



# Standard Specification for Steel Line Pipe, Black, Plain-End, Seamless<sup>1</sup>

This standard is issued under the fixed designation A1024/A1024M; 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

1.1 This specification covers seamless, black, plain-end steel pipe for use in the conveyance of fluids under pressure. Pipe in sizes NPS 1 to 26, inclusive, as given in ASME B36.10M is included. Pipe having other dimensions, in this size range, may be furnished provided such pipe complies with all other requirements of this specification.

1.2 It is intended that the pipe be capable of being circumferentially welded in the field when welding procedures in accordance with the requirements of the applicable pipeline construction code are used.

1.3 The values stated in either inch-pound units or in SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values in each system are not exact equivalents; therefore, each system is to be used independently of the other.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A450/A450M Specification for General Requirements for Carbon and Low Alloy Steel Tubes

A530/A530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

### 2.2 API Standard:

API RP 5L3 Recommended Practice for Conducting Drop-Weight Tear Tests on Line Pipe<sup>3</sup>

### 2.3 ASME Standard:

ASME B36.10M Welded and Seamless Wrought Steel Pipe<sup>4</sup>

## 3. Terminology

3.1 *Definitions*—For terminology used in this specification, refer to Terminology A941.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *lot, n*—a quantity of pipe of the same ordered diameter, heat, wall thickness, and grade as given in Table 1.

3.2.2 *seamless pipe, n*—a tubular product made without a welded seam; it is manufactured usually by hot working the material, and if necessary, by subsequently cold-finishing the hot worked tubular product to produce the desired shape, dimensions, and properties.

3.2.3 *specified outside diameter (OD), n*—the outside diameter specified in the purchase order or the outside diameter listed in ASME B36.10M for the nominal pipe size specified in the purchase order.

## 4. General Requirements

4.1 Pipe furnished under this specification shall conform to the applicable requirements of Specification A530/A530M unless otherwise provided herein.

## 5. Ordering Information

5.1 Information items to be considered, if appropriate, for inclusion in the purchase order are as follows:

5.1.1 Specification designation and year of issue,

5.1.2 Quantity (feet or metres),

5.1.3 Grade (see Table 2 and 8.1.5),

5.1.4 Size (either nominal (NPS) or outside diameter and wall thickness),

5.1.5 Nominal length (see 14.3),

5.1.6 End finish (plain-end beveled or special, see 15.1),

5.1.7 Impact test temperature (see 8.2.5),

5.1.8 Heat treatment condition (see 6.1),

5.1.9 Carbon equivalent for over 0.800 in. [20.3 mm] wall thicknesses (see 7.4),

5.1.10 Reduced under thickness variation (see Table 5),

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<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.

<sup>3</sup> Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, http://api-ec.api.org.

<sup>4</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

**TABLE 1 Lot Size and Sample Size for Mechanical and Toughness Testing**

Pipe Size	Lot Size	Sample Size
<NPS 2	50 tons or fraction thereof	1
NPS 2 through NPS 5	400 lengths	1
NPS 6 through NPS 12	200 lengths	1
>NPS 12	100 lengths	1

**TABLE 2 Tensile Requirements**

Grade	Yield Strength, Min.		Yield Strength, <sup>A</sup> Max.		Tensile Strength, Min.	
	psi	MPa	psi	MPa	psi	MPa
35	35 000	240	65 000	450	60 000	415
50	50 000	345	77 000	530	70 000	485
60	60 000	415	80 000	550	75 000	515
70	70 000	485	87 000	600	80 000	550
80	80 000	550	97 000	670	90 000	620

<sup>A</sup> See 8.1.1.

