



Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service¹

This standard is issued under the fixed designation A 106; 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.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This specification² covers seamless carbon steel pipe for high-temperature service (Note 1) in NPS ½ to NPS 48 inclusive, with nominal (average) wall thickness as given in ANSI B 36.10. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification. Pipe ordered under this specification shall be suitable for bending, flanging, and similar forming operations, and for welding. When the steel is to be welded, it is presupposed that a welding procedure suitable to the grade of steel and intended use or service will be utilized (Note 2).

NOTE 1—Consideration should be given to possible graphitization of the material at the higher temperatures at which it may be used.

NOTE 2—Grade A rather than Grade B or Grade C pipe should be used for close coiling, or cold bending. The purpose for which the pipe is to be used should be stated in the order. This note is not intended to prohibit the cold bending of Grade B seamless pipe.

1.2 Supplementary requirements (S1 to S7) of an optional nature are provided for seamless pipe intended for use in applications where a superior grade of pipe is required. These supplementary requirements call for additional tests to be made and when desired shall be so stated in the order.

1.3 When these products are to be used in applications conforming to ISO Recommendations for Boiler Construction, the requirements of Specification A 520 (Mechanical Property Requirements Section) shall supplement and supersede the requirements of this specification.

1.4 The values stated in inch-pound units are to be regarded as the standard.

NOTE 3—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as “nominal diameter”, “size”, and “nominal size”.

1.5 The following precautionary caveat pertains only to the test method portion, Sections 11, 12, 13, 14, and 15, 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 520 Specification for Supplementary Requirements for Seamless and Electric-Resistance-Welded Carbon Steel Tubular Products for High-Temperature Service Conforming to ISO Recommendations for Boiler Construction³
- A 530/A530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe³
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance With Specifications⁴
- E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing⁵
- E 309 Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation⁵
- E 381 Method of Macroetch Testing, Inspection, and Rating Steel Products, Comprising Bars, Billets, Blooms, and Forgings⁶
- E 570 Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products⁵

2.2 ANSI Standard:

- ANSI B 36.10 Welded and Seamless Wrought Steel Pipe³

2.3 Military Standards:

- MIL-STD-129 Marking for Shipment and Storage⁷
- MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage⁷

2.4 Federal Standard:

- Fed. Std. No. 123 Marking for Shipments (Civil Agencies)⁷
- Fed. Std. No. 183 Continuous Identification Marking of Iron and Steel Products⁷

2.5 Other Standards:

- SSPC-SP 6 Surface Preparation Specification No. 6⁸

³ Annual Book of ASTM Standards, Vol 01.01.

⁴ Annual Book of ASTM Standards, Vol 14.02.

⁵ Annual Book of ASTM Standards, Vol 03.03.

⁶ Annual Book of ASTM Standards, Vol 03.01.

⁷ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁸ Available from Steel Structures Painting Council, 4400 5th Ave., Pittsburgh, PA 15213-2683.

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² For ASME Boiler and Pressure Vessel Code applications see related Specifications SA-106 in Section II of that Code.

3. Ordering Information

3.1 Orders for materials under this specification should include the following, as required, to describe the desired material adequately:

- 3.1.1 Quantity (feet or number of lengths),
- 3.1.2 Name of material (seamless carbon steel pipe),
- 3.1.3 Grade (Table 1),
- 3.1.4 Manufacture (hot-finished or cold-drawn),
- 3.1.5 Size (either NPS and weight class or schedule number, or both, or outside diameter and nominal wall thickness, ANSI B 36.10),
- 3.1.6 Length (specific or random, Section 20),
- 3.1.7 Optional requirements (Section 9 and S1 to S4),
- 3.1.8 Test report required (Section on Certification of Specification A 530/A 530M),
- 3.1.9 Specification designation,
- 3.1.10 End use of material,
- 3.1.11 Hydrostatic test in accordance with Specification A 530/A 530M or 13.3 of this specification, or NDE in accordance with Section 14 of this specification.
- 3.1.12 Special requirements.

