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Standard Specification for Centrifugally Cast Iron-Chromium-Nickel High-Alloy Tubing for Pressure Application at High Temperatures¹

This standard is issued under the fixed designation A608/A608M; 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 specification covers iron-chromium-nickel, high-alloy tubes made by the centrifugal casting process intended for use under pressure at high temperatures.

1.2 The grades of high alloys detailed in [Table 1](#) are intended for applications requiring strength and resistance to corrosion and scaling at high temperatures.

1.3 Optional Supplementary Requirements S1 to S11 are provided; these call for additional tests to be made if desired.

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 exact equivalents; therefore, each system must be used independently of each other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 ASTM Standards:²

- [A342/A342M Test Methods for Permeability of Feebly Magnetic Materials](#)
- [A488/A488M Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel](#)
- [A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe](#)
- [E8 Test Methods for Tension Testing of Metallic Materials](#)
- [E21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials](#)
- [E94 Guide for Radiographic Examination](#)
- [E139 Test Methods for Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials](#)

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 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.

- [E142 Method for Controlling Quality of Radiographic Testing](#)
- [E151 Recommended Practice for Tension Tests of Metallic Materials at Elevated Temperatures with Rapid Heating and Conventional or Rapid Strain Rates](#)
- [E165 Practice for Liquid Penetrant Examination for General Industry](#)
- [E340 Test Method for Macroetching Metals and Alloys](#)

3. Ordering Information

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

- 3.1.1 Quantity (feet, centimetres, or number of lengths),
- 3.1.2 Name of material (centrifugally cast tubing),
- 3.1.3 Specification number and grade ([Table 1](#)),
- 3.1.4 Size (outside or inside diameter and minimum wall thickness, see [Section 8](#)),
- 3.1.5 Condition (see [Section 9](#), as cast or as cast with machining on outside or inside surfaces, or machined; see [5.1](#), [8](#), and [9](#)),
- 3.1.6 Length (specific or random), (Permissible Variations in Length Section of Specification [A999/A999M](#)),
- 3.1.7 End finish (Ends Section of Specification [A999/A999M](#)),
- 3.1.8 Optional requirements (see [8.2.3](#) regarding the manufacturer's wall thickness allowance for as cast tubing and Supplementary Requirements S1 to S11),
- 3.1.9 Test report required (see [Section 13](#)), and
- 3.1.10 Special requirements to be added to the specification.

4. General Requirements

4.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification [A999/A999M](#), unless otherwise provided herein.

5. Materials and Manufacture

5.1 The tubing may be supplied in the as cast condition or as cast with machining on the outside or inside surfaces, or machined, as agreed upon between the manufacturer and the purchaser.

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

TABLE 1 Chemical Requirements

Grade	Composition, %							
	Carbon	Manganese	Silicon	Chromium	Nickel	Phosphorus	Sulfur	Molybdenum
HC30	0.25–0.35	0.5–1.0	0.50–2.00	26–30	4.0 max	0.04 max	0.04 max	0.50 max
HD50	0.45–0.55	1.50 max	0.50–2.00	26–30	4–7	0.04 max	0.04 max	0.50 max
HE35	0.30–0.40	1.50 max	0.50–2.00	26–30	8–11	0.04 max	0.04 max	0.50 max
HF30	0.25–0.35	1.50 max	0.50–2.00	19–23	9–12	0.04 max	0.04 max	0.50 max
HH30	0.25–0.35	1.50 max	0.50–2.00	24–28	11–14	0.04 max	0.04 max	0.50 max
HH33 ^A	0.28–0.38	1.50 max	0.50–2.00	24–26	12–14	0.04 max	0.04 max	0.50 max
HI35	0.30–0.40	1.50 max	0.50–2.00	26–30	14–18	0.04 max	0.04 max	0.50 max
HK30	0.25–0.35	1.50 max	0.50–2.00	23–27	19–22	0.04 max	0.04 max	0.50 max
HK40	0.35–0.45	1.50 max	0.50–2.00	23–27	19–22	0.04 max	0.04 max	0.50 max
HL30	0.25–0.35	1.50 max	0.50–2.00	28–32	18–22	0.04 max	0.04 max	0.50 max
HL40	0.35–0.45	1.50 max	0.50–2.00	28–32	18–22	0.04 max	0.04 max	0.50 max
HN40	0.35–0.45	1.50 max	0.50–2.00	19–23	23–27	0.04 max	0.04 max	0.50 max
HT50	0.40–0.60	1.50 max	0.50–2.00	15–19	33–37	0.04 max	0.04 max	0.50 max
HU50	0.40–0.60	1.50 max	0.50–2.00	17–21	37–41	0.04 max	0.04 max	0.50 max
HW50	0.40–0.60	1.50 max	0.50–2.00	10–14	58–62	0.04 max	0.04 max	0.50 max
HX50	0.40–0.60	1.50 max	0.50–2.00	15–19	64–68	0.04 max	0.04 max	0.50 max