**TABLE 3 Hydrostatic Test Pressure**

NPS Designator	Specified OD in. [mm]	Specified Wall Thickness in. [mm]	Test Pressure, Min. psi [kPa]
1	1.315 [33.4]	0.133 [3.4]	700 [4800]
		0.179 [4.6]	850 [5900]
		0.250 [6.4]	950 [6600]
		0.358 [9.1]	1000 [6900]
1¼	1.660 [42.2]	0.140 [3.6]	1300 [9000]
		0.191 [4.9]	1900 [13 100]
		0.250 [6.4]	2000 [13 800]
1½	1.900 [48.3]	0.382 [9.7]	2300 [15 900]
		0.145 [3.7]	1300 [9000]
		0.200 [5.1]	1900 [13 100]
		0.281 [7.1]	2000 [13 800]
		0.400 [10.2]	2300 [15 900]

**TABLE 4 Acceptance Limits**

Type of Notch	Acceptance Limit Signal, %
Parallel Sided Notch	100
Drilled Hole	100

**TABLE 5 Permissible Variations in Wall Thickness**

NPS Designator	Permissible Variations from Specified Wall Thickness, <sup>A</sup> %	
	Over	Under
1 to 2½, incl.	20.0	10.0
3 and larger	15.0	10.0

<sup>A</sup> If a reduced under thickness variation is specified in the purchase order, it is permissible for the over thickness variation to be increased, provided that the applicable total tolerance range in percent is not increased.

5.1.11 Special requirements,

5.1.12 Supplementary requirements, and

5.1.13 Bar coding (see 18.3).

## 6. Manufacture

6.1 Pipe shall be manufactured by the seamless process. Unless a specific heat treatment condition is specified in the purchase order, pipe shall be furnished in the as-rolled, normalized, normalized and tempered, or quenched and tempered condition.

## 7. Chemical Composition

7.1 The steel for any grade, by heat and product analyses, shall contain no more than 0.24 % carbon, 0.015 % sulfur, and 0.025 % phosphorus.

7.2 The steel shall contain no more than 0.0007 % boron, by heat analysis.

7.3 For pipe with a specified wall thickness less than or equal to 0.800 in. [20.3 mm], the carbon equivalent (CE) shall not exceed 0.43 %, calculated from the product analysis using the following equation:

$$CE = C + F [Mn/6 + Si/24 + Cu/15 + Ni/20 + (Cr + Mo + V + Cb)/5] \quad (1)$$

where:

$F$  = a compliance factor that is dependent on the carbon content as shown below:

Carbon Content, %	$F$	Carbon Content, %	$F$
<0.06	0.53	0.15	0.88
0.06	0.54	0.16	0.92
0.07	0.56	0.17	0.94
0.08	0.58	0.18	0.96
0.09	0.62	0.19	0.97
0.10	0.66	0.20	0.98
0.11	0.70	0.21	0.99
0.12	0.75	>0.21	1.00
0.13	0.80		
0.14	0.85		

7.4 For pipe with a specified wall thickness greater than 0.800 in. [20.3 mm], the carbon equivalent (CE) shall be as specified in the purchase order.

7.5 A heat analysis shall be made for each heat of steel furnished under this specification. All pipe shall be marked with either a heat number or heat code in accordance with 18.1 and 18.2.

7.6 Product analyses shall be made on at least two samples from each heat of steel.

7.7 All analyses shall be in accordance with Test Methods, Practices, and Terminology A751, and shall include all elements required in the carbon equivalent equation of 7.3, in addition to titanium, phosphorus, sulfur, and boron, except that the product analysis for boron is not required. Titanium is reported for information only and is not a cause for rejection.

7.8 If one or both of the product analyses representing a heat fail to conform to the specified requirements, the heat shall be rejected, or analyses shall be made on double the original number of test samples that failed, each of which shall conform to the specified requirements.

## 8. Mechanical Properties

### 8.1 Tension Test:

8.1.1 The material shall conform to the tensile requirements given in Table 2 and 8.1.6. The yield strength maxima apply only to pipe NPS 8 and larger.

8.1.2 The yield strength corresponding to a total extension under load of 0.5 % of the gage length shall be determined.

8.1.3 Transverse tension tests shall be performed on pipe NPS 8 and larger, or longitudinal, subject to approval by

purchaser. Transverse test specimens shall be either strip test specimens or round bar test specimens, at the option of the manufacturer. All transverse strip test specimens shall be approximately 1½ in. [38 mm] wide in the gage length and each shall represent the full wall thickness of the pipe from which the test specimen was cut.

