



# Standard Specification for Steel Line Pipe, Black, Plain End, Longitudinal and Helical Seam, Double Submerged-Arc Welded<sup>1</sup>

This standard is issued under the fixed designation A 1005/A 1005M; 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 reappraisal. A superscript epsilon (ε) indicates an editorial change since the last revision or reappraisal.

<sup>e1</sup> NOTE—Editorial corrections were applied throughout August 2000.

## 1. Scope

1.1 This specification covers double submerged-arc welded, black, plain end steel pipe for use in the conveyance of fluids under pressure. Pipe in sizes NPS 16 and larger, as given in ASME B36.10, are included; pipe having other dimensions, in this size range, are permitted, provided such pipe complies with all other requirements of this specification.

1.2 It is intended that pipe be capable of being 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. The values in each system are not exact equivalents, therefore, each system is to be used independently of the other, without combining values in any way.

1.4 The following precautionary statement pertains to the test method portion, Section 14 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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>2</sup>

A 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes<sup>2</sup>

A 530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe<sup>2</sup>

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products<sup>3</sup>

A 941 Terminology Relating to Steel, Stainless Steel, Re-

lated Alloys, and Ferroalloys<sup>2</sup>

### 2.2 ASME Standards:

ASME B36.10 Welded and Seamless Wrought Steel Pipe<sup>4</sup>  
ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels<sup>4</sup>

ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications<sup>4</sup>

### 2.3 API Publications:

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

API Standard 1104 Welding of Pipelines and Related Facilities<sup>5</sup>

## 3. Terminology

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

3.1.1 *double submerged-arc welding, n*—a welding process that produces coalescence of metals by heating them with an arc of arcs between a bare metal electrode or electrodes and the work pieces, using at least one pass from the inside and at least one pass from the outside to make the longitudinal, helical, and skelp end weld seams, whichever are applicable, the arc or arcs and the molten metal are shielded by a blanket of granular, fusible material on the work pieces.

3.1.2 *jointer, n*—not more than three lengths of pipe circumferentially welded together to produce a single length that complies with the length provisions of this specification.

3.1.3 *skelp, n*—the flat rolled product intended to be formed into pipe.

3.1.4 *skelp end, n*—the weld joining the ends of two lengths of skelp.

3.1.5 *specified outside diameter, n*—the outside diameter shown in B36.10M or that stated on the order.

3.1.6 *test lot, n*—a quantity of pipe of the same ordered diameter, heat, and wall thickness.

3.2 *Definitions:* For definitions of other terms used in this specification, refer to Terminology A 941.

<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.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 01.02.

<sup>4</sup> Available from American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

<sup>5</sup> Available from American Petroleum Institute, 1220 L Street, N.W., Washington, DC 20005-4070.

#### 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 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 1 or 8.5),
- 5.1.4 Size, either nominal (NPS) or outside diameter and wall thickness,
- 5.1.5 Nominal length (see 16.3),
- 5.1.6 Diameter tolerances for pipe larger than NPS 43 (see 16.4),
- 5.1.7 End finish (plain and beveled or special, see 17.1),
- 5.1.8 Jointers (See Section 19),
- 5.1.9 Special requirements,
- 5.1.10 Supplementary requirements,
- 5.1.11 Charpy V-notch impact energy (see 9.4), and
- 5.1.12 Bar coding (see 21.2).

#### 6. Materials and Manufacture

6.1 Skelp widths for helical seam pipe shall be neither less than 0.8 nor more than 3.0 times the pipe's specified outside diameter.

6.2 The longitudinal, helical, and skelp end welds, whichever are applicable, shall be made using welding procedures qualified in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section IX.

6.3 Skelp end welds shall not be permitted in finished pipe, except for helical seam pipe having its skelp end welds manufactured by double submerged-arc welding. For such pipe, skelp ends shall have been properly prepared for welding. Junctions of skelp end welds and helical seam welds shall not be located within 12 in. [300 mm] of pipe ends or jointer welds. Junctions of skelp end welds and jointer welds shall be separated by a minimum circumferential distance of 6 in. [150 mm] from junctions of the helical seam weld and the jointer weld. Skelp end welds shall be permitted at finished pipe ends, provided that there is a minimum circumferential separation of 6 in. [150 mm] between the skelp end weld and the helical seam weld at the applicable pipe ends.

