



Designation: A451/A451M – 14

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

This standard is issued under the fixed designation A451/A451M; 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 SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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 [A297/A297M](#).

1.4.1 Within the text, the SI units are shown in brackets.

2. Referenced Documents

2.1 *ASTM Standards*:³

[A297/A297M Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application](#)

[A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe](#)

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E94 Guide for Radiographic Examination](#)

[E165 Practice for Liquid Penetrant Examination for General Industry](#)

[E186 Reference Radiographs for Heavy-Walled \(2 to 4½-in. \(50.8 to 114-mm\)\) Steel Castings](#)

[E280 Reference Radiographs for Heavy-Walled \(4½ to 12-in. \(114 to 305-mm\)\) Steel Castings](#)

[E446 Reference Radiographs for Steel Castings Up to 2 in. \(50.8 mm\) in Thickness](#)

2.2 *ANSI Standard*:

[B46.1 Surface Texture](#)⁴

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, meters, 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 millimeters),

3.1.5 Length (specific or random, Specification [A999/A999M](#)),

3.1.6 End Finish of Specification [A999/A999M](#),

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- μ in. [6.35- μ m] 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

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 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.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

TABLE 1 Chemical Requirements^A

Composition, % (max. except where range or minimum is given)											
Grade (UNS Number)	Car- bon	Man- ga- nese	Phos- pho- rus	Sul- fur	Sili- con	Nickel	Chromium	Molybde- num	Columbium	Tan- ta- lum	Nitrogen
CPF3 (J92500)	0.03	1.50	0.040	0.040	2.00	8.0–12.0	17.0–21.0	...	...	...	...
CPF3A (J92500)	0.03	1.50	0.040	0.040	2.00	8.0–12.0	17.0–21.0	...	...	...	...
CPF8 (J92600)	0.08	1.50	0.040	0.040	2.00	8.0–11.0	18.0–21.0	...	...	...	...
CPF8A (J92600)	0.08	1.50	0.040	0.040	2.00	8.0–11.0	18.0–21.0	...	...	...	...
CPF3M (J92800)	0.03	1.50	0.040	0.040	1.50	9.0–13.0	17.0–21.0	2.0–3.0	...	...	...
CPF8M (J92804)	0.08	1.50	0.040	0.040	1.50	9.0–12.0	18.0–21.0	2.0–3.0	...	...	...
CPF10MC ^B	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 ^B (J92710)	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) ^C	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 (J93400)	0.08	1.50	0.040	0.040	1.50	12.0–15.0	22.0–26.0	...	...	...	...
CPH20 or CPH10 (J93402)	0.20 ^D	1.50	0.040	0.040	2.00	12.0–15.0	22.0–26.0	...	...	...	...
CPK20 (J94202)	0.20	1.50	0.040	0.040	1.75	19.0–22.0	23.0–27.0	...	...	...	...
CPE20N (J92802)	0.20	1.50	0.040	0.040	1.50	8.0–11.0	23.0–26.0	...	...	...	0.08–0.20

^A Where ellipses (...) appear in this table there is no requirement, and the element need not be analyzed or reported.

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

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

^D 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

specified in **Table 1**. The analysis shall be made on a test 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 **E29** 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 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.

TABLE 3 Tensile Requirements

Grade	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa]	Elongation, min %, in 2 in. [50 mm]
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].