8.1.4 Longitudinal tension tests shall be performed on pipe smaller than NPS 8. Longitudinal test specimens shall be either strip test specimens, full-size test specimens, or round bar test specimens, at the option of the manufacturer.

8.1.5 Grades intermediate to those given in **Table 2** shall be furnished if so specified in the purchase order. For intermediate grades, the difference between the specified maximum yield strength and the specified minimum yield strength and the difference between the specified minimum tensile strength and the specified minimum yield strength shall be as given in **Table 2** for the next higher listed grade.

8.1.6 For each grade, the minimum elongation in 2 in. [50 mm] shall be as determined by the following equation:

$$e = C (A^{0.2}/U^{0.9}) \quad (2)$$

where:

- $e$  = minimum elongation in percent, rounded to the nearest percent,
- $C$  = constant = 625 000 [1940],
- $A$  = the lesser of 0.75 in.<sup>2</sup> [485 mm<sup>2</sup>] and the cross-sectional area of the tension test specimen in in.<sup>2</sup> [mm<sup>2</sup>], based upon the specified outside diameter of the pipe or the nominal width of the tension test specimen and the specified wall thickness, rounded to the nearest 0.01 in.<sup>2</sup> [1 mm<sup>2</sup>],
- $U$  = specified minimum tensile strength, psi [MPa].

## 8.2 Impact Test:

8.2.1 Except as allowed by 8.2.2, pipe shall be Charpy V-notch tested in accordance with Test Methods and Definitions **A370**. For pipe smaller than NPS 5, such test specimens shall be taken longitudinal to the pipe axis. For pipe NPS 5 and larger, the test specimens shall be taken transverse to the pipe axis.

8.2.2 The basic test specimen is full size Charpy V-notch. Where full size test specimens, either conventional or containing the original OD surface, cannot be obtained due to a combination of specified outside diameter and specified wall thickness, two-thirds size or half-size test specimens shall be used. Where combinations of specified outside diameter and specified wall thickness do not permit half-size test specimens to be obtained, there is no requirement for impact testing. In all cases, the largest possible test specimen size shall be used, except where such a test specimen size will result in absorbed energy values greater than 80 % of the testing machine capacity.

8.2.3 When subsize test specimens are used, the requirements for absorbed energy shall be the adjusted values obtained by the following relationships, with the calculated values rounded to the nearest foot pound-force [joule]:

$$\text{For } 2/3 \text{ size: } N = R \times 0.67 \quad (3)$$

$$\text{For } 1/2 \text{ size: } N = R \times 0.50$$

where:

$N$  = adjusted value, ft-lbf [J], and

$R$  = value required by 8.2.4.

8.2.4 For pipe NPS 5 through NPS 26, the absorbed energy requirement for full size test specimens shall be 20 ft-lbf [27 J]. For pipe smaller than NPS 5, the absorbed energy requirement for full size test specimens shall be 30 ft-lbf [40 J].

8.2.5 Charpy impact testing shall be performed at 32°F [0°C], unless a lower test temperature is specified in the purchase order.

## 9. Hydrostatic Test

9.1 Each length of pipe shall be subjected to the hydrostatic test without leakage through the wall.

9.2 Each length of pipe NPS 2 or larger shall be tested, by the manufacturer, to a minimum hydrostatic pressure calculated from the following relationship:

$$\text{Inch – Pound Units: } P = 2 (St/D) \times C \quad (4)$$

$$\text{SI Units: } P = 2000 (St/D) \times C$$

where:

- $S$  = specified minimum yield strength, psi [MPa],
- $t$  = specified wall thickness, in. [mm],
- $D$  = specified outside diameter, in. [mm],
- $C$  = 0.60 for pipe NPS 2 through NPS 5,  
0.75 for pipe larger than NPS 5 through NPS 8,  
0.85 for pipe larger than NPS 8 through NPS 18,  
0.90 for pipe larger than NPS 18, and
- $P$  = minimum hydrostatic test pressure, psi [kPa].

