.04
Molybdenum	over 5.0 to 20.0, incl	0.15
Phosphorus	up to 0.04, incl	0.005

TABLE 3 Mechanical Property Requirements

Alloy	Tensile Strength min, psi (MPa)	Yield Strength 0.2 % offset min, psi (MPa)	Elongation in 2 in. or 50 mm, min, %
UNS N06110	95 000 (655)	45 000 (310)	60

7.4 *Nondestructive Test Requirements*—Tube shall be subjected to nondestructive tests (see 13.2) at the manufacturer's option.

7.4.1 For ultrasonic testing, a longitudinal calibration notch shall be made on the outside diameter and inside diameter. The depth of the notch shall not exceed 12½ % of the specified wall thickness of the material or 0.004 in. (0.10 mm), whichever is greater. Place the notch in the weld if visible.

7.4.2 *Acceptance and Rejection*—Material producing a signal equal to or greater than the calibration imperfections shall be subject to rejection.

7.4.2.1 Test signals produced by imperfections that cannot be identified or produced by cracks or crack-like imperfections shall result in rejection of the tube, subject to rework and retest. To be accepted, the material shall pass the same electric test to which it was originally subjected provided that the dimensional requirements are met.

7.4.2.2 If the imperfection is judged as injurious, the tube shall be rejected but may be reconditioned and retested providing the dimensional requirements are met. To be accepted, retested material shall meet the original electric test requirements.

7.4.2.3 If the imperfection is explored to the extent that it can be identified as noninjurious, the material may be accepted without further test provided the imperfection does not encroach on the minimum wall thickness.

TABLE 4 Permissible Variations in Outside Diameter[A] and Wall Thickness

Specified Outside Diameter, in. (mm)	Permissible Variations			
	Outside Diameter, in. (mm)[B]		Wall Thickness, %	
	Plus	Minus	Plus	Minus
⅛ (3.2) to ⅝ (15.9), excl	0.005 (0.13)	0.005 (0.13)	12.5	12.5
⅝ (15.9) to 1½ (38.1), incl	0.0075 (0.19)	0.0075 (0.19)	10.0	10.0
Over 1½ (38.1) to 3½ (88.9), incl	0.010 (0.25)	0.010 (0.25)	10.0	10.0
Over 3½ (88.9) to 4½ (114.3), incl	0.015 (0.38)	0.015 (0.38)	10.0	10.0
Over 4½ (114.3) to 5 (127), incl	0.020 (0.51)	0.020 (0.51)	12.5	12.5

[A] These permissible variations in outside diameter apply only to material as finished at the mill before subsequent swaging, expanding, bending, polishing, or other fabricating operations.

[B] Ovality is the difference between maximum and minimum outside diameter measured at any one cross section. There is no additional tolerance for ovality on material having a nominal wall thickness of more than 3 % of the outside diameter. On this material, the average of maximum and minimum outside diameter measurements will fall within the outside diameter tolerance shown in the table above. An additional ovality allowance of twice the outside diameter tolerance spreads shown above, applied one half plus and one half minus, is allowed for material having nominal wall thickness of 3 % or less of nominal outside diameter.

8. Dimensions and Permissible Variations

8.1 *Diameter and Wall Thickness*—Outside diameter and nominal wall thickness shall not exceed the permissible variations prescribed in Table 4.

8.1.1 Material having a specified wall thickness that is 3 %, or less, of the outside diameter cannot be straightened properly without a certain amount of ovality resulting in the diameter. The limits to this ovality are stated in Footnote B to Table 4.

8.2 *Straightness*—Material shall be reasonably straight and free of bends or kinks.

8.3 *Length*—Variations from the specified length shall not exceed the amounts prescribed in Table 5.

9. Workmanship, Finish, and Appearance

9.1 The material shall be uniform in quality and temper, smooth, commercially straight, and free of injurious imperfections.

10. Sampling

10.1 *Lot Definition:*

10.1.1 A lot for chemical analysis shall consist of one heat.

10.1.2 A lot for mechanical properties, flattening, and flange testing shall consist of all material from the same heat, nominal size (excepting length), and condition (temper).

10.2 *Test Material Selection:*

10.2.1 *Chemical Analysis*—Representative samples from each lot shall be taken during pouring or subsequent processing.

10.2.1.1 Product (check) analysis shall be wholly the responsibility of the purchaser.

TABLE 5 Permissible Variations in Length[A]

Outside Diameter in. (mm)	Cut Length, in. (mm)	
	Over	Under
Under 2 (50.8)	⅛ (3)	0
2 (50.8) and over	3⁄16 (5)	0

[A] These permissible variations in length apply to tube before bending. They apply to cut lengths up to and including 24 ft (7.3 m). For lengths over 24 ft, an additional over-tolerance of ⅛ in. (3 mm) for each 10 ft (3.0 m) or fraction thereof shall be permissible up to a maximum additional over-tolerance of ½ in. (12.7 mm).

10.2.2 *Mechanical Properties, Flattening, and Flange Testing*—Samples of the material to provide test specimens shall be taken from such locations in each lot as to be representative of that lot.

11. Number of Tests

11.1 *Chemical Analysis*—One test per lot.

11.2 *Mechanical Properties*—One test per lot.

11.3 *Flattening*—One test per lot.

11.4 *Flange*—One test per lot.

