



Designation: **A523 – 96 (Reapproved 2012) A523/A523M – 20**

## Standard Specification for Plain End Seamless and Electric-Resistance-Welded Steel Pipe for High-Pressure Pipe-Type Cable Circuits<sup>1</sup>

This standard is issued under the fixed designation ~~A523~~A523/A523M; 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.

### 1. Scope\* Scope\*

1.1 This specification covers two types, seamless (S) and electric-resistance-welded (E), of steel pipe used as conduit for the installation of high-pressure pipe-type electrical cables in NPS 4 to NPS 42, 12 [DN 100 to DN 300], inclusive, with nominal (average) wall thicknesses 0.219 to 0.562 in., [5.56 to 14.27 mm], depending on size. Pipe having other dimensions (Note 2) may be furnished, provided such pipe complies with all other requirements of this specification.

NOTE 1—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as “nominal diameter,” “size,” and “nominal size.”

NOTE 2—A comprehensive listing of standardized pipe dimensions is contained in ~~ANSI~~ASME B36.10.

1.2 Pipe ordered under this specification is suitable for welding and for forming operations involving flaring, beelling, and bending.

1.3 Pipe for this purpose shall be furnished in Grade A or Grade B as specified in the purchase order. Grade A is more suitable for forming operations involving bending, flaring, or beelling and this grade is normally preferred. This provision is not intended to prohibit the cold bending, flaring, or beelling of Grade B pipe.

1.4 This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable M specification designation (SI units), the inch-pound units shall apply. The values stated in either inch-pound or SI 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 separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore each system shall be used independently of the other. Combining values from the two systems may results in nonconformance with the standard.

1.5 The following hazard caveat applies to the test method portion, Section 20, 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~~ safety, health, and ~~health~~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:<sup>2</sup>

[A370 Test Methods and Definitions for Mechanical Testing of Steel Products](#)

[A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products](#)

~~[E59 Practice for Sampling Steel and Iron for Determination of Chemical Composition \(Withdrawn 1996\)](#)~~<sup>3</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.09 on Carbon Steel Tubular Products.

Current edition approved ~~March 1, 2012~~March 1, 2020. Published ~~November 2012~~March 2020. Originally approved in 1964. Last previous edition approved in ~~2005~~2012 as A523 – 96 (2012). (2005). DOI: ~~10.1520/A0523-96R12~~10.1520/A0523\_A0523M-20.

This specification was initiated by the IEEE Insulated Conductors Committee in recognition of the need for a specification embodying the special requirements of pipe for high-voltage electrical circuits. It was prepared for acceptance as an ASTM specification by a task group of Subcommittee A01.09 of ASTM Committee A01.

<sup>2</sup> 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



## 2.2 *ANSI/ASME Standard:*

**B36.10** Welded and Seamless Wrought Steel Pipe<sup>3</sup>

### 3. Ordering Information

3.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately:

3.1.1 Quantity (feet [meters] or number of lengths),

3.1.2 Name of material (steel pipe),

3.1.3 ~~Method of manufacture—Type S or E (seamless or electric-resistance-welded),~~

3.1.4 Grade (Table 1),

3.1.5 Size (~~outside—(NPS [DN] or diameter and nominal wall thickness or weight pounds per foot), foot [kg/m)],~~

3.1.6 Length when other than specified in Section 13,

3.1.7 End finish (Section 16),

3.1.8 Skelp for tension tests, if permitted 20.2,

3.1.9 When mill applied coating is required (Section 10), and

3.1.10 ASTM specification number.

### 4. Process

4.1 The steel shall be made by one or more of the following processes: ~~open-hearth, basic-oxygen, or electric-furnace;~~ electric-furnace, or any other currently recognized practice.

4.2 Steel may be cast in ingots or may be strand cast. When steels of different grades are sequentially strand cast, identification of the resultant transition material is required. The producer shall remove the transition material by any established procedure that positively separates the grades.

### 5. Chemical Composition

5.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 2 and the chemical analysis shall be in accordance with Test Methods, Practices, and Terminology A751.

### 6. Heat Analysis

6.1 When specified in the purchase order, the manufacturer shall report the heat analysis of each heat of steel used in the manufacture of pipe to this specification. The analysis shall conform to the requirements specified in Section 5 for the grade of pipe ordered.