9.3 For pipe sizes smaller than NPS 2, the test pressures given in **Table 3** are arbitrary. For pipe in sizes smaller than NPS 2 with specified wall thicknesses lighter than those listed, the test pressure for the next heavier listed specified wall thickness shall be used. For intermediate specified outside diameters for pipe sizes smaller than NPS 2, the test pressures given for the next smaller specified outside diameter shall be used.

9.4 When computed test pressures are not an exact multiple of 10 psi [100 kPa], they shall be rounded to the nearest 10 psi [100 kPa].

9.5 The minimum hydrostatic test pressure required to satisfy these requirements need not exceed 3000 psi [20 700 kPa]. This does not prohibit testing at a higher pressure at the manufacturer's option. The hydrostatic test pressure shall be maintained for not less than 5 s for all pipe sizes.

## 10. Nondestructive Electric Test

10.1 The entire outside surface of each pipe shall be inspected full length for longitudinal defects by either magnetic particle inspection, ultrasonic inspection, electromagnetic inspection, or a combination thereof. The location of the equipment in the mill shall be at the discretion of the manufacturer; however, the nondestructive inspection shall take place after all heat treating and expansion operations, if performed, but may take place before cropping, beveling, and end sizing.

10.2 *Magnetic Particle Inspection*—The depth of all imperfections revealed by magnetic particle inspection shall be determined; and when found to be greater than 10 % of the specified wall thickness, the imperfection shall be considered a defect.

10.3 *Ultrasonic and Electromagnetic Inspection*—Any equipment utilizing the ultrasonic or electromagnetic principles and capable of continuous and uninterrupted inspection shall be used. The equipment shall be checked with an applicable reference standard as described in 10.4 at least once every 8 h of inspection to demonstrate the effectiveness of the inspection procedures. The equipment shall be adjusted to produce well-defined indications when the reference standard is scanned by the inspection unit in a manner simulating the inspection of the product.

10.4 *Reference Standards*—Reference standards shall have both outside diameter and wall thickness within the tolerances specified for the production pipe to be inspected, and may be of any convenient length as determined by the pipe manufacturer. For ultrasonic inspection, the reference standard shall contain a machined notch as shown in Fig. 1. For electromagnetic inspection, the reference standard shall contain either a machined notch or a 1/8-in. [3-mm] drilled hole as shown in Fig. 1. The notch shall be in the outer surface of the reference standard and parallel to the longitudinal axis of the pipe or, at the option of the manufacturer, may be oriented at such an angle as to optimize the detection of anticipated defects. The 1/8-in. [3-mm] drilled hole shall be drilled radially through the wall of the reference standard.

NOTE 1—The calibration standards shown in Fig. 1 are convenient standards for the calibration of nondestructive equipment. The dimensions of such standards should not be construed as the minimum size imperfection detectable by such equipment.

10.5 *Acceptance Limits*—Table 4 gives the height of acceptance limit signals in percent of the height of signals produced by the calibration standards. Imperfections that produce a signal greater than the acceptance limit given in Table 4 shall be considered defects. Pipe containing defects shall be given one of the dispositions specified in 16.2.

10.6 Surface condition, operator qualification, extent of examination, and standardization procedure shall be in accordance with the provisions of Specification A450/A450M.

**11. Number of Tests**

11.1 Tension and impact testing shall be performed on a lot basis with the lot size and sample sizes as given in Table 1.

**12. Test Methods**

12.1 The test specimens and the tests required by this specification shall conform to those described in Test Methods and Definitions A370.

**13. Dimensions and Weights [Masses] Per Unit Length**

13.1 The dimensions and weights [masses] per unit length of some of the pipe sizes included in this specification are given in ASME B36.10M. The weight [mass] per unit length of pipe having an intermediate diameter or specified wall thickness, or both, shall be calculated by the equation in 14.1.

