



Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application¹

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This standard has been approved for use by agencies of the Department of Defense.

^{ε1} NOTE—Section S12 was corrected editorially in May 1999.

1. Scope

1.1 This specification covers iron-chromium and iron-chromium-nickel alloy castings for general corrosion-resistant application. The grades covered by this specification represent types of alloy castings suitable for broad ranges of application which are intended for a wide variety of corrosion environments.

NOTE 1—For alloy castings for severe corrosion-resistant service, reference should be made to Specification A 744/A 744M. For general heat-resistant alloy castings, reference should be made to Specification A 297/A 297M. For nickel alloy castings for corrosion-resistant service, reference should be made to Specification A 494/A 494M.

1.2 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 the other. Combining values from the two systems may result in nonconformance with the specification. Inch-pound units are applicable for material ordered to Specification A 743 and SI units for material ordered to Specification A 743M.

2. Referenced Documents

2.1 ASTM Standards:

- A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels²
- A 297/A297M 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 Products²

¹ This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.18 on Castings.

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² Annual Book of ASTM Standards, Vol 01.03.

³ Annual Book of ASTM Standards, Vol 01.02.

A 447/A447M Specification for Steel Castings, Chromium-Nickel-Iron Alloy (25-12 Class), for High-Temperature Service³

A 494/A494M Specification for Castings, Nickel and Nickel Alloy³

A 744/A744M Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service³

A 781/A781M Specification for Castings, Steel and Alloy, Common Requirements, for General Industrial Use³

3. General Conditions for Delivery

3.1 Material furnished to this specification shall conform to the requirements of Specification A 781/A 781M, including any supplementary requirements that are indicated on the purchase order. Failure to comply with the general requirements of Specification A 781/A 781M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A 781/A 781M, this specification shall prevail.

4. Ordering Information

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

- 4.1.1 Description of the casting by pattern number or drawing,
- 4.1.2 Grade,
- 4.1.3 Heat treatment,
- 4.1.4 Options in the specification, and
- 4.1.5 Supplementary requirements desired, including the standards of acceptance.

5. Process

5.1 The steel shall be made by the electric furnace process with or without separate refining such as argon-oxygen decarburization (AOD).

6. Heat Treatment

6.1 Castings shall be heat treated in accordance with the requirements in Table 1.

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TABLE 1 Heat Treatment Requirements

Grade	Heat Treatment
CF-8, CG-3M (J92999), CG-8M, CG-12, CF-20, CF-8M, CF-8C, CF-16F, CF-16Fa, CH-10, CH-20, CE-30, CK-20	Heat to 1900°F [1040°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means. Heat to 2000°F [1093°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.
CA-15, CA-15M, CA-40, CA-40F	(1) Heat to 1750°F [955°C] minimum, air cool and temper at 1100°F [595°C] minimum, or (2) Anneal at 1450°F [790°C] minimum.
CB-30, CC-50	(1) Heat to 1450°F [790°C] minimum, and air cool, or (2) Heat to 1450°F [790°C] minimum, and furnace cool.
CF-3, CF-3M, CF-3MN	(1) Heat to 1900°F [1040°C] minimum, hold for sufficient time to heat casting to temperature, and cool rapidly. (2) As cast if corrosion resistance is acceptable.
CN-3M (J94652)	Heat to 2150°F [1175°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.
CN-3MN	Heat to 2100°F [1150°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.
CN-7M, CG-6MMN	Heat to 2050°F [1120°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.
CN-7MS	Heat to 2100°F [1150°C] minimum, 2150°F [1180°C] maximum, hold for sufficient time (2 h minimum) to heat casting to temperature and quench in water.
CA-6NM	Heat to 1850°F [1010°C] minimum, air cool to 200°F [95°C] or lower prior to any optional intermediate temper and prior to the final temper. The final temper shall be between 1050°F [565°C] and 1150°F [620°C].
CA-6N (J91541)	Heat to 1900°F [1040°C], air cool, reheat to 1500°F [815°C], air cool, and age at 800°F [425°C], holding at each temperature sufficient time to heat casting uniformly to temperature.
CF10SMnN	Heat to 1950°F [1065°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.
CA-28MwV	(1) Heat to 1875–1925°F [1025–1050°C], quench in air or oil, and temper at 1150°F [620°C] minimum, or (2) Anneal at 1400°F [760°C] minimum.
CK-3MCuN	Heat to 2100°F [1150°C] minimum, hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.
CK-35MN	Heat to 2100–2190F [1150–1200C], hold for sufficient time to heat casting to temperature, quench in water or rapid cool by other means.
CB-6 (J91804)	Heat between 1800°F [980°C] and 1920°F [1050°C], forced air, cool to 120°F [50°C] maximum, and temper between 1100°F and 1160°F [595°C and 625°C].