^A Manufacturing control should ensure that this composition contain a minimal amount of ferrite. See Supplementary Requirement S5.

5.2 Heat treatment of the tubing shall not be required under this specification.

6. Chemical Requirements

6.1 The material shall conform to the requirements as to chemical composition as prescribed in [Table 1](#).

7. Tensile Properties

7.1 Tension tests at room temperature are not recommended as acceptance criteria under this specification since the alloys are intended for elevated-temperature service, and room-temperature tests do not have a dependable relationship to elevated-temperature properties. (Where the design of the tubing is based on an assumption of certain minimum creep-rupture properties, one of the supplementary requirements of this specification may be stipulated on the order to ascertain the ability of the material to meet the design properties.)

8. Permissible Variation in Dimensions

8.1 *Machined Tubing (Tubing Machined on Inside and Outside):*

8.1.1 The tolerances given in Specification [A999/A999M](#) shall govern, except that the wall thickness shall not vary over the specified minimum wall thickness by more than 10 % or 1/16 in. [1.6 mm], whichever is greater. There shall be no variation under the specified minimum wall thickness.

8.2 *As-Cast Tubing (No Machining or Machined on Inside or Outside):*

8.2.1 *Outside Diameter (For Tubes Ordered to Outside Diameter):*

8.2.1.1 Tubes machined on the outside shall meet the requirements of Specification [A999/A999M](#).

8.2.1.2 Tubes not machined on the outside shall meet the permissible variations of [Table 2](#).

8.2.2 *Inside Diameter (For Tubes Ordered to Inside Diameter):*

8.2.2.1 Tubes machined on the inside shall meet the requirements of Specification [A999/A999M](#).

TABLE 2 Permissible Variations in As-Cast Outside Diameter

Specified Outside Diameter of Tubing		Permissible Plus or Minus Variations from Specified Outside Diameter	
in.	mm	in.	mm
From 2 to 4	50 to 100	0.08	2.0
Over 4 to 12	100 to 300	0.10	2.5
Over 12 to 24	300 to 600	0.12	3.0
Over 24 to 36	600 to 900	0.16	4.1
Over 36 to 54	900 to 1350	0.25	6.4

8.2.2.2 Tubes not machined on the inside shall have permissible variations as agreed upon by the purchaser and the manufacturer.

8.2.3 *Wall Thickness*—The wall thickness shall not exceed the calculated minimum as cast wall thickness by more than the limits shown in [Table 3](#). The calculated minimum wall thickness shall be equal to the specified minimum wall thickness plus the manufacturer’s allowance for “inside surface feed metal” and outside surface roughness. Upon request, the manufacturer’s allowance shall be furnished to the purchaser. There shall be no variation under the calculated minimum as cast wall thickness. For tubes over 24 up to and including 54 in. [600 to 1350 mm] in diameter the “permissible variations over specified minimum as cast wall thickness” shall be agreed upon by the manufacturer and the purchaser.

8.2.4 *Length*—If definite lengths are ordered, no length of tubing shall be under the length specified and not longer than the tolerance shown in [Table 4](#).

