Designation: A 984/A 984M – 03

Standard Specification for Steel Line Pipe, Black, Plain-End, Electric-Resistance-Welded[1]

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. [19.1 mm] or less, 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:* [2]

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

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

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

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

A 941 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[3]

2.3 *ASME Standard:*

ASME B36.10M Welded and Seamless Wrought Steel Pipe[4]

3. Terminology

3.1 *Definitions*—For terminology used in this specification, refer to Terminology 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 given 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 Pipe furnished under this specification shall conform to the applicable requirements of Specification 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 and year of issue,

5.1.2 Quantity (feet or metres),

5.1.3 Grade (standard or intermediate, see Table 2 and 8.1.6),

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

5.1.5 Length (see 12.4),

5.1.6 End finish (plain-end beveled or special, see 13.1),

[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.

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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.

[3] Available from The American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005.

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

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

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

Size Designation	Lot Size	Sample Size
<NPS 2	50 tons [45 Mg] 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,[A] 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

[A] See 8.1.1.

5.1.7 End use of the pipe,
5.1.8 Special requirements,
5.1.9 Supplementary requirements, and
5.1.10 Bar coding (see 16.3).

6. Manufacture

6.1 Pipe shall be manufactured by the electric-resistance-welding process. The entire pipe shall be normalized or the weld seam and its heat-affected zones shall receive a continuous in-line heat treatment above the Ac_3 temperature. Complete penetration and coverage of the weld seam and its heat-affected zones by such heat treatment shall be confirmed by metallographic examination of weld area cross-section specimens, taken at least once per eight hours per operating shift, but more frequently if diameter or wall thickness changes are made.

6.2 The internal and external flash resulting from the welding process shall be removed (see 14.1 and 14.2).

7. Chemical Composition

7.1 The steel for any grade, by heat and product analyses, shall contain no more than 0.22 % 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 The carbon equivalent (CE) shall not exceed 0.40 %, 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 upon the carbon content, as given 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, except that 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. Mechanical Properties

8.1 *Tension Test*:

8.1.1 The material shall conform to the tensile requirements given in Table 2 and in 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 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 smaller than NPS 8.

8.1.4 Transverse tension tests shall be performed on pipe NPS 8 and larger and the test specimens shall be taken opposite the weld. All transverse 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.

8.1.5 Longitudinal tension tests shall be performed on pipe smaller than NPS 8. Longitudinal test specimens shall be either full-size test specimens or strip test specimens, at the option of the manufacturer. Strip test specimens shall be from a location approximately 90° from the weld.

8.1.6 Grades intermediate to those given in Table 2 may be furnished. 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. For each grade, the minimum elongation in 2 in. [50 mm] shall be calculated using the following equation:

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

where:
e = minimum elongation in percent, rounded to the nearest percent,
C = constant = 625 000 [1940],

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A = cross-sectional area of the tensile test specimen in in.^{2} [mm^2], based upon the specified outside diameter or the nominal specimen width and the specified wall thickness, rounded to the nearest 0.01 in.^{2} [1 mm^2]. If the area thus calculated is greater than 0.75 in.^{2} [485 mm^2], the value of 0.75 in.^{2} [485 mm^2] shall be used.
U = specified minimum tensile strength, psi [MPa].

8.2 *Impact Test*:

8.2.1 Except as allowed by 8.2.2, all sizes of pipe shall be Charpy V-notch tested in accordance with Test Methods and Definitions A 370. For pipe smaller than NPS 5, such tests shall be longitudinal, taken 90° from the weld. For pipe NPS 5 and larger, such tests shall be transverse, taken 90° from the weld.

8.2.2 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 thickness do not permit the smallest specimen size, there is no requirement for impact testing. In all cases, the largest possible specimen size shall be used, except where such a specimen size will result in absorbed energy values greater than 80 % of the testing machine capacity.

8.2.3 Where subsize 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]:

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

$$\text{For } \frac{1}{2} \text{ size: } N = R \times 0.50 \tag{4}$$

$$\text{For } \frac{1}{3} \text{ size: } N = R \times 0.33 \tag{5}$$

where:
N = adjusted value, ft·lbf [J], and
R = value required by 8.2.4.