**14. Permissible Variations in Weight [Mass] and Dimensions**

14.1 *Weight [Mass]*—The weight [mass] of a single length of pipe shall not vary more than +10 %, -3.5 % from its theoretical weight, as calculated using its weight [mass] per unit length and its measured length. Pipe weights [masses] per unit length not listed in ASME B36.10M shall be calculated from the following equation:

$$\begin{aligned} \text{Inch - Pound Units: } W &= t(D - t) \times 10.69 & (5) \\ \text{SI Units: } W &= t(D - t) \times 0.024\ 66 \end{aligned}$$

where:

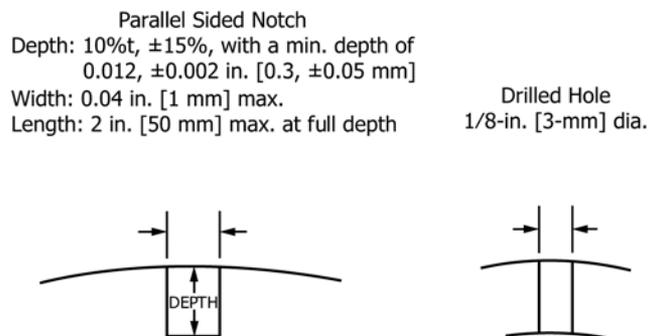
- $D$  = specified outside diameter, in. [mm],
- $t$  = specified wall thickness, in. [mm], and
- $W$  = weight [mass] per unit length, lb/ft [kg/m].

The weight [mass] of any order item shall not be more than 1.75 % under its theoretical weight [mass].

14.2 *Wall Thickness*—Variations in wall thickness shall not exceed those given in Table 5.

14.3 *Length*—Unless otherwise agreed upon between the purchaser and the manufacturer, pipe shall be furnished in the nominal lengths and within the permissible variations given in Table 6.

14.4 *Outside Diameter*—Pipe sizes NPS 20 and smaller shall permit the passage over the ends, for a distance of 4 in.



**FIG. 1 Calibration Standards**

**TABLE 6 Permissible Variations in Length**

Nominal Length		Minimum Length		Minimum Average Length for Each Order Item		Maximum Length	
ft	m	ft	m	ft	m	ft	m
20	6	9.0	3.00	17.5	5.00	22.5	7.00
40	12	14.0	4.00	35.0	11.00	45.0	14.00
50	15	17.5	5.00	43.8	14.00	55.0	17.00
60	18	21.0	6.00	52.5	16.00	65.0	20.00

[100 mm], of a ring gage that has a bore diameter no larger than the specified outside diameter plus the diameter plus tolerance. Outside diameter measurements of pipe larger than NPS 20 shall be made with a diameter tape. Outside diameter measurements, away from the ends, of pipe NPS 20 and smaller, shall be made with a snap gage, caliper, or other device that measures actual outside diameter in a single plane.

### 15. End Finish

15.1 Pipe furnished to this specification shall be plain-end beveled, with ends beveled to an angle of 30°, +5°, -0°, measured from a line drawn perpendicular to the axis of the pipe, and with a root face of 1/16-in. ± 1/32-in. [1.5 mm, +1.0, -0.5 mm], or another plain-end configuration as specified in the purchase order.

### 16. Workmanship, Finish, and Appearance

16.1 Surface imperfections that are deeper than 10 % of the specified wall thickness shall be considered defects.

16.2 Pipe with defects shall be given one of the following dispositions:

16.2.1 The defect shall be removed by grinding, provided that a smooth curved surface remains and the remaining wall thickness is within specified limits.

NOTE 2—It is acceptable for the outside diameter at the point of grinding to be reduced by the amount so removed.

16.2.2 The section of the pipe containing the defect shall be cut off within the requirements for length.

16.2.3 The length shall be rejected.

16.3 Wall thickness measurements shall be made with a mechanical caliper or with a properly calibrated nondestructive

testing device of appropriate accuracy. In case of a dispute, the measurement determined by the use of a mechanical caliper shall govern.

