



Standard Specification for Steel Line Pipe, Black, Plain-End, Electric-Resistance- Welded¹

This standard is issued under the fixed designation A 984/A 984M; 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 electric resistance welded, black, plain-end-steel pipe for use in the conveyance of fluids under pressure. Pipe in sizes NPS 1 to 26, inclusive, with nominal wall thickness 0.750 in. [19 mm] or less, as given in ASME B 36.10M 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 shall 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 (metric) 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 shall be used independently of the other, without combining values in any way.

2. Referenced Documents

2.1 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products²

A 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy and Austenitic Alloy Steel Tubes²

A 530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe²

A 751 Test Methods, Practices and Terminology for Chemical Analysis of Steel Products²

A 919 Terminology Relating to Heat Treatment of Metals²

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys and Ferroalloys²

2.2 API Standard:

API RP 5L3 Recommended Practice for Conducting Drop-Weight Tear Tests on Line Pipe³

¹ 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 10, 2000. Published May 2000. Originally published as A 984 – 98. Last previous edition A 984 – 98a.

² *Annual Book of ASTM Standards*, Vol 01.01.

³ Available from the American Petroleum Institute, 1220 L Street, N.W., Washington, DC 20005.

2.3 ASME Standard:

ASME B36.10M Welded and Seamless Wrought Steel Pipe⁴

3. Terminology

3.1 Definitions—For terminology used in this specification, see Terminologies A 919 and A 941.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *electric resistance welding, n*—electric resistance welding is a process of forming a longitudinal seam wherein the edges are pressed together mechanically after the heat for welding has been generated by the resistance to the flow of electric current.

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

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 Material furnished under this specification shall conform to the applicable requirements of Specification of A 530/A 530M unless otherwise provided herein.

5. Ordering Information

5.1 It is the purchaser's responsibility to specify in the purchase order all information necessary to purchase the needed material. Examples of such information include, but are not limited to, the following:

5.1.1 Specification designation,

5.1.2 Quantity (feet or meters),

5.1.3 Grade (see Table 2 or 8.6),

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

5.1.5 Length,

5.1.6 End finish, plain-end beveled or special, (see Section 16),

5.1.7 End use of the material,

5.1.8 Special requirements,

5.1.9 Supplementary requirements, and

⁴ Available from ASME International, Three Park Avenue, New York, NY 10016-5990.

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

Size Designation	Lot Size	Sample Size
<NPS2	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		Yield Strength ^A		Tensile Strength	
	Min psi	MPa	Max psi	MPa	Min psi	MPa
35	35 000	245	70 000	450	60 000	415
45	45 000	315	72 000	500	65 000	450
55	55 000	380	80 000	520	70 000	485
65	65 000	450	85 000	570	75 000	520
80	80 000	550	97 000	670	90 000	625

^ASee 8.1.

5.1.10 Bar coding.

6. Manufacture

6.1 Pipe shall be manufactured by the electric resistance welding process. The weld seam and its heat affected zones shall receive either a normalizing heat treatment or a continuous in-line heat treatment above the Ac3 temperature. Complete penetration and coverage of the weld and the weld heat affected zone by this heat treatment shall be confirmed by periodic metallographic examination of weld area cross-section specimens.

6.2 The internal and external flash resulting from the welding process shall be removed, in accordance with the requirements of 17.1 and 17.2.

7. Chemical Composition

7.1 The steel for any grade shall contain no more than 0.22 % carbon, 0.015 sulfur, and 0.025 phosphorus by heat and product analysis.

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

7.3 The carbon equivalent (CE) shall not exceed .40 %, calculated from the product analysis using the following equation:

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

Where:

F is 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	0.22	1.00
0.13	0.80		
0.14	0.85		

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

7.5 All analyses shall be in accordance with Test Methods,

Practices, and Terminology A 751, and shall include all elements required in the carbon equivalent equation of 7.3, in addition to titanium, phosphorus, sulfur, and boron. Product analysis for boron is not required.

7.6 If one or both of the product analyses representing a heat fails 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. Tensile Requirements

8.1 The material shall conform to the requirements for tensile properties shown in Table 2 and in 8.6. The yield strength maxima apply only to NPS 8 and larger.

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

8.3 A test specimen taken across the weld shall show a tensile strength not less than the minimum tensile strength specified for the grade of pipe required. Neither yield strength nor elongation determinations are required for transverse weld specimens. This test is not required for pipe under NPS 8.

8.4 Transverse tension tests shall be performed on NPS 8 and larger and the specimens shall be taken opposite the weld. All transverse test specimens shall be approximately 1 1/2 in. [38 mm] wide in the gage length and shall represent the full wall thickness of the pipe from which the specimen was cut.

8.5 For pipe smaller than NPS 8, longitudinal tests shall be performed. Such tests shall be either strip specimens taken 90° from the weld or full section specimens, at the option of the manufacturer.

