



Designation: A 451/A 451M – 02

Standard Specification for Centrifugally Cast Austenitic Steel Pipe for High- Temperature Service¹

This standard is issued under the fixed designation A 451/A 451M; 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 specification² covers austenitic alloy steel pipe for use in high-temperature, corrosive, or nuclear pressure service.

1.2 Several grades of austenitic stainless steel are covered as indicated in Table 1.

1.3 Optional supplementary requirements are provided when additional testing may be required.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exactly equivalents; therefore, each system must be used independently of each other. Combining values from the two systems may result in nonconformance with the specification.

NOTE 1—This specification is not intended to cover centrifugal pipe made from alloys containing more than 0.20 % carbon, such as are covered by Specification A 297.

2. Referenced Documents

2.1 ASTM Standards:

A 297 Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application³

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products⁴

A 530/A530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe⁵

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance With Specifications⁶

E 94 Guide for Radiographic Examination⁷

E 165 Test Method for Liquid Penetrant Examination⁷

E 186 Reference Radiographs for Heavy-Walled (2 to 4½-in. [51 to 114-mm]) Steel Castings⁷

E 280 Reference Radiographs for Heavy-Walled (4½ to 12-in. [114 to 305-mm]) Steel Castings⁷

E 446 Reference Radiographs for Steel Castings up to 2 in. [51 mm] in Thickness⁷

2.2 ANSI Standard:

B46.1 Surface Texture⁸

3. Ordering Information

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

3.1.1 Quantity (feet, metres, or number of lengths),

3.1.2 Name of material (centrifugally cast pipe),

3.1.3 Grade (Table 1),

3.1.4 Size (outside or inside diameter and minimum wall thickness in inches or millimetres),

3.1.5 Length (specific or random, Specification A 530/A 530M),

3.1.6 End Finish of Specification A 530/A 530M,

3.1.7 Optional Requirements (9.4 and Supplementary Requirements S1 through S7),

3.1.8 Test Report Required (Section 14), and

3.1.9 Special Requirements or Additions to Specification.

4. Materials and Manufacture

4.1 *Heat-Treatment*—The pipe shall receive a heat-treatment at the temperature and time specified in Table 2, followed by a quench in water or rapid cool by other means.

4.2 *Machining*—The pipe shall be machined on the inner and outer surfaces to a roughness value no greater than 250-µin. [6.35-µm] arithmetical average deviation (AA) from the mean line, as defined in American National Standard B46.1.

5. Chemical Analysis

5.1 *Heat Analysis*—An analysis of each heat shall be made by the manufacturer to determine the percentages of elements specified in Table 1. The analysis shall be made on a test

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 A01.18 on Castings.

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² For ASME Boiler and Pressure Vessel Code applications see related specification SA-451 in Section II of that Code.

³ *Annual Book of ASTM Standards*, Vol 01.02.

⁴ *Annual Book of ASTM Standards*, Vol 01.03.

⁵ *Annual Book of ASTM Standards*, Vol 01.01.

⁶ *Annual Book of ASTM Standards*, Vol 14.02.

⁷ *Annual Book of ASTM Standards*, Vol 03.03.

⁸ Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

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

TABLE 1 Chemical Requirements

Grade	Composition, %										
	Carbon, max	Manganese, max	Phosphorus, max	Sulfur, max	Silicon, max	Nickel	Chromium	Molybdenum	Columbium	Tantalum, max	Nitrogen
CPF3	0.03	1.50	0.040	0.040	2.00	8.0–12.0	17.0–21.0	...	...	...	...
CPF3A	0.03	1.50	0.040	0.040	2.00	8.0–12.0	17.0–21.0	...	...	...	...
CPF8	0.08	1.50	0.040	0.040	2.00	8.0–11.0	18.0–21.0	...	...	...	...
CPF8A	0.08	1.50	0.040	0.040	2.00	8.0–11.0	18.0–21.0	...	...	...	...
CPF3M	0.03	1.50	0.040	0.040	1.50	9.0–13.0	17.0–21.0	2.0–3.0	...	...	...
CPF8M	0.08	1.50	0.040	0.040	1.50	9.0–12.0	18.0–21.0	2.0–3.0	...	...	...
CPF10MC ^A	0.10	1.50	0.040	0.040	1.50	13.0–16.0	15.0–18.0	1.75–2.25	1.2 max, 10 × C min	...	...
CPF8C ^A	0.08	1.50	0.040	0.040	2.00	9.0–12.0	18.0–21.0	...	1 max, 8 × C min	...	...
CPF8C(Ta max) ^B	0.08	1.50	0.040	0.040	2.00	9.0–12.0	18.0–21.0	...	1 max, 8 × C min	0.10	...
CPH8	0.08	1.50	0.040	0.040	1.50	12.0–15.0	22.0–26.0	...	...	...	...
CPH20 or CPH10	0.20 ^C	1.50	0.040	0.040	2.00	12.0–15.0	22.0–26.0	...	...	...	...
CPK20	0.20	1.50	0.040	0.040	1.75	19.0–22.0	23.0–27.0	...	...	...	...
CPE20N	0.20	1.50	0.040	0.040	1.50	8.0–11.0	23.0–26.0	...	...	...	0.08–0.20