8.2.4 For pipe smaller than NPS 5, the absorbed energy requirement for full size specimens shall be 15 ft·lbf [20 J]. For pipe NPS 5 through NPS 26, 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 15 ft·lbf [20 J] , whichever is the greater.

$$V \text{ (full size)} = Cx\sqrt{D}xS^{1.5} \tag{6}$$

where:
V = minimum average value required for full size specimens, ft·lbf [J],
C = constant = 0.024 [0.00036],
D = specified outside diameter, in. [mm], and
S = 0.72 × specified minimum yield strength, ksi [MPa].

8.2.5 The factor of 0.72 in 8.2.4 may be increased by agreement between the purchaser and the manufacturer.

8.2.6 Charpy impact testing shall be performed at 32°F [0°C], unless a lower temperature is agreed upon between the purchaser and the manufacturer.

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

8.3 *Flattening Test*:

8.3.1 The weld ductility shall be determined by tests on two full-section specimens of at least 2 in. [50 mm] long. Such 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). Except as allowed by 8.3.2, no cracks or breaks exceeding ⅛ in. [3 mm] in any direction in the weld or in the parent metal shall occur on the outside surface of the specimen before the distance between the plates is less than the value of H calculated using the following equation:

$$H = \frac{3.05t}{(0.05 + 3\ t/D)} \tag{7}$$

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

8.3.2 Cracks that originate at the edge of the specimen and are less than ¼ in. [6 mm] in any direction shall not be cause for rejection.

9. Hydrostatic Test

9.1 Each length of pipe shall be subjected to the hydrostatic test without leakage through the weld seam or the pipe body.

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 equation:

$$\text{Inch–Pound Units: } P = 2\left(\frac{St}{D}\right) \times C \tag{8}$$

$$\text{SI Units: } P = 2000\frac{St}{D} \times C \tag{9}$$

where:
P = minimum hydrostatic test pressure, psi [kPa],
S = specified minimum yield strength, psi [MPa],
t = specified wall thickness, in. [mm],
D = specified outside diameter, in. [mm], and
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.

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 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 Where 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.

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TABLE 3 Hydrostatic Test Pressure

