Designation: ~~B751 – 19~~ B751 – 20

Standard Specification for General Requirements for Nickel and Nickel Alloy Welded Tube[1]

This standard is issued under the fixed designation B751; 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 contains various requirements that, with the exception of Sections 6 and 7, are mandatory requirements to the following ASTM nickel and nickel alloy, longitudinally welded tubular product specifications:

Title of Specification	ASTM Designation
Welded UNS N08020, N08024, and UNS N08026 Alloy Tubes	B468
Welded UNS N08120, UNS N08800, UNS N08810, UNS N08811 Alloy Tubes	B515
Welded Nickel-Chromium-Iron Alloy (UNS N06600, UNS N06603, UNS N06025, and UNS N06045) Tubes	B516
Welded Nickel and Nickel-Cobalt Alloy Tube	B626
UNS N08904, UNS N08925, and UNS N08926 Welded Tube	B674
UNS N08366 and UNS N08367 Welded Tube	B676
Welded UNS N06625, N06219, and N08825 Alloy Tubes	B704
Ni-Cr-Mo-Co-W-Fe-Si Alloy (UNS N06333) Welded Tube	B726
Welded Nickel (UNS N02200/UNS N02201) and Nickel Copper Alloy (UNS N04400) Tube	B730

1.2 One or more of the test requirements of Section 6 apply only if specifically stated in the product specification or in the purchase order.

1.3 In case of conflict between a requirement of the product specification and a requirement of this general specification, only the requirement of the product specification need be satisfied.

1.4 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.

1.5 *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, health, and environmental practices, and determine the applicability of regulatory limitations prior to use.*

1.6 *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]

B468 Specification for Welded UNS N08020 Alloy Tubes

B515 Specification for Welded Nickel-Iron-Chromium Alloy Pipe

B516 Specification for Welded Nickel-Chromium-Aluminum Alloy (UNS N06699) and Nickel-Chromium-Iron Alloy (UNS N06600, UNS N06601, UNS N06603, UNS N06025, UNS N06045, UNS N06690, and UNS N06693) Tubes

B626 Specification for Welded Nickel and Nickel-Cobalt Alloy Tube

B674 Specification for UNS N08925, UNS N08354, and UNS N08926 Welded Tube

[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.

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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.

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

B676 Specification for UNS N08367 Welded Tube
B704 Specification for Welded Nickel Alloy Tubes
B726 Specification for Nickel-Chromium-Molybdenum-Cobalt-Tungsten-Iron-Silicon Alloy (UNS N06333) Welded Tube
B730 Specification for Welded Nickel (UNS N02200/UNS N02201) and Nickel Copper Alloy (UNS N04400) Tube
B880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys
E8/E8M Test Methods for Tension Testing of Metallic Materials
E18 Test Methods for Rockwell Hardness of Metallic Materials
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E39 Methods for Chemical Analysis of Nickel (Withdrawn 1995)[3]
E76 Test Methods for Chemical Analysis of Nickel-Copper Alloys (Withdrawn 2003)[3]
E112 Test Methods for Determining Average Grain Size
E213 Practice for Ultrasonic Testing of Metal Pipe and Tubing
E273 Practice for Ultrasonic Testing of the Weld Zone of Welded Pipe and Tubing
E309 Practice for Eddy Current Examination of Steel Tubular Products Using Magnetic Saturation
E426 Practice for Electromagnetic (Eddy Current) Examination of Seamless and Welded Tubular Products, Titanium, Austenitic Stainless Steel and Similar Alloys
E571 Practice for Electromagnetic (Eddy-Current) Examination of Nickel and Nickel Alloy Tubular Products
E1473 Test Methods for Chemical Analysis of Nickel, Cobalt and High-Temperature Alloys

2.2 *Other Documents:*
SNT-TC-1A Recommended Practice for Nondestructive Personnel Qualification and Certification[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *average diameter, n*—the average of the maximum and minimum outside diameters, as determined at any one cross section of the tube.

3.1.2 *nominal wall, n*—a specified wall thickness with a plus and minus tolerance from the specified thickness.

3.1.3 *thin wall tube, n*—tube with specified wall thickness 3 % or less of the specified outside diameter.

3.1.4 *welded tube, n*—a hollow product of round or any other cross section having a continuous periphery.

4. Dimensions and Permissible Variations

4.1 *Diameter and Wall Thickness*—Individual measurements shall not exceed the tolerances specified in Table 1. The permissible variation in outside diameter is not sufficient to provide for ovality in thin-walled tubes. For thin-walled tubes the maximum and minimum diameters at any cross section shall not deviate from the nominal diameter by more than twice the permissible variation in outside diameter given in the table; however, the mean diameter at that cross section must still be within the permissible variation.

4.2 *Length*—When material is ordered cut-to-length, the length shall conform to the permissible variations prescribed in Table 2.

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

4.4 *Ends*—Ends shall be plain or cut and deburred.