^A Grades CPF10MC and CPF8C may have a columbium plus tantalum content maximum of 1.35 %.

^B No designation as yet assigned by ASTM International or Steel Founders' Society of America.

^C By agreement between the manufacturer and the purchaser, the carbon content of Grade CPH20 may be restricted to 0.10 % max. When so agreed, the grade designation shall be CPH10.

TABLE 2 Heat-Treatment Requirements

Grade	Temperature, min		Hold Time, h/in. of Thickness
	°F	°C	
CPF3, CPF3A, CPF8, CPF8A, CPF3M, CPF8M	1900	1040	1
CPF10MC, CPF8C, CPF8C (Ta max)	1950	1065	2
CPH8, CPH10, CPH20, CPK20	2100	1150	1
CPE20N	2225	1220	1

TABLE 3 Tensile Requirements

Grade	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa]	Elongation in 2 in. or 50 mm, min
CPF3	70 [485]	30 [205]	35
CPF3A ^A	77 [535]	35 [240]	35
CPF3M	70 [485]	30 [205]	30
CPF8	70 [485]	30 [205]	35
CPF8A ^A	77 [535]	35 [240]	35
CPF8M	70 [485]	30 [205]	30
CPF10MC	70 [485]	30 [205]	20
CPH10	70 [485]	30 [205]	30
CPF8C (Ta max), CPF8C	70 [485]	30 [205]	30
CPH8	65 [448]	28 [195]	30
CPK20	65 [448]	28 [195]	30
CPH20	70 [485]	30 [205]	30
CPE20N	80 [550]	40 [275]	30

^A The properties shown are obtained by adjusting the composition within the limits shown in Table 1 to obtain a ferrite-austenite ratio that will result in the higher ultimate and yield strengths indicated. A lowering of impact values may develop in these materials when exposed to service temperature above 800°F [425°C].

sample taken preferably during the pouring of the heat. The chemical composition thus determined shall conform to the requirements specified in Table 1.

5.2 *Product Analysis*—A product analysis may be made by the purchaser. The sample for analysis shall be selected so as to be thoroughly representative of the pipe being analyzed. The chemical composition thus determined shall conform to the requirements specified in Table 1.

5.3 To determine conformance with the chemical analysis requirements, an observed value or calculated value shall be rounded in accordance with Practice E 29 to the nearest unit in the last right-hand place of values listed in Table 1.

6. Tensile Requirements

6.1 Test Specimens:

6.1.1 Test specimens shall be prepared in accordance with Test Methods and Definitions A 370. Test bars shall be poured in special blocks from the same heat as the castings represented. Test bars shall be supplied in sufficient number to furnish all specimens required in 6.2 and 6.3 (see Table 3).

6.1.2 Test specimens may be cut from heat-treated castings instead of from test bars when agreed upon between the manufacturer and the purchaser.

6.1.3 Tension test specimens shall be machined to the form and dimensions of the standard round 2-in. [50-mm] gage length specimens shown in Fig. 6 of Test Methods and Definitions A 370.

6.2 Number of Tests:

6.2.1 One tension test shall be made from each heat. The bar from which the test specimen is taken shall be heat-treated in the same manner as the castings represented.

6.2.2 If a specimen is machined improperly or flaws are revealed by machining or during testing, the specimen may be discarded and another substituted from the same heat.

6.3 *Retests*—If the results of the mechanical tests for any heat do not conform to the requirements specified, the castings may be reheat-treated and retested, but may not be solution-treated more than twice.

7. Hydrostatic Test

7.1 Each length of pipe shall be hydrostatically tested in accordance with Specification A 530/A 530M.

7.2 It is realized that the foundry may be unable to perform the hydrostatic test prior to shipment, or that the purchaser may wish to defer testing until additional work has been performed on the casting. In such cases, the foundry is responsible for the satisfactory performance of the casting when it is tested.