#### 7. Chemical Composition

7.1 The steel for any grade shall contain no more than 0.16 % carbon, by heat and product analyses.

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 any reported 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 follows:

Carbon Content, %	<i>F</i>	Carbon Content, %	<i>F</i>
<0.06	0.53	0.11	0.70
0.06	0.54	0.12	0.75
0.07	0.56	0.13	0.80
0.08	0.58	0.14	0.85
0.09	0.62	0.15	0.88
0.10	0.66	0.16	0.92

7.4 A heat analysis shall be made for each heat of steel furnished under this specification.

7.5 Product analyses shall be made on at least two samples from each heat of steel. Product analysis for boron is not required.

7.6 Except as provided in 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.

7.7 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 requirements.

#### 8. Tensile Property Requirements

8.1 Except as allowed by 8.5 the material shall conform to the requirements for tensile properties given in Table 1.

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 longitudinal, helical, or skelp end weld, whichever are applicable, shall show a tensile strength not less than the minimum tensile strength specified for the grade of pipe required. Test specimens shall contain the weld reinforcement and shall exhibit at least 10 % elongation in 2 in. [50 mm].

8.4 Transverse body tension test specimens shall be taken opposite the weld, for longitudinally welded pipe. For helical welded pipe the transverse body tension test shall be taken 90° to the axis of the pipe and approximately halfway between adjacent weld convolutions.

8.5 Grades intermediate to those given in Table 1 shall be furnished if so specified in the purchase order. For such grades, the permissible yield strength range shall be as given in Table 1 for the next higher grade, and the required minimum tensile strength shall exceed the required minimum yield strength by the same amount as given in Table 1 for the next higher grade.

8.6 The ratio of yield strength to tensile strength for all pipe body tests shall not exceed 0.90 for Grades 70 and lower. For grades higher than Grade 70, the ratio shall not exceed 0.93.

**TABLE 1 Tensile Requirements<sup>A</sup>**

Grade	Yield Strength, min		Yield Strength, max		Tensile Strength, min	
	psi	MPa	psi	MPa	psi	MPa
35	35000	[240]	65 000	[450]	60 000	[415]
50	50000	[345]	77 000	[530]	70 000	[485]
60	60000	[415]	80 000	[550]	75 000	[515]
70	70000	[485]	87 000	[600]	80 000	[550]
80	80000	[550]	97 000	[670]	90 000	[620]

<sup>A</sup>Yield strength requirements do not apply to transverse weld tests.

8.7 For pipe body tests, the minimum elongation in 2 in. [50 mm] for all grades shall be that determined by the following equation:

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

where:

$e$  = minimum elongation in 2 in. [50 mm] in percent, rounded to the nearest percent,

$C$  = 625 000 [1940],

$A$  = the lesser of  $0.75 \text{ in}^2$  [ $485 \text{ mm}^2$ ] and the cross-sectional area of the tension test specimen, calculated using the specified width of the test specimen and the specified wall thickness of the pipe, with the calculated value rounded to the nearest  $0.01 \text{ in}^2$  [ $1 \text{ mm}^2$ ], and

$U$  = specified minimum tensile strength, psi [MPa].

## 9. Charpy V-Notch Test

9.1 Except as allowed by 9.2, all pipe shall be Charpy V-notch tested in accordance with Test Methods and Definitions A 370. All pipe body tests shall be transverse to the pipe axis, taken approximately  $90^\circ$  from the weld. All weld tests shall be transverse to the weld axis.

9.2 The basic specimen is full size Charpy V-notch. For pipe with a specified wall thickness of 0.236 in [5.9 mm] or less, there is no requirement for Charpy V-notch testing. Where combinations of diameter and wall do not permit the smallest specimen size, there is no requirement for proven 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:

Specified Wall Thickness, in. [mm]	Specimen Size To Be Used
$\geq 0.434$ [11.0]	Full
0.304–0.433 [7.7–10.9]	$\frac{2}{3}$
0.237–0.303 [6.0–7.6]	$\frac{1}{2}$

9.3 When specimens smaller than full size are used, the requirements of 9.4 shall be adjusted by one of the following relationships:

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

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

where:

$N$  = adjusted value, rounded to the nearest whole number, and

$R$  = applicable value from 9.4 and 9.6.

9.4 The Charpy V-notch energy impact energy for the pipe body shall be not less than 30 ft-lbf [40 J] minimum average, or any higher value specified in the purchase order.