11.5 *Nondestructive Tests:*

11.5.1 *Class 1*—Each piece in each lot shall be subjected to one of the following four tests: hydrostatic, pneumatic (air underwater), eddy current, or ultrasonic.

11.5.2 *Class 2*—Each piece in each lot shall be subjected to a leak test and an electric test as follows:

11.5.2.1 *Leak Test*—Hydrostatic or pneumatic (air underwater).

11.5.2.2 *Electric Test*—Eddy current or ultrasonic.

11.5.3 The manufacturer shall have the option to test to Class 1 or 2 and select the nondestructive test methods, if not specified by the purchaser.

12. Specimen Preparation

12.1 Tension test specimens shall be taken from material in the final condition (temper) and tested in the direction of fabrication.

12.1.1 Whenever possible, all material shall be tested in full tubular size. When testing in full tubular size is not possible, longitudinal strip specimens shall be used. In the event of disagreement when full tubular testing is not possible, a longitudinal strip specimen with reduced gage length as contained in Test Methods E8 shall be used.

13. Test Methods

13.1 The chemical composition, mechanical, and other properties of the material as enumerated in this specification shall be determined, in case of disagreement, in accordance with the following methods:

Test	ASTM Designation
Chemical analysis	E8, E354[A]
Tension	E8
Rounding procedure	E29

[A] Methods E38 is to be used only for elements not covered by Test Methods E354.

13.2 *Nondestructive Tests:*

13.2.1 *Hydrostatic Test*—Test each piece at a pressure not exceeding 1000 psi (6.9 MPa), calculated as follows:

$$P = 2St/D, \text{ or} \quad (1)$$

$$S = PD/2t \quad (2)$$

where:

P = hydrostatic test pressure, psi or MPa;
S = allowable fiber stress as follows: UNS N06110-35000 psi (242 MPa);
t = specified wall thickness in. or mm; and
D = specified outside diameter, in. or mm.

13.2.1.1 Hold the test pressure for a minimum of 5 s.

13.2.1.2 Make visual examination when the material is under pressure. Examine the full length of material for leaks. If any tube shows leaks during the hydrostatic test, reject it.

13.2.2 *Pneumatic (Air Underwater) Test*—Test each piece at a pressure of 150 psi (1.05 MPa).

13.2.2.1 Hold the test pressure for a minimum of 5 s.

13.2.2.2 Make visual examination when the material is submerged and is under pressure. Examine the full length of material for leaks. If any piece shows leaks during the test, reject it.

13.2.3 *Electric Test*—Give each tube an electric test in accordance with either Practice E213 or Practice E571. For eddy-current testing, the calibration tube shall contain, at the option of the producer, any of the following discontinuities to establish a minimum sensitivity level for rejection. The discontinuity shall be placed in the weld if visible.

13.2.3.1 *Drilled Hole*—Drill a hole, not larger than 0.031-in. (0.79-mm) diameter radially and completely through the wall, taking care to avoid distortion of the material while drilling.

13.2.3.2 *Transverse Tangential Notch*—Using a round file or tool with a ¼-in. (6.4 mm) diameter, file or mill a notch tangential to the surface and transverse to the longitudinal axis of the material. Said notch shall have a depth not exceeding 12½ % of the specified wall thickness of the material or 0.004 in. (0.102 mm), whichever is greater.

13.2.3.3 *Longitudinal Notch*—Machine a notch 0.031 in. (0.79 mm) or less in width in a radical plane parallel to the material axis on the outside surface of the tube to have a depth not exceeding 12½ % of the specified wall thickness of the material or 0.004 in. (0.102 mm), whichever is greater. The length of the notch shall be compatible with the testing method.

13.3 *Rounding Method*—For the purpose of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value, or a calculated value, shall be rounded as indicated below, in accordance with the rounding method of Practice E29:

Test	Rounded Unit for Observed or Calculated Value
Chemical composition and tolerances (when expressed in decimals)	Nearest unit in the last right-hand place of figures of the specified limit. If two choices are possible, as when the digits dropped are exactly a 5 or a 5 followed only by zeros, choose the one ending in an even digit, with zero defined as an even digit.
Tensile strength, yield strength	Nearest 1000 psi (6.9 MPa)
Elongation	Nearest 1 %

14. Inspection

14.1 Inspection of the material shall be agreed upon between the purchaser and the supplier as part of the purchaser contract.

15. Rejection and Rehearing

15.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

16. Certification

16.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification together with a report of the test results shall be furnished.

17. Product Marking

17.1 *Material*—The name or brand of the manufacturer, the trade name of the material or UNS number, the letters ASTM, the specification number, heat number, class and nominal size shall be legibly stenciled on each piece ½ in. (12.7 mm) and over in outside diameter, provided the length is not under 3 ft (914 mm). The material marking shall be by any method that will not result in harmful contamination.

17.1.1 For material less than ½ in. in outside diameter and material under 3 ft in length, the information specified in 17.1 shall be either stenciled or marked on a tag securely attached to the bundle or box in which the tube is shipped.

17.2 *Packaging*—Each bundle or shipping container shall be marked with the name or brand of the manufacturer, the trade name of the material or UNS number, the letters ASTM, this specification number, heat number, class, and nominal size; gross, tare, and net weight; consignor and consignee address; contract or order number; or such other information as may be defined in the contract or order.

18. Keywords

18.1 nickel-chromium-molybdenum-tungsten; UNS N06110; welded tube