### 7. Product Analysis

7.1 When specified in the purchase order, a product analysis report shall be furnished by the manufacturer on two pipes from each lot of 400 lengths, or fraction thereof, of 4½-in. [115 mm] outside diameter and 5¼-in. [140 mm] outside diameter sizes and from each lot of 200 lengths, or fraction thereof, of each size 6⅝-in. [170 mm] outside diameter through 12¾-in. [325 mm] outside diameter pipe. Samples for chemical analysis, ~~except for spectrographic analysis,~~ analysis shall be taken in accordance with ~~Practice—Test Methods, Practices, and Terminology E59A751.~~ The chemical composition thus determined shall conform to the requirements specified in Section 5.

7.2 *Product Analysis Retests*—If both lengths of pipe representing the lot fail the specified product analysis, the lot shall be rejected, or at the option of the manufacturer, all of the remaining lengths of the lot shall be tested individually for conformance to the specified requirements. If only one of the lengths of pipe representing the lot fails the specified check analysis, the lot shall be rejected or, at the option of the manufacturer, two retest analyses shall be made on two additional lengths selected from the same lot. If both of these retest analyses conform to the specified requirements, the lot shall be accepted except for the length which failed on the initial analysis. If one or both of the retest analyses fail the specified requirements, the entire lot shall be rejected, or, at the option of the manufacturer, each of the remaining lengths shall be tested individually. Only analysis of the rejecting element or elements is necessary in checking the remaining lengths.

### 8. Tensile Requirements

8.1 The material shall conform to the requirements as to tensile properties prescribed in Table 1.

<sup>3</sup>The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>3</sup> Available from American National Standards Institute, 11 West 42nd St., 13th Floor, Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 40036-10016-5990, <http://www.asme.org>.



TABLE 1 Tensile Requirements

	Grade A	Grade B
Tensile strength, min, ksi (MPa)	48 (330)	60 (415)
Tensile strength, min, ksi [MPa]	48 [330]	60 [415]
Yield strength, min, ksi (MPa)	30 (205)	35 (240)
Yield strength, min, ksi [MPa]	30 [205]	35 [240]
Elongation in 2 in. or 50 mm, %:		
Basic minimum elongation for walls $\frac{5}{16}$ in. (7.94 mm) and over in thickness, longitudinal strip tests, and for small sizes tested in full section.	35	30
Basic minimum elongation for walls $\frac{5}{16}$ in. [7.9 mm] and over in thickness, longitudinal strip tests, and for small sizes tested in full section.	35	30
When standard round 2-in. or 50-mm gage length test specimen is used	28	22
When standard round 2-in. [50-mm] gage length test specimen is used	28	22
For longitudinal strip tests, the width of the gage section shall be 1½ in. (38.1 mm) and a deduction for each ½ in. (0.79 mm) decrease in wall thickness below $\frac{5}{16}$ in. (7.94 mm) from the basic minimum elongation of the following percentage points	1.75 <sup>A</sup>	1.50 <sup>A</sup>
For longitudinal strip tests, the width of the gage section shall be 1½ in. [38.1 mm] and a deduction for each ½ in. [0.79 mm] decrease in wall thickness below $\frac{5}{16}$ in. [7.94 mm] from the basic minimum elongation of the following percentage points	1.75 <sup>A</sup>	1.50 <sup>A</sup>

<sup>A</sup> The following table<sup>B</sup> gives the minimum computed values:

Wall Thickness		Elongation in 2 in. or 50 mm, min, %	
in.	mm	Grade A	Grade B
$\frac{5}{16}$ (0.312)	7.94	35.0	30.0
$\frac{9}{32}$ (0.281)	7.14	33.2	28.5
$\frac{1}{4}$ (0.250)	6.35	31.5	27.0
$\frac{7}{32}$ (0.219)	5.56	29.8	25.5
$\frac{3}{16}$ (0.188)	4.76	28.0	24.0
$\frac{9}{64}$ (0.156)	3.97	26.2	22.5
$\frac{1}{8}$ (0.125)	3.18	24.5	21.0
$\frac{3}{32}$ (0.094)	2.38	22.8	19.5
$\frac{1}{16}$ (0.062)	1.59	21.0	18.0

Wall Thickness		Elongation in 2 in. [50 mm], min, %	
in.	[mm]	Grade A	Grade B
$\frac{5}{16}$ (0.312)	[7.9]	35.0	30.0
$\frac{9}{32}$ (0.281)	[7.1]	33.2	28.5
$\frac{1}{4}$ (0.250)	[6.4]	31.5	27.0
$\frac{7}{32}$ (0.219)	[5.6]	29.8	25.5
$\frac{3}{16}$ (0.188)	[4.8]	28.0	24.0
$\frac{9}{64}$ (0.156)	[4.0]	26.2	22.5
$\frac{1}{8}$ (0.125)	[3.2]	24.5	21.0
$\frac{3}{32}$ (0.094)	[2.4]	22.8	19.5
$\frac{1}{16}$ (0.062)	[1.6]	21.0	18.0

