Standard Specification for
Steel Line Pipe, Black, Plain End, Longitudinal and Helical
Seam, Double Submerged-Arc Welded

This standard is issued under the fixed designation A1005/A1005M; 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 (e) indicates an editorial change since the last revision or reapproval.

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 require-
ments 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 limita-
tions prior to use.

2. Referenced Documents

2.1 ASTM Standards:
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 Chemi-
cal Analysis of Steel Products
A941 Terminology Relating to Steel, Stainless Steel, Related
Alloys, and Ferroalloys

2.2 ASME Standards:
ASME B36.10 Welded and Seamless Wrought Steel Pipe
ASME Boiler and Pressure Vessel Code, Section VIII,
Unfired Pressure Vessels
ASME Boiler and Pressure Vessel Code, Section IX, Weld-
ing and Brazing Qualifications

2.3 API Publications:
API RP 5L3 Recommended Practice for Conducting Drop-
Weight Tear Tests on Line Pipe
API Standard 1104 Welding of Pipelines and Related Facili-
ties

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 circum-
ferentially 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 ASME B36.10 or that stated on the order.

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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 A941.

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 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 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:

\[
CE = C + \frac{F Mn}{6} + \frac{Si}{24} + \frac{Cu}{15} + \frac{Ni}{20} + \frac{Cr+Mo+V+Cb}{5}
\]

where: \(F\) is a compliance factor that is dependent on the carbon content as follows:

<table>
<thead>
<tr>
<th>Carbon Content, %</th>
<th>(F)</th>
<th>Carbon Content, %</th>
<th>(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&lt;0.06)</td>
<td>0.53</td>
<td>(0.11)</td>
<td>0.70</td>
</tr>
<tr>
<td>0.06</td>
<td>0.54</td>
<td>0.12</td>
<td>0.75</td>
</tr>
<tr>
<td>0.07</td>
<td>0.56</td>
<td>0.13</td>
<td>0.80</td>
</tr>
<tr>
<td>0.08</td>
<td>0.58</td>
<td>0.14</td>
<td>0.85</td>
</tr>
<tr>
<td>0.09</td>
<td>0.62</td>
<td>0.15</td>
<td>0.88</td>
</tr>
<tr>
<td>0.10</td>
<td>0.66</td>
<td>0.16</td>
<td>0.92</td>
</tr>
</tbody>
</table>

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 A751, 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,

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Table 1: Tensile Requirements

<table>
<thead>
<tr>
<th>Grade</th>
<th>Yield Strength, min psi</th>
<th>Yield Strength, max psi</th>
<th>Tensile Strength, min psi</th>
<th>Tensile Strength, max psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>350000 [240]</td>
<td>65 000 [450]</td>
<td>60 000 [415]</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>500000 [345]</td>
<td>77 000 [530]</td>
<td>70 000 [485]</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>600000 [415]</td>
<td>80 000 [550]</td>
<td>75 000 [515]</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>700000 [485]</td>
<td>87 000 [600]</td>
<td>80 000 [550]</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>800000 [550]</td>
<td>97 000 [670]</td>
<td>90 000 [620]</td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\) Yield strength requirements do not apply to transverse weld tests.
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 A370. All pipe body tests shall be transverse to the pipe axis, taken approximately 90° 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:

<table>
<thead>
<tr>
<th>Specified Wall Thickness, in. [mm]</th>
<th>Specimen Size To Be Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0.434 [11.0]</td>
<td>Full</td>
</tr>
<tr>
<td>0.304–0.433 [7.7–10.9]</td>
<td>½</td>
</tr>
<tr>
<td>0.237–0.303 [6.0–7.6]</td>
<td>½</td>
</tr>
</tbody>
</table>

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

For 2/3 size: \( N = R \times 0.67 \)  

For 1/2 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°F [0°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 and Definitions A370. 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 ¼ in. [3 mm] and deeper than 12.5% of the specified wall thickness, except that cracks that occur at the edges of the specimen and are less than ¼ 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 hydraulically 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:**

\[ P = 2 \frac{St}{D} \times C \]  

**SI Units:**

\[ P = \frac{2000 \frac{St}{D} \times C}{D} \]

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,
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:

<table>
<thead>
<tr>
<th>Notch Type</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel Sided Notch (A)</td>
<td>0.012 ± 0.002 in.</td>
</tr>
<tr>
<td>Drilled Hole</td>
<td>0.04 in. [1 mm] max</td>
</tr>
<tr>
<td>Lengt: 2 in. [50 mm] min at full depth</td>
<td></td>
</tr>
</tbody>
</table>


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.

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 A370.

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 B36.10. The weight [mass] per unit length of pipe having intermediate diameter or wall thickness, or both, 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 B36.10 shall be determined using the following equation:

inch-pound units:

\[ W = t \left( D - t \right) \times 10.69 \]  \hspace{1cm} (6)

SI units:

\[ W = t \left( D - t \right) \times 0.02466 \]  \hspace{1cm} (7)

where:

\[ W = \text{weight [mass] per unit length, lb/ft [kg/m]}, \]
\[ D = \text{specified outside diameter, in. [mm]}, \]
\[ t = \text{specified wall thickness, in. [mm].} \]

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.

### Table 2 Acceptance Limits

<table>
<thead>
<tr>
<th>Top of Notch</th>
<th>Size of Hole</th>
<th>Acceptance Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1/16 in. [1.6 mm]</td>
<td>100</td>
</tr>
</tbody>
</table>

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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 $\pm \frac{1}{32}, +\frac{3}{32}$ 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 $\frac{1}{16}$ in. [1.6 mm] or $\frac{6}{32}$ 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 $\frac{1}{8}$ in. [3.2 mm] 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 A530/A530M 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 Standard 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 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.