16.4 Repairs of the pipe body, by welding, are not permitted.

16.5 Pipe smaller than NPS 4 shall be reasonably straight. All other pipe sizes shall be randomly checked for straightness, and deviation from a straight line shall not exceed 0.2 % of the pipe length.

16.6 The pipe shall contain no dents greater than 10 % of the specified outside diameter or 1/4 in. [6 mm], whichever is smaller, measured as the gap between the lowest point of the dent and a prolongation of the original contour of the pipe. Cold formed dents deeper than 1/8 in. [3 mm] shall be free of sharp bottom gouges. The gouges may be removed by grinding provided the remaining wall thickness is within specified limits. The length of the dent in any direction shall not exceed one half the pipe specified outside diameter.

### 17. Certification

17.1 A test report shall be furnished.

### 18. Product Marking

18.1 Except as allowed in 18.2, each length of pipe shall be marked legibly by painting to show the specification number; the name or brand of the manufacturer; the grade; the specified wall thickness; the specified outside diameter; the heat number or heat code; and the length. The length shall be marked in feet and tenths of a foot, or metres to two decimal places, whichever is applicable.

18.2 For bundled pipe NPS 1½ or smaller, the required markings may be included on a tag that is fastened securely to the bundle.

18.3 In addition to the requirements of 18.1 and 18.2, bar coding is acceptable as a supplementary identification method. The purchaser may specify in the order that a specific bar coding system be used.

### 19. Keywords

19.1 black steel pipe; line pipe; seamless

## SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified in the purchase order.

### S1. Ductile Fracture Arrest

S1.1 Except as allowed by S1.2, one pipe per heat of steel shall be Charpy V-notch tested in accordance with Test Methods A370 with the test specimens taken transverse to the pipe axis.

S1.2 The basic test specimen is full size Charpy V-notch. Where full size test specimens, either conventional or containing the original OD surface, cannot be obtained due to a combination of specified outside diameter and specified wall

thickness, two-thirds size or half-size test specimens shall be used. Where combinations of specified outside diameter and specified wall thickness do not permit half-size test specimens to be obtained, there is no requirement for impact testing. In all cases, the largest possible test specimen size shall be used, except where such a test specimen size will result in absorbed energy values greater than 80 % of the testing machine capacity.

S1.3 When subsize test specimens are used, the requirements for absorbed energy shall be the adjusted values obtained by one of the following relationships, with the calculated values rounded to the nearest foot pound-force [joule]:

$$\text{For } 2/3 \text{ size: } N = R \times 0.67$$

$$\text{For } 1/2 \text{ size: } N = R \times 0.50$$

where:

$N$  = adjusted value, ft-lbf [J], and

$R$  = specified value required by S1.4.

S1.4 The absorbed energy requirement for full size specimens shall be the value calculated using the following equation, rounded to the nearest foot pound-force, or 30 ft-lbf [40 J], whichever is the greater:

$$V \text{ (full size)} = C \times D^{0.5} \times S^{1.5}$$

where:

$D$  = specified outside diameter, in. [mm],

$S$  =  $0.72 \times$  specified minimum yield strength, ksi [MPa],

$C$  = constant 0.024 [0.000 36], and

$V$  = minimum average value required, ft-lbf [J].

S1.5 The factor of 0.72 as shown in S1.4 may be increased by agreement between the purchaser and the manufacturer.

S1.6 Charpy impact testing shall be performed at 32°F [0°C], or lower as agreed upon between the purchaser and the manufacturer.

S1.7 Each Charpy impact test shall exhibit at least 70 % shear area average for the three specimens.

## S2. Drop Weight Tear Testing

S2.1 The drop weight tear test shall be conducted in accordance with API RP 5L3.

S2.2 The temperature selected for conducting the drop weight tear test, the test frequency, and the criteria for acceptance shall be as specified in the purchase order.

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