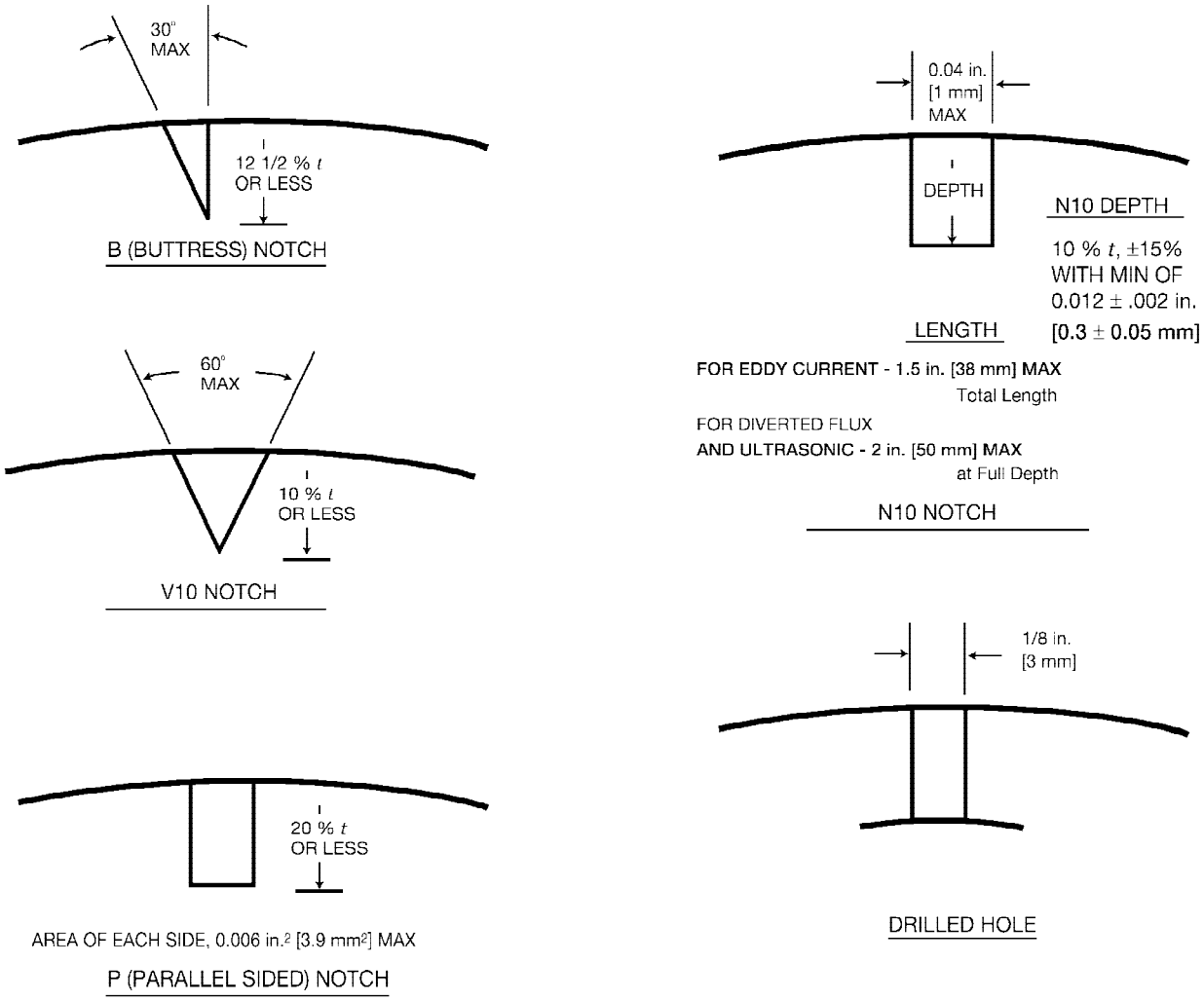
NPS Designator	OD, in. [mm]	Wall Thickness, in. [mm]	Test Pressure, Min, psi [kPa]
1	1.315 [33.4]	0.133 [3.4]	700 [4800]
		0.179 [4.6]	850 [5900]
		0.250 [6.4]	950 [6600]
		0.358 [9.1]	1000 [6900]
1¼	1.660 [42.2]	0.140 [3.6]	1300 [9000]
		0.191 [4.9]	1900 [13 100]
		0.250 [6.4]	2000 [13 800]
		0.382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

10. Nondestructive Electric Test

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

10.2 *Ultrasonic and Electromagnetic Inspection*—Any equipment utilizing the ultrasonic or electromagnetic principles and capable of continuous and uninterrupted inspection of the weld seam shall be used. The equipment shall be checked with an applicable reference standard as described in 10.3 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. The location of the equipment shall be at the manufacturer's option.

10.3 *Reference Standards*—Reference standards shall have both the outside diameter and the 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. Reference standards shall be either full sections or coupons taken from the pipe. Reference standards shall contain machined notches as shown in Fig. 1, one on the inside surface and one on the outside surface, or a drilled hole as shown in Fig. 1, at the option of the pipe manufacturer. The notches shall be parallel to the weld seam, and shall be separated by a distance sufficient to produce two separate and distinguishable signals. The ⅛-in. [3-mm] drilled hole shall be drilled through the wall and perpendicular to the surface of the



NOTE 1—t = specified wall thickness

FIG. 1 Calibration Standards

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reference standard as shown in Fig. 1. Care should be taken in the preparation of the standard to ensure freedom from fins or other edge roughness, or distortion of the standard.

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

10.4 *Acceptance Limits*—Table 4 gives the height of acceptance limit signals in percent of the height of signals produced by the calibration standards. Imperfections in the weld seam that produce a signal greater than the acceptance limit given in Table 4 shall be considered defects.

10.5 Surface condition, operator qualification, extent of examination, and standardization procedure shall be in accordance with the provisions of Specification A 450/A 450M.