8.6 Grades intermediate to those shown in Table 2 may be furnished. The maximum yield strength range of such grades shall be the same as the next higher listed grade. The tensile strength of intermediate grades shall be higher than the yield strength by the same amount as the next higher grade shown in Table 2. The minimum elongation in 2 in. [50 mm] for all grades shall be that determined by the following equation:

$$e = \frac{A^{0.2}}{U^{0.5}} \quad (2)$$

where:

e = minimum elongation in percent rounded to the nearest 0.05 %,

C = constant = 625 000 [1942.57],

A = cross-sectional area of the tensile test specimen in in.², mm², based on specified outside diameter or nominal specimen width and specified wall thickness rounded to the nearest 0.01 in.²[6.5 mm²]. If the area thus calculated is greater than 0.75 in.²[485 mm²] the value of 0.75 in.²[485 mm²] shall be used.

U = specified minimum tensile strength, psi [MPa]

9. Fracture Toughness Requirements

9.1 Charpy V-Notch Testing:

9.1.1 All pipe shall be Charpy V-notch tested in accordance with Test Methods A 370, except as shown in 9.1.2. For pipe smaller than NPS 5, such tests shall be longitudinal, taken 90° from the weld. For pipe NPS 5 and larger, the tests shall be transverse, taken 90° from the weld.

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

9.1.3 When specimens smaller than full size are used the requirements of 9.1.4 shall be adjusted by one of the following relationships:

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

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

$$\text{For } \frac{1}{3} \text{ size: } N = R \times 0.33$$

where:

N = adjusted value, and
 R = calculated value from 9.1.4.

9.1.4 Fracture toughness requirements are calculated from the equation shown below for pipe NPS 5 through NPS 26. Values calculated by this equation as less than 15 ft/lb [20 J] shall be taken as 15 ft/lb [20 J]. For pipe smaller than NPS 5, the requirement for fracture toughness is 15 ft/lb [20 J] for full size specimens.

$$CV(\text{fullsize}) = Cx\sqrt{DxS^{1.5}} \quad (4)$$

where:

D = outside diameter, in. [mm],
 S = $0.72 \times$ minimum specified yield strength, ksi [MPa],
 C = constant 0.024 [.0003538], and
 CV = minimum average value required, ft/lb [J].

9.1.5 The factor of 0.72 as shown in 9.1.4 may be increased by agreement between purchaser and manufacturer.

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

9.1.7 Each Charpy impact test shall exhibit at least 75 % shear area average for the three specimens.

10. Weld Ductility Test (Flattening Test)

10.1 The weld ductility shall be determined by tests on full section specimens of 2 in. [50 mm] minimum length. The specimens shall be flattened cold between parallel plates. The weld shall be placed at 90° and at 0° from the direction of applied force (point of maximum bending). No crack or breaks exceeding 1/8 in. [3 mm] in any direction in the weld or in the parent metal shall occur on the outside surface until the distance between the plates is less than the value of H in the following equation. Cracks that originate at the edge of the specimen and that are less than 0.025 in. [6.4 mm] shall not be cause for rejection:

$$H = \frac{3.05t}{(.05 + 3 t/D)} \quad (5)$$

where:

H = distance between flattening plates, in. [mm],
 t = specified wall thickness, in. [mm], and
 D = specified outside diameter, in. [mm].

11. Hydrostatic Test

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

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

$$\text{U.S. Customary } P = 2 \frac{St}{D} \times C \quad (6)$$

$$\text{Metric: } P = 2000 \frac{St}{D} \times C$$

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.

11.3 For pipe sizes smaller than NPS 2 the test pressures shown in Table 3 are arbitrary. For pipe in sizes smaller than NPS 2 with wall thicknesses lighter than those shown, the test pressure for the next heavier wall shall be used. For intermediate diameters smaller than NPS 2, the test pressures shown for the next smaller diameter shall be used.

11.4 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].

11.5 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 sizes.

12. Nondestructive Electric Test

12.1 The weld seam of each length of pipe NPS 2 or larger shall be inspected using a nondestructive electric test as follows:

TABLE 3 Hydrostatic Test Pressure

NPS Designator	OD in. [mm]	Wall Thickness in. [mm]	Test Pressure psi [kPa] [min]
1	1.315 [33.4]	0.133 [3.38]	700 [4800]
		0.179 [4.55]	850 [5900]
		0.250 [6.35]	950 [6600]
		0.358 [9.09]	1000 [6900]
1 1/4	1.660 [42.2]	0.140 [3.56]	1300 [9000]
		0.191 [4.85]	1900 [13 100]
		0.250 [6.35]	2000 [13 800]
		0.382 [9.70]	2300 [15 900]
1 1/2	1.900 [48.3]	0.145 [3.68]	1300 [9000]
		0.200 [5.08]	1900 [13 100]
		0.281 [7.14]	2000 [13 800]
		0.400 [10.16]	2300 [15 900]