4. Process

4.1 The steel shall be killed steel made by one or more of the following processes: open-hearth, basic-oxygen, or electric-furnace. The primary melting may incorporate separate degassing or refining, and may be followed by secondary melting, using electroslag remelting or vacuum-arc remelting. If secondary melting is employed, the heat shall be defined as all of the ingots remelted from a single primary heat.

4.2 Steel may be cast in ingots or may be strand cast. When steels of different grades are sequentially strand cast, identification of the resultant transition material is required. The producer shall remove the transition material by any established procedure that positively separates the grades.

4.3 Pipe NPS 1½ and under may be either hot finished or cold drawn.

4.4 Unless otherwise specified, pipe NPS 2 and over shall be furnished hot finished. When agreed upon between the manufacturer and the purchaser, cold-drawn pipe may be furnished.

5. Heat Treatment

5.1 Hot-finished pipe need not be heat treated. Cold-drawn pipe shall be heat treated after the final cold draw pass at a temperature of 1200°F (650°C) or higher.

6. General Requirements

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

7. Chemical Composition

7.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 1.

8. Heat Analysis

8.1 An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the elements specified in Section 7. If the secondary melting processes of 5.1 are employed, the heat analysis shall be obtained from one remelted ingot or the product of one remelted ingot of each primary melt. The chemical composition thus determined, or that determined from a product analysis made by the manufacturer, if the latter has not manufactured the steel, shall be reported to the purchaser or the purchaser's representative, and shall conform to the requirements specified in Section 7.

9. Product Analysis

9.1 At the request of the purchaser, analyses of two pipes from each lot (Note 4) of 400 lengths or fraction thereof, of each size up to, but not including, NPS 6, and from each lot of 200 lengths or fraction thereof of each size NPS 6 and over, shall be made by the manufacturer from the finished pipe. The results of these analyses shall be reported to the purchaser or the purchaser's representative and shall conform to the requirements specified in Section 7.

9.2 If the analysis of one of the tests specified in 9.1 does not conform to the requirements specified in Section 7, analyses shall be made on additional pipes of double the original number from the same lot, each of which shall conform to requirements specified.

NOTE 4—A lot shall consist of the number of lengths specified in Sections 9 and 20 of the same size and wall thickness from any one heat of steel.

10. Tensile Requirements

10.1 The material shall conform to the requirements as to tensile properties prescribed in Tables 2 and 3.

11. Bending Requirements

11.1 For pipe NPS 2 and under a sufficient length of pipe shall stand being bent cold through 90° around a cylindrical mandrel, the diameter of which is twelve times the outside diameter (as shown in ANSI B 36.10) of the pipe, without developing cracks. When ordered for close coiling (Note 2), the pipe shall stand being bent cold through 180° around a cylindrical mandrel, the diameter of which is eight times the outside diameter (as shown in ANSI B 36.10) of the pipe, without failure.

TABLE 1 Chemical Requirements

	Composition, %		
	Grade A	Grade B	Grade C
Carbon, max ^A	0.25	0.30	0.35
Manganese	0.27–0.93	0.29–1.06	0.29–1.06
Phosphorus, max	0.035	0.035	0.035
Sulfur, max	0.035	0.035	0.035
Silicon, min	0.10	0.10	0.10
Chrome, max ^B	0.40	0.40	0.40
Copper, max ^B	0.40	0.40	0.40
Molybdenum, max ^B	0.15	0.15	0.15
Nickel, max ^B	0.40	0.40	0.40
Vanadium, max ^B	0.08	0.08	0.08

^AFor each reduction of 0.01 % below the specified carbon maximum, an increase of 0.06 % manganese above the specified maximum will be permitted up to a maximum of 1.35 %.

^BThese five elements combined shall not exceed 1 %.