TABLE 1 Permissible Variations for Outside Diameter and Wall Thickness of Welded Tube[A,B]

Specified Outside Diameter	Outside Diameter		Permissible Variations of Thickness of Specified Nominal Wall, %		Thickness of Specified Minimum Wall,%	
in. (mm)	+	−	+	−	+	−
~~Over 0.125 (3.2) to ⅝ (16), excl~~	~~0.004 (0.13)~~	~~0.005 (0.10)~~	~~12.5~~	~~12.5~~	~~28~~	~~0~~
Over 0.125 (3.2) to ⅝ (16), excl	0.004 (0.10)	0.005 (0.13)	12.5	12.5	28	0
⅝ (16) to 1½ (38), incl	0.0075 (0.19)	0.0075 (0.19)	12.5	12.5	28	0
Over 1½ (38) to 3 (76), incl	0.010 (0.25)	0.010 (0.25)	12.5	12.5	28	0
Over 3 (76) to 4½ (114), incl	0.015 (0.38)	0.015 (0.38)	12.5	12.5	28	0
Over 4½ (114) to 6 (152), incl	0.020 (0.51)	0.020 (0.51)	12.5	12.5	28	0

[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] The ovality provisions of 4.1 apply.

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

TABLE 2 Permissible Variations in Length[A]

Outside Diameter, in. (mm)	Cut Length, in. (mm)	
	Over	Under
Cold-finished: under 2 (50.8)	⅛ (3.2)	0
Hot-finished: 2 (50.8) and over	3⁄16 (4.8)	0
all sizes	3⁄16 (4.8)	0

[A] These permissible variations in length apply to tube in straight lengths. 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. (3.2 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).

5. Workmanship, Finish, and Appearance

5.1 The material shall be uniform in quality and temper, smooth, and free of imperfections that would render it unfit for use.

6. Test Requirements

6.1 *Flange Test:*

6.1.1 A length of tube not less than three times the specified diameter or 4 in. (102 mm), whichever is longer, shall be capable of having a flange turned over at a right angle to the body of the tube without cracking or showing imperfections rejectable under the provisions of the product specification. The width of the flange shall not be less than 15 % of the tube diameter.

6.1.2 The flanged specimen shall not exhibit through wall cracking or any cracking observable without magnification.

6.2 *Flattening Test:*

6.2.1 A length of tube not less than 4 in. (102 mm), shall be flattened 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.

6.2.2 The flattened specimen shall not exhibit cracks.

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

6.3 *Flare Test*—The flare test shall consist of flaring a test specimen with an expanding tool having an included angle of 60° until the specified outside diameter has been increased by 30 %. The flared specimen shall not exhibit cracking through the wall.

6.4 *Pressure (Leak Test):*

6.4.1 *Hydrostatic*—Each tube with an outside diameter ⅛ in. (3 mm) and larger, and with wall thickness of 0.015 in. (0.38 mm) and over, shall be tested by the manufacturer to a minimum internal hydrostatic pressure of 1000 psi (6.9 MPa) provided that the fiber stress calculated in accordance with the following equation does not exceed the allowable fiber stress, *S*, indicated as follows:

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

where:

P = hydrostatic test pressure, psi (MPa),
S = allowable fiber stress, for material in the condition (temper) furnished as specified in the product specification (S is calculated as the lower of ⅔ of the specified minimum 0.2 % offset yield strength or ¼ of the specified minimum ultimate strength for the material),
t = minimum wall thickness, in. (mm), equal to the specified average wall minus the permissible minus wall tolerance, or the specified minimum wall thickness, and
D = outside diameter of the tube, in. (mm).

6.4.1.1 The test pressure shall be held for a sufficient time to permit the entire length of the tube to be inspected.

6.4.2 *Pneumatic (Air Underwater) Test*—Each tube with a nominal wall thickness exceeding 0.025 in. (0.64 mm) shall be tested at a minimum pressure of 150 psi (1.05 MPa). The test pressure for tubes having a nominal wall thickness of 0.025 in. (0.64 mm) and under shall be 75 psi (0.52 MPa) minimum. The test pressure shall be held for a minimum of 5 s. Visual examination is to be made when the material is submerged and under pressure. The full length of material must be examined for leaks.

6.4.3 If any tube shows leaks during hydrostatic or pneumatic testing, it shall be rejected.

6.5 *Nondestructive Examination:*

6.5.1 Each tube shall be examined by a nondestructive examination method in accordance with Practices E213, E309, E426, or E571. Upon agreement, Practice E273 shall be employed in addition to one of the full periphery tests. The range of tube sizes that may be examined by each method shall be subject to the limitations in the scope of that practice. In case of conflict between these methods and practices and this specification, the requirements of this specification shall prevail.