9.5 All Charpy V-notch testing shall be performed at  $32^\circ\text{F}$  [ $0^\circ\text{C}$ ], or lower as agreed upon between purchaser and manufacturer or at the manufacturer's option.

9.6 A test of weld and HAZ Charpy V-notch impact energy properties shall be made on each type (longitudinal, helical, or skelp end) of weld. The Charpy V-notch impact energy shall be not less than 30 ft-lbf [40 J].

9.7 Each pipe body Charpy V-notch specimen shall exhibit at least 75 % shear area.

## 10. Guided Bend Test

10.1 Root and face guided bend tests shall be conducted in accordance with Test Methods A 370. The specimens shall not fracture completely and shall not reveal any cracks or ruptures in the parent metal, heat affected zone, or fusion line longer than  $\frac{1}{8}$  in. [3 mm] and deeper than 12  $\frac{1}{2}$  % of the specified wall thickness, except that cracks that occur at the edges of the specimen and are less than  $\frac{1}{4}$  in. [6 mm] long shall not be cause for rejection, regardless of depth.

## 11. Hydrostatic Test

11.1 Each length of pipe shall be subjected to the hydrostatic test without leakage through the wall, except that jointers that are comprised of segments that have passed hydrostatic testing need not be hydrostatically tested.

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

*Inch-Pound Units:*

$$P = 2 \frac{St}{D} \times C \quad (4)$$

*SI Units:*

$$P = 2000 \frac{St}{D} \times C \quad (5)$$

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],

$C$  = 0.85 for pipe NPS 16 through NPS 18, and  
= 0.90 for pipe larger than NPS 18.

11.3 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].

11.4 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 Examination

12.1 *General*—The full length of each longitudinal, helical and skelp end weld shall be subjected to ultrasonic inspection in accordance with 12.3, in combination with radiography in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Paragraph UW51. Radiographic inspection shall include at least 8 in. [200 mm] of weld from each pipe end.

12.2 All required nondestructive examination (NDE) shall be performed after hydrostatic test, except for the nondestructive examination (NDE) of jointer welds and the radiographic inspection of pipe ends.

12.3 *Ultrasonic Inspection*—Any equipment utilizing ultrasonic 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 12.3.1 at least once every working turn or not more than 8 hours 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 inspection of the product.

12.3.1 *Reference Standards*—Reference standards shall have the same diameter and thickness as the product 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. The reference standard shall contain machined notches or a drilled hole, with the following dimensions:

Parallel Sided Notch (A)	Drilled Hole
Depth – 5 % t ± 15 %	1/16 in. [1.6 mm] diameter
with min of	
0.012 ± 0.002 in.	
[0.3 ± 0.05 mm]	
Width – 0.04 in. [1 mm] max	
Length – 2 in. [50 mm] min at full depth	

NOTE 1—The reference discontinuities defined herein are convenient standards for calibration of nondestructive testing equipment. The dimensions of these discontinuities should not be construed as the minimum size imperfection detectable by such equipment.

12.3.2 *Surface Condition, Operator Qualifications*—Extent of Examination, and Standardization Procedure— Surface condition, extent of examination, operator qualifications, and standardization procedure shall be in accordance with the requirements of Specification A 450/A 450M.

12.3.3 *Acceptance Limits*—Table 2 gives the height of acceptance limit signals in percent of the height of signals produced by the reference discontinuities. Imperfections in the weld seam that produce a signal greater than the acceptance limit given in Table 2 shall be considered defects.

12.4 *Disposition of NDE Defects*—Pipe that has been rejected in accordance with the provisions of 12.1 or 12.3 shall be given one of the following dispositions:

- 12.4.1 The pipe length shall be rejected.
- 12.4.2 The portion of the pipe containing the defect shall be cut off.
- 12.4.3 The defect shall be removed by grinding, provided that the remaining wall thickness is within specified limits.
- 12.4.4 The area of the pipe containing the defect shall be repaired by welding.

**13. Number of Tests**

13.1 Tensile testing of the pipe body, longitudinal welds, and helical welds shall be performed on a test lot basis with a lot size of one sample for each lot of 100 joints of pipe or less.

13.2 Tensile testing of skelp end welds shall be performed at a frequency of one test per lot of 100 lengths containing skelp end welds.