TABLE 2 Tensile Requirements

	Grade A (Explanatory Note 2)		Grade B		Grade C	
Tensile strength, min, psi (MPa)	48 000 (330)		60 000 (415)		70 000 (485)	
Yield strength, min, psi (MPa)	30 000 (205)		35 000 (240)		40 000 (275)	
	Longitu- dinal	Transverse	Longitu- dinal	Transverse	Longitu- dinal	Transverse
Elongation in 2 in. or 50 mm, min, %:						
Basic minimum elongation transverse strip tests, and for all small sizes tested in full section	35	25	30	16.5	30	16.5
When standard round 2-in. or 50-mm gage length test specimen is used	28	20	22	12	20	12
For longitudinal strip tests	A,B		A,B		A,B	
For transverse strip tests, a deduction for each 1/32-in. (0.8-mm) decrease in wall thickness below 5/16 in. (7.9 mm) from the basic minimum elongation of the following percentage shall be made		1.25 ^C		1.00 ^C		1.00 ^C

^AThe minimum elongation in 2 in. (50.8 mm) shall be determined by the following equation:

$$e = 625\,000A^{0.2} / U^{0.9}$$

where

e = minimum elongation in 2 in. (50.8 mm), %, rounded to the nearest 0.5%

A = cross-sectional area of the tension test specimen, in.², based on specified outside diameter or nominal specimen width and specified wall thickness rounded to the nearest 0.01 in.² (if the area thus calculated is greater than the value 0.75 in.² shall be used), and

U = specified tensile strength, psi.

^BSee Table 3 for minimum elongation values for various size tension specimens and grades.

^CThe following table gives the computed minimum values:

Wall Thickness		Elongation in 2 in. or 50 mm, min, %	
in.	mm	Grade A, Transverse	Grades B and C, Transverse
5/16 (0.312)	7.9	25.00	16.50
3/32 (0.281)	7.1	23.75	15.50
1/4 (0.250)	6.4	22.50	14.50
7/32 (0.219)	5.6	...	...
3/16 (0.188)	4.8	...	...
5/32 (0.156)	4.0	...	...
1/8 (0.125)	3.2	...	...
3/32 (0.094)	2.4	...	...
1/16 (0.062)	1.6	...	...

Note — The above table gives the computed minimum elongation values for each 1/32-in. (0.8-mm) decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value is determined by the following equation:

Grade	Direction of Test	Equation
A	Transverse	$E = 40t + 12.50$
B and C	Transverse	$E = 32t + 6.50$

where:

E = elongation in 2 in. or 50 mm, %, and

t = actual thickness of specimen, in.

TABLE 3 Elongation Values

Area, in. ^{2A}	Tension Test Specimen Wall Thickness, in. ^B				Elongation in 2 in. min., Specified Tensile Strength, psi		
					Grade A	Grade B	Grade C
	1/2 in. Specimen	3/4 in. Specimen	1 in. Specimen	1 1/2 in. Specimen	48 000	60 000	70 000
≥ 0.75	≥ 1.491	≥ 0.994	≥ 0.746	≥ 0.497	36.0	29.5	25.5
0.74	1.470–1.490	0.980–0.993	0.735–0.745	0.490–0.496	36.0	29.5	25.5
0.73	1.451–1.469	0.967–0.979	0.726–0.734	0.484–0.489	36.0	29.5	25.5
0.72	1.430–1.450	0.954–0.966	0.715–0.725	0.477–0.483	36.0	29.5	25.5
0.71	1.411–1.429	0.941–0.953	0.706–0.714	0.471–0.476	35.5	29.0	25.5
0.70	1.390–1.410	0.927–0.940	0.695–0.705	0.464–0.470	35.5	29.0	25.5
0.69	1.371–1.389	0.914–0.926	0.686–0.694	0.457–0.463	35.5	29.0	25.5
0.68	1.350–1.370	0.900–0.913	0.675–0.685	0.450–0.456	35.5	29.0	25.0
0.67	1.331–1.349	0.887–0.899	0.666–0.674	0.444–0.449	35.5	29.0	25.0
0.66	1.310–1.330	0.874–0.886	0.655–0.665	0.437–0.443	35.0	29.0	25.0
0.65	1.291–1.309	0.861–0.873	0.646–0.654	0.431–0.436	35.0	28.5	25.0
0.64	1.270–1.290	0.847–0.860	0.635–0.645	0.424–0.430	35.0	28.5	25.0
0.63	1.251–1.269	0.834–0.846	0.626–0.634	0.417–0.423	35.0	28.5	25.0
0.62	1.230–1.250	0.820–0.833	0.615–0.625	0.410–0.416	35.0	28.5	25.0