6.5.2 The following information is for the benefit of the user of this specification.

6.5.2.1 Calibration standards for the nondestructive electric test are convenient standards for calibration of nondestructive testing equipment only. For several reasons, including shape, orientation, width, etc., the correlation between the signal produced in the electric test from an imperfection and from calibration standards is only approximate. A purchaser interested in ascertaining

the nature (type, size, location, and orientation) of discontinuities that can be detected in the specific application of these examinations should discuss this with the manufacturer of the tubular product.

6.5.2.2 The ultrasonic examination referred to in this specification is intended to detect longitudinal discontinuities having a reflective area similar to or larger than the calibration reference notches specified in 6.5.8. The examination may not detect circumferentially oriented imperfections or short, deep defects.

6.5.2.3 The eddy current examination referenced in this specification has the capability of detecting significant discontinuities, especially of the short abrupt type. Practices E309 and E426 contain additional information regarding the capabilities and limitations of eddy-current examination.

6.5.2.4 The hydrostatic test referred to in 6.4.1 is a test method provided for in many product specifications. This test has the capability of finding defects of a size permitting the test fluid to leak through the tube wall and may be either visually seen or detected by a loss of pressure. This test may not detect very tight, through-the-wall defects or defects that extend an appreciable distance into the wall without complete penetration.

6.5.2.5 A purchaser interested in ascertaining the nature (type, size, location, and orientation) of discontinuities that can be detected in the specific application of these examinations should discuss this with the manufacturer of the tubular products.

6.5.3 *Time of Examination:* Nondestructive examination for specification acceptance shall be performed after all deformation processing, heat treating, welding, and straightening operations. This requirement does not preclude additional testing at earlier stages in the processing.

6.5.4 *Surface Condition:*

6.5.4.1 All surfaces shall be free of scale, dirt, grease, paint, or other foreign material that could interfere with interpretation of test results. The methods used for cleaning and preparing the surfaces for examination shall not be detrimental to the base metal or the surface finish.

6.5.4.2 Excessive surface roughness or deep scratches can produce signals that interfere with the test.

6.5.5 *Extent of Examination:*

6.5.5.1 The relative motion of the tube and the transducer(s), coil(s), or sensor(s) shall be such that the entire tube surface is scanned, except for end effects as noted in 6.5.5.2.

6.5.5.2 The existence of end effects is recognized, and the extent of such effects shall be determined by the manufacturer, and, if requested, shall be reported to the purchaser. Other nondestructive tests may be applied to the end areas, subject to agreement between the purchaser and the manufacturer.

6.5.6 *Operator Qualifications:*

6.5.6.1 The test unit operator shall be certified in accordance with SNT-TC-1A, or an equivalent documented standard agreeable to both purchaser and manufacturer.

6.5.7 *Test Conditions:*

6.5.7.1 For examination by the ultrasonic method, the minimum nominal transducer frequency shall be 2.0 MHz, and the maximum transducer size shall be 1.5 in. (38 mm).

6.5.7.2 For eddy current testing, the excitation coil frequency shall be chosen to ensure adequate penetration, yet provide good signal-to-noise ratio. The maximum coil frequency shall be:

Specified Wall Thickness, in. (mm)	Maximum Frequency, kHz
<0.050 in. (1.25 mm)	100
0.050 to 0.150 (1.25 to 3.80 mm)	50
>0.150 (3.80 mm)	10

6.5.8 *Reference Standards:*

6.5.8.1 Reference standards of convenient length shall be prepared from a length of tube of the same grade, specified size (outside diameter and wall thickness), surface finish, and heat treatment condition as the tubing to be examined.

6.5.8.2 For eddy current testing, the reference standard shall contain, at the option of the manufacturer, any one of the following discontinuities:

(a) Drilled Hole—The reference standard shall contain three or more holes, equally spaced circumferentially around the tube and longitudinally separated by a sufficient distance to allow distinct identification of the signal from each hole. The holes shall be drilled radially and completely through the tube wall, with care being taken to avoid distortion of the tube while drilling. The holes shall no be larger than 0.031 in. (0.8 mm) in diameter. As an alternative, the producer may choose to drill one hole and run the calibration standard through the test coil three times, rotating the tube approximately 120° each time More passes with smaller angular increments may be used, provided testing of the full 360° of the coil is obtained. For welded tubing, if the weld is visible, one of the multiple holes or the single hole shall be drilled in the weld.

(b) Transverse Tangential Notch—Using a round tool or file with a ¼ in. (6.4 mm) diameter, a notch shall be milled or filed tangential to the surface and transverse to the longitudinal axis of the tube. Said notch shall have a depth not exceeding 12½ % of the specified wall thickness of the tube or 0.04 in. (0.1 mm), whichever is greater.

(c) Longitudinal Notch—A notch 0.031 in. (0.8 mm) or less in width shall be machined in a radial plane parallel to the tube axis on the outside surface of the tube, to have a depth not exceeding 12½ % of the specified wall thickness of the tube or 0.004 in. (0.1 mm), whichever is greater. The length of the notch shall be compatible with the testing method.