11. Number of Tests

11.1 For pipe produced from coils, the flattening test in Section 10 shall be performed on pipe from each end of the coil length. In the event of a weld stop, the test shall be performed on each pipe end adjacent to the weld stop. For pipe produced in single lengths, the test shall be performed on each end of each length.

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

12. Dimensions, Mass, and Permissible Variations

12.1 The dimensions and masses per unit length of some of the pipe sizes included in this specification are given in ASME B36.10M. The mass per unit length of pipe having an intermediate specified outside diameter or intermediate specified wall thickness, or both, shall be calculated using the appropriate equation in 12.2.

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

$$\text{Inch–Pound Units: } M = t\,(D - t) \times 10.69 \quad (10)$$

$$\text{SI Units: } M = t\,(D - t) \times 0.024\,66 \quad (11)$$

where:

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

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

12.3 *Wall Thickness*— The wall thickness at any point shall be not more than 8 % under the specified wall thickness.

TABLE 4 Acceptance Limits

Type of Notch	Size of Hole, in. [mm]	Acceptance Limit Signal, %
N10, V10	⅛ [3]	100
B, P		80

12.4 *Length*—Unless otherwise agreed upon between the purchaser and the manufacturer, pipe shall be furnished in the nominal lengths and within the tolerances given in Table 5, as specified.

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

13. End Finish

13.1 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 shall have another plain-end configuration, as specified in the purchase order.

14. Workmanship, Finish, and Appearance

14.1 The depth of groove resulting from the removal of the internal flash shall not be greater than that given in Table 6 for the various wall thicknesses. Depth of groove is defined as the difference between the wall thickness measured approximately 1 in. [25 mm] from the weld line and the wall thickness measured at the groove.

14.2 The external flash shall not extend above the surface of the pipe by more than 0.010 in. [0.2 mm].

14.3 Surface imperfections that penetrate more than 8 % of the specified wall thickness or encroach on the minimum permissible wall thickness shall be considered defects. Pipe with defects shall be given one of the following dispositions:

14.3.1 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.

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

14.3.3 The length shall be rejected.

14.4 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.

TABLE 5 Tolerances on 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	2.74	17.5	5.33	22.5	6.86
40	12	14.0	4.27	35.0	10.67	45.0	13.72
50	15	17.5	5.33	43.8	13.35	55.0	16.76
60	18	21.0	6.40	52.5	16.00	65.0	19.81
80	24	28.0	8.53	70.0	21.34	85.0	25.91

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TABLE 6 Depth of Groove Tolerance

Specified Wall Thickness (*t*)	Maximum Depth of Groove
0.150 in. [3.8 mm] or less	0.10*t*
0.151 in. [3.8 mm] to 0.301 in. [7.6 mm], excl	0.015 in. [0.4 mm]
0.301 in. [7.6 mm] or greater	0.05*t*

14.5 Repairs of the weld seam or the pipe body, by welding, are not permitted.

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

14.7 The pipe shall contain no dents greater than 10 % of the specified outside diameter or ¼ in. [6 mm], whichever is the lesser, 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 ⅛ 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's specified outside diameter.

15. Certification

15.1 Where specified in the purchase order or contact, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. Where specified in the purchase order or contact, a report of the test results shall be furnished.

16. Product Marking

16.1 Except as allowed by 16.2, each length of pipe shall be legibly marked to show the specification number, the name or brand of the manufacturer, ERW, 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.

16.2 For bundled pipe NPS 1½ or smaller, it shall be permissible for the required markings to be included on a tag that is fastened securely to each bundle.

16.3 In addition to the requirements of 16.1 and 16.2, bar coding is acceptable as a supplementary identification method. The purchaser may specify in the order that a specific bar coding system be used.

17. Keywords

17.1 black steel pipe; electric-resistance-welded; line pipe

SUPPLEMENTARY REQUIREMENTS

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

S1. **Drop-Weight Tear Testing**

S1.1 The drop-weight tear test shall be conducted in accordance with API RP 5L3.

S1.2 The temperature selected for conducting the drop-weight tear test and the criteria for acceptance shall be as specified in the purchase order.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 984/A 984M-02, that may impact the use of this specification. (Approved September 10, 2003)

(*1*) Revised Table 2.

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