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TABLE 3 Continued

Area, in. ² _A	Tension Test Specimen Wall Thickness, in. ^B				Elongation in 2 in., min., Specified Tensile Strength, psi		
	1/2 in. Specimen	3/4 in. Specimen	1 in. Specimen	1 1/2 in. Specimen	Grade A	Grade B	Grade C
0.61	1.211-1.229	0.807-0.819	0.606-0.614	0.404-0.409	34.5	28.5	23.5
0.60	1.190-1.210	0.794-0.806	0.595-0.605	0.397-0.403	34.5	28.5	24.5
0.59	1.171-1.189	0.781-0.793	0.586-0.594	0.391-0.396	34.5	28.0	24.5
0.58	1.150-1.170	0.767-0.780	0.575-0.585	0.384-0.390	34.5	28.0	24.5
0.57	1.131-1.149	0.754-0.766	0.566-0.574	0.377-0.383	34.0	28.0	24.5
0.56	1.110-1.130	0.740-0.753	0.555-0.565	0.370-0.376	34.0	28.0	24.5
0.55	1.091-1.109	0.727-0.739	0.546-0.554	0.364-0.369	34.0	28.0	24.5
0.54	1.070-1.090	0.714-0.726	0.535-0.545	0.357-0.363	34.0	27.5	24.0
0.53	1.051-1.069	0.701-0.713	0.526-0.534	0.351-0.356	33.5	27.5	24.0
0.52	1.030-1.050	0.687-0.700	0.515-0.525	0.344-0.350	33.5	27.5	24.0
0.51	1.011-1.029	0.674-0.686	0.506-0.514	0.337-0.343	33.5	27.5	24.0
0.50	0.990-1.010	0.660-0.673	0.495-0.505	0.330-0.336	33.5	27.0	23.5
0.49	0.971-0.989	0.647-0.659	0.486-0.494	0.324-0.329	33.0	27.0	23.5
0.48	0.950-0.970	0.634-0.646	0.475-0.485	0.317-0.323	33.0	27.0	23.5
0.47	0.931-0.949	0.621-0.633	0.466-0.474	0.311-0.316	33.0	27.0	23.5
0.46	0.910-0.930	0.607-0.620	0.455-0.465	0.304-0.310	33.0	27.0	23.5
0.45	0.891-0.909	0.594-0.606	0.446-0.454	0.297-0.303	32.5	26.5	23.0
0.44	0.870-0.890	0.580-0.593	0.435-0.445	0.290-0.296	32.5	26.5	23.0
0.43	0.851-0.869	0.567-0.579	0.426-0.434	0.284-0.289	32.5	26.5	23.0
0.42	0.830-0.850	0.554-0.566	0.415-0.425	0.277-0.283	32.0	26.0	23.0
0.41	0.811-0.829	0.541-0.553	0.406-0.414	0.271-0.276	32.0	26.0	23.0
0.40	0.790-0.810	0.527-0.540	0.395-0.405	0.264-0.270	32.0	26.0	22.5
0.39	0.771-0.789	0.514-0.526	0.386-0.394	0.257-0.263	31.5	26.0	22.5
0.38	0.750-0.770	0.500-0.513	0.375-0.385	0.250-0.256	31.5	26.0	22.5
0.37	0.731-0.749	0.487-0.499	0.366-0.374	0.244-0.249	31.5	25.5	22.5
0.36	0.710-0.730	0.474-0.486	0.355-0.365	0.237-0.243	31.0	25.5	22.0
0.35	0.691-0.709	0.461-0.473	0.346-0.354	0.231-0.236	31.0	25.0	22.0
0.34	0.670-0.690	0.447-0.460	0.335-0.345	0.224-0.230	31.0	25.0	22.0
0.33	0.651-0.669	0.434-0.446	0.326-0.334	0.217-0.223	30.5	25.0	22.0
0.32	0.630-0.650	0.420-0.433	0.315-0.325	0.210-0.216	30.5	25.0	21.5
0.31	0.611-0.629	0.407-0.419	0.306-0.314	0.204-0.209	30.5	25.0	21.5