TABLE 3 Permissible Variations in As-Cast Wall Thickness

Specified Outside Diameter of Tubing		Permissible Variations over Calculated Minimum As-Cast Wall Thickness	
in.	mm	in.	mm
From 2 to 6	50 to 150	0.08	2.0
Over 6 to 12	150 to 300	0.10	2.5
Over 12 to 24	300 to 600	0.13	3.3

TABLE 4 Excess Length Tolerances for Centrifugally Cast Tubes

Outside Diameter of Tube		Permissible Excess Length	
in.	mm	in.	mm
From 2 to 12	50 to 300	1/4	6.4
Over 12 to 24	300 to 600	1/2	13
Over 24 to 54	600 to 1350	1	25

9. Finish

9.1 *Machined Tubing*—All tubes shall be reasonably straight and free of rejectable indications. All visual irregularities shall be explored for depths. When the depth encroaches on the specified minimum wall thickness, such irregularities shall be considered rejectable indications.

9.2 *As-Cast Tubing*:

9.2.1 The outside surface shall be adequately cleaned (such as by shotblasting, sandblasting, wire brushing, grinding, or machining). The metal surface so revealed shall be visually inspected and shall be free of linear discontinuities or other imperfections that encroach on the specified minimum wall of the tube.

9.2.2 Various degrees of surface roughness occur on unmachined tubing. If a specific surface finish is required, it shall be a matter of agreement between the manufacturer and the purchaser.

9.3 *Surface Irregularities Not Classified as Rejectable*—Visual surface defects that have been explored and that do not encroach on the minimum sound wall thickness shall be blended either by machining or grinding the surface into the surrounding unaffected surface area of the tubing.

9.4 *Repair by Welding*—Repair of injurious defects by welding shall be permitted and major weld repairs shall be permitted only subject to the approval of the purchaser. Weld repairs shall be considered major if the depth of the cavity prepared for welding exceeds 20 % of the required minimum wall thickness or if the total surface area exceeds 10 in.² [65 cm²]. Defects shall be completely removed before welding. If defects are linear, complete removal shall be checked by liquid penetrant inspection (Practice E165). Only qualified operators and procedures in accordance with Practice A488/A488M shall be used. All weld repairs shall be subjected to the same inspection standard as the tubing.

10. Pressure Test

10.1 All tubing shall be subjected to an internal air pressure of at least 75 psi [515 kPa] for at least 1 min either while submerged in clear water or with the entire outer surface coated with sulfur-free soap suds at the discretion of the manufacturer. In the usable portion of the tube, leaks are not permitted. If the Hydrostatic Test, Supplementary Requirement S6, is invoked, the exact details of the test and testing procedure shall be clearly defined and made a part of the Ordering Information (3.1.8).

10.2 Leaks may be repaired by welding only if such repair is approved by the purchaser.

11. Flattening Test

11.1 Flattening tests are not required since material covered by this specification is not intended to be bent, flanged, or otherwise formed.

12. Mechanical Tests Required

12.1 *Air Pressure Test*—Each length of tubing shall be subjected to the pressure test described in Section 10.

13. Certification

13.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification together with a report of the test results shall be furnished at the time of shipment.

14. Product Marking

14.1 In addition to the marking prescribed in Specification A999/A999M, the marking shall include the length, an additional symbol "S" if the tubing conforms to the supplementary requirements specified in Supplementary Requirements S1 to S11, and the heat number or manufacturer's number by which the tube can be identified, and, when as cast (see 8.2), the notation "AS CAST."

15. Keywords

15.1 alloy; centrifugal casting; high temperatures; pressure containing parts; steel tube; temperature service applications

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements may become a part of the specification when specified on the inquiry or invitation to bid, and purchase order or contract.

S1. Product Analysis

S1.1 Product analysis may be made on any length of tubing. Individual lengths failing to conform to the chemical requirements shall be rejected. For product analysis the outside surface of the tube shall be ground clean before sampling and a sample taken from this area by drilling. If drillings are taken, the drill should penetrate at least to the mid point of the tube

wall, but the inner 1/8 in. [3 mm] of the tube wall shall not be included in the sample unless the tube has been bored.

S2. Short-Time, High-Temperature Tension Test

S2.1 Short-time, high-temperature tension tests shall be made from a longitudinal or transverse section cut from the end of the tubing representing each heat or lot as agreed upon between the manufacturer and the purchaser.