13.3 The guided bend test specimens shall be taken from each lot of 50 lengths or less of each combination of specified outside diameter, specified wall thickness, and grade.

**TABLE 2 Acceptance Limits**

Top of Notch	Size of Hole		Acceptance Limit Signal, %
	in.	mm	
A	1/16	1.6	100

13.4 Charpy V-notch test frequency shall be one set of specimens for each 100 joint test lot, except for skelp end welds, which shall be tested one for each 100 pipe containing such end welds.

**14. Test Methods**

14.1 The test specimens and the tests required by this specification shall conform to those described in Test Methods and Definitions A 370.

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

15.1 The dimensions and weights [masses] per unit length of some of the pipe sizes included in this specification are shown in ASME B36.10M. The weight [mass] per unit length of pipe having intermediate diameter and/or wall thickness is determined using the applicable equation in 16.1.

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

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

inch-pound units:

$$W = t(D-t) \times 10.69 \tag{6}$$

SI units:

$$W = t(D-t) \times 0.024\ 66 \tag{7}$$

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

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

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

16.3 *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 3.

16.4 *Diameter*—For pipe sizes larger than NPS 48, the diameter tolerances shall be subject to agreement between the manufacturer and the purchaser. The diameter tolerance within 4 in. [100 mm] of each pipe end shall be –1/32 , + 3/32 in. [–1, +3 mm].

**17. End Finish**

17.1 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. [1.6 mm] ± 1/32 in. [0.8 mm], or special plain end, as specified in the purchase order.

**18. Workmanship, Finish and Appearance**

18.1 The weld bead shall not extend above the prolongation of the original surface of the pipe by more than 1/8 in. [3.2 mm]

**TABLE 3 Permissible Variations on Lengths**

Nominal Length		Minimum Length		Minimum Avg 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]

for pipe specified wall thickness 0.500 in. [12.7 mm] and smaller, or more than  $\frac{3}{16}$  in. [4.8 mm] for specified wall thicknesses greater than 0.500 in. [12.7 mm]. The weld surface shall not be below a prolongation of the original surface.

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

18.2.1 The defect shall be removed by grinding, provided that the remaining wall thickness is within specified limits.

18.2.2 When imperfections or defects are removed by grinding, a smooth curved surface shall be maintained, and the wall thickness shall not be decreased below that permitted by this specification. The outside diameter at the point of grinding may be reduced by the amount so removed.

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

18.2.4 The length shall be rejected.

18.3 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.

18.4 Pipe body repairs by welding are not permitted.

18.5 Repairs of the weld are permissible in accordance with Specification A 530/A 530M except that the repair depth shall not exceed 70 % of the specified wall thickness of the pipe and back-to-back repairs are not permitted. No repair of repair weld is permitted.

18.6 Pipe shall be randomly checked for straightness. Deviation from a straight line shall not exceed 0.2 % of the length.

18.7 The pipe shall contain no dents greater than  $\frac{1}{4}$  in. [6.4 mm], 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  $\frac{1}{8}$  in. [3.2 mm] shall be free of sharp-bottom gouges. The gouges may be removed by grinding, provided that the remaining wall thickness is within specified limits. The length of the dent in any direction shall not exceed one half the pipe diameter.

## 19. Jointers

19.1 Jointers may be furnished, subject to agreement between manufacturer and purchaser as to minimum length of each piece and total number of jointers. Circumferential jointer welds shall be made using a procedure qualified in accordance with the requirements of API 1104 or ASME Boiler and Pressure Vessel Code, Section IX and inspected by radiographic or ultrasonic procedures or a combination of both.

## 20. Certification

20.1 A certified test report shall be furnished.

## 21. Product Marking

21.1 Each length of pipe shall be legibly marked by stenciling to show: specification number, the name or brand of the manufacturer, the specified outside diameter, the specified wall thickness, the grade, the heat number, and the length. The length shall be marked in feet and tenths of a foot, or metres to two decimal places, as applicable.

21.2 In addition to the requirements of 21.1, bar coding is acceptable as a supplementary identification method. The purchaser may specify in the order a specific bar coding system to be used.

## 22. Keywords

22.1 black steel pipe; double submerged-arc welded; line pipe

**SUPPLEMENTARY REQUIREMENTS**

The following supplementary requirement 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, the test frequency, and the criteria for acceptance shall be as specified in the purchase order.

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