0.30	0.590-0.610	0.394-0.406	0.295-0.305	0.197-0.203	30.0	25.0	21.5
0.29	0.571-0.589	0.381-0.393	0.286-0.294	0.191-0.196	30.0	24.5	21.5
0.28	0.550-0.570	0.367-0.380	0.275-0.285	0.184-0.190	29.5	24.5	21.0
0.27	0.531-0.549	0.354-0.366	0.266-0.274	0.177-0.183	29.5	24.0	21.0
0.26	0.510-0.530	0.340-0.353	0.255-0.265	0.170-0.176	29.0	24.0	21.0
0.25	0.491-0.509	0.327-0.339	0.246-0.254	0.164-0.169	29.0	23.5	20.5
0.24	0.470-0.489	0.314-0.326	0.235-0.245	0.157-0.163	28.5	23.5	20.5
0.23	0.451-0.469	0.301-0.313	0.226-0.234	0.151-0.156	28.5	23.0	20.5
0.22	0.430-0.450	0.287-0.300	0.215-0.225	0.144-0.150	28.5	23.0	20.0
0.21	0.411-0.429	0.274-0.286	0.206-0.214	0.137-0.143	28.0	23.0	20.0
0.20	0.390-0.410	0.260-0.273	0.195-0.205	0.130-0.136	27.5	22.5	19.5
0.19	0.371-0.389	0.247-0.259	0.186-0.194	0.124-0.129	27.5	22.5	19.5
0.18	0.350-0.370	0.234-0.246	0.175-0.185	0.117-0.123	27.0	22.0	19.5
0.17	0.331-0.349	0.221-0.233	0.166-0.174	0.111-0.116	27.0	22.0	19.0
0.16	0.310-0.330	0.207-0.220	0.155-0.165	0.104-0.110	26.5	21.5	19.0
0.15	0.291-0.309	0.194-0.206	0.146-0.154	0.097-0.103	26.0	21.5	18.5
0.14	0.270-0.290	0.180-0.193	0.135-0.145	0.091-0.096	26.0	21.0	18.5
0.13	0.251-0.269	0.167-0.179	0.126-0.134	0.084-0.090	25.5	21.0	18.0
0.12	0.230-0.250	0.154-0.166	0.115-0.125	0.077-0.083	25.0	20.5	18.0
0.11	0.211-0.229	0.141-0.153	0.106-0.114	0.071-0.076	24.5	20.0	17.5
0.10	0.190-0.210	0.127-0.140	0.095-0.105	0.064-0.070	24.0	19.5	17.0
0.09	0.171-0.189	0.114-0.126	0.086-0.094	0.057-0.063	23.5	19.5	17.0
0.08	0.150-0.170	0.100-0.113	0.075-0.085	0.050-0.056	23.0	19.0	16.5
0.07	0.131-0.149	0.087-0.099	0.066-0.074	0.044-0.049	22.5	18.5	16.0
0.06	0.110-0.130	0.074-0.086	0.055-0.065	0.037-0.043	22.0	18.0	15.5
0.05	0.091-0.109	0.061-0.073	0.046-0.054	0.031-0.036	21.0	17.0	15.0
0.04	0.070-0.090	0.047-0.060	0.035-0.045	0.024-0.030	20.0	16.5	14.5
0.03	0.051-0.069	0.034-0.046	0.026-0.034	0.017-0.023	19.0	15.5	13.5
0.02	0.030-0.050	0.020-0.033	0.015-0.025	0.010-0.016	17.5	14.5	12.5
≤ 0.01	≤ 0.029	≤ 0.019	≤ 0.014	≤ 0.009	15.0	12.5	11.0

^A 1 in.² = 645.16 mm².

^B 1 in. = 25.4 mm.

11.2 For pipe whose diameter equals or exceeds 10 in. (254 mm) a bend test may be conducted instead of the flattening test. The bend test specimens shall be bent at room temperature

through 180° without cracking on the outside of the bent portion. The inside diameter of the bend shall be 1 in. (25.4 mm). Substitution of the bend test for the flattening test shall be