



Designation: ~~A451/A451M – 06 (Reapproved 2010)~~ 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 ~~inch-pound~~SI units or ~~SI~~inch-pound 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 may not exactly be exact equivalents; therefore, each system must shall be used independently of eachthe other. Combining values from the two systems may result in noneonformanceenon-conformance with the specification-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
- ~~[A370](#) Test Methods and Definitions for Mechanical Testing of Steel Products~~
- [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
- ~~[ASTM A451/A451M-14](#)~~
- [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 Texture⁴

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,~~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 ~~millimetres~~;millimeters),
 - 3.1.5 Length (specific or random, Specification [A999/A999M](#)),

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~~10036, <http://www.ansi.org>.

*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

TABLE 1 Chemical Requirements^A

Grade (UNS Number)	Composition, % (max. except where range or minimum is given)										
	Carbon	Manganese	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Molybdenum	Columbium	Tantalum	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.

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 m. [6.35- μ m] arithmetical average deviation (AA) from the mean line, as defined in American National Standard B46.1.



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

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 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 specimens shall be prepared in accordance with Test Methods and Definitions A370. 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 A370.

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.

TABLE 3 Tensile Requirements

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