<sup>B</sup> This table gives the computed minimum elongation values for each ½ in. (0.79 mm) [0.79 mm] decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

Grade	Equation
A	$E = 56t + 17.50$
B	$E = 48t + 15.00$

  

Grade	Equation
<u>A</u>	$E = 56t + 17.50$ $[E = 2.2t + 17.5]$
<u>B</u>	$E = 48t + 15.00$ $[E = 1.9t + 15.0]$



TABLE 2 Chemical Requirements

Grade Type	Composition, %							
	Carbon, max		Manganese, max		Phosphorus, max		Sulfur, max	
	Heat	Product	Heat	Product	Heat	Product	Heat	Product
Grade A Seamless	0.22	0.25	0.90	0.95	0.035	0.045	0.050	0.060
E.R.W. <sup>A</sup>	0.21	0.25	0.90	0.95	0.035	0.045	0.050	0.060
Grade B Seamless	0.27	0.30	1.15	1.20	0.035	0.045	0.050	0.060
E.R.W. <sup>A</sup>	0.26	0.30	1.15	1.20	0.035	0.045	0.050	0.060

<sup>A</sup> Electric-Resistance-Welded pipe.

8.2 The yield point shall be determined by the drop of the beam or by the halt in the gauge of the testing machine, by the use of dividers, or by other approved methods. When a definite yield point is not exhibited, the yield strength corresponding to a permanent offset of 0.2 % of the gauge length of the specimen or to a total extension of 0.5 % of the gauge length of the specimen under load shall be determined.

8.3 The test specimen taken across the weld shall show a tensile strength not less than the minimum tensile strength specified for the grade of pipe ordered. This test will not be required for pipe under NPS 8–8 [DN 200].

## 9. Flattening Test Requirements

9.1 *Seamless Pipe*—For seamless pipe, a section not less than 2½ in. (63.5 mm) [65 mm] in length shall be flattened cold between parallel plates in two steps. During the first step, which is a test for ductility, no cracks or breaks on the inside or outside or end surfaces, except as provided for in 9.5, shall occur until the distance between the plates is less than the value of  $H$  calculated by the following equation:

$$H = \frac{(1+e)t}{e + \frac{t}{D}} \quad (1)$$

where:

$H$  = distance between flattening plates, in. (mm);  
 $e$  = deformation per unit length (constant for a given grade of steel, 0.09 for Grade A and 0.07 for Grade B);  
 $t$  = specified wall thickness, in. (mm), and  
 $D$  = specified outside diameter, in. (mm).

$H$  = distance between flattening plates, in. [mm],  
 $e$  = deformation per unit length (constant for a given grade of steel, 0.09 for Grade A and 0.07 for Grade B),  
 $t$  = specified wall thickness, in. [mm], and  
 $D$  = specified outside diameter, in. [mm].

During the second step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet. Evidence of laminated or unsound material that is revealed during the entire flattening test shall be cause for rejection.

9.2 *Electric-Resistance-Welded Pipe*—A specimen at least 4 in. (101.6 mm) [100 mm] in length shall be flattened cold between parallel plates in three steps with the weld located either 0 or 90° from the line of direction of force as required in 9.2.1 during the first step, which is a test for ductility of the weld, no cracks or breaks on the inside or outside surfaces shall occur until the distance between the plates is less than two thirds of the original outside diameter of the pipe. As a second step, the flattening shall be continued. During the second step, which is test for ductility exclusive of the weld, no cracks or breaks on the inside or outside surfaces, except as provided for in 9.5, shall occur until the distance between the plates is less than one third of the original outside diameter of the pipe but is not less than five times the wall thickness of the pipe. During the third step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet. Evidence of laminated or unsound material or of incomplete weld that is revealed during the entire flattening test shall be cause for rejection.

9.2.1 For pipe produced in single lengths, the flattening test specified in 9.2 shall be made on both crop ends cut from each length of pipe. The tests from each end shall be made alternately with the weld at 0° and at 90° from the line of direction of force. For pipe produced in multiple lengths, the flattening test shall be made on crop ends representing the front and back of each coil with the weld at 90° from the line of direction of force, and on two intermediate rings representing each coil with the weld 0° from the line of direction of force.