TABLE 2 Chemical Requirements

NOTE 1—CD-4MCu has been deleted from A 743/A 743M and added to A 890/A 890M. CD-4MCu may now be supplied and purchased in compliance with A 890/A 890M. The chemical and mechanical property requirements of CD-4MCu were identical in A 743/A 743M and A 890/A 890M at the time of removal from A 743/A 743M.

Grade	Type	Composition, %													
		Carbon, max	Manganese, max	Silicon, max	Phosphorus, max	Sulfur, max	Chromium	Nickel	Molybdenum	Columbium	Selenium	Copper	Tungsten, max	Vanadium, max	Nitrogen
CF-8	19 Chromium, 9 Nickel	0.08	1.50	2.00	0.04	0.04	18.0–21.0	8.0–11.0	...	...	...	...	...	...	...
CG-12	22 Chromium, 12 Nickel	0.12	1.50	2.00	0.04	0.04	20.0–23.0	10.0–13.0	...	...	...	...	...	...	...
CF-20	19 Chromium, 9 Nickel	0.20	1.50	2.00	0.04	0.04	18.0–21.0	8.0–11.0	...	...	...	...	...	...	...
CF-8M	19 Chromium, 10 Nickel, with Molybdenum	0.08	1.50	2.00	0.04	0.04	18.0–21.0	9.0–12.0	2.0–3.0	...	...	...	...	...	...
CF-8C	19 Chromium, 10 Nickel, with Columbium	0.08	1.50	2.00	0.04	0.04	18.0–21.0	9.0–12.0	...	A	...	...	...	...	...
CF-16F	19 Chromium, 9 Nickel, Free Machining	0.16	1.50	2.00	0.17	0.04	18.0–21.0	9.0–12.0	1.50 max	...	0.20–0.35	...	...	...	...
CF-16Fa	19 Chromium, 9 Nickel, Free Machining	0.16	1.50	2.00	0.04	0.20–0.40	18.0–21.0	9.0–12.0	0.40–0.80	...	...	...	...	...	...
CH-10	25 Chromium, 12 Nickel	0.10	1.50	2.00	0.04	0.04	22.0–26.0	12.0–15.0	...	...	...	...	...	...	...
CH-20	25 Chromium, 12 Nickel	0.20	1.50	2.00	0.04	0.04	22.0–26.0	12.0–15.0	...	...	...	...	...	...	...
CK-20	25 Chromium, 20 Nickel	0.20	2.00	2.00	0.04	0.04	23.0–27.0	19.0–22.0	...	...	...	...	...	...	...
CE-30	29 Chromium, 9 Nickel	0.30	1.50	2.00	0.04	0.04	26.0–30.0	8.0–11.0	...	...	...	...	...	...	...
CA-15	12 Chromium	0.15	1.00	1.50	0.04	0.04	11.5–14.0	1.00 max	0.50 max	...	...	...	...	...	...



TABLE 2 *Continued*

Grade	Type	Composition, %													
		Carbon, max	Manganese, max	Silicon, max	Phosphorus, max	Sulfur, max	Chromium	Nickel	Molybdenum	Columbium	Selenium	Copper	Tungsten, max	Vanadium, max	Nitrogen
CA-15M	12 Chromium	0.15	1.00	0.65	0.040	0.040	11.5–14.0	1.0 max	0.15–1.0	...	...	...	...	...	...
CB-30	20 Chromium	0.30	1.00	1.50	0.04	0.04	18.0–21.0	2.00 max	...	...	...	^B	...	...	...
CC-50	28 Chromium	0.50	1.00	1.50	0.04	0.04	26.0–30.0	4.00 max	...	...	...	...	...	...	...
CA-40	12 Chromium	0.20–0.40	1.00	1.50	0.04	0.04	11.5–14.0	1.0 max	0.5 max	...	...	...	...	...	...
CA-40F	12 Chromium, Free Machining	0.20–0.40	1.00	1.50	0.04	0.20–0.40	11.5–14.0	1.0 max	0.5 max	...	...	...	...	...	...
CF-3	19 Chromium, 9 Nickel	0.03	1.50	2.00	0.04	0.04	17.0–21.0	8.0–12.0	...	...	...	...	...	...	...
CF10SMnN	17 Chromium, 8.5 Nickel with Nitrogen	0.10	7.00–9.00	3.50–4.50	0.060	0.030	16.0–18.0	8.0–9.0	...	...	...	...	...	...	0.08–0.18
CF-3M	19 Chromium, 10 Nickel, with Molybdenum	0.03	1.50	1.50	0.04	0.04	17.0–21.0	9.0–13.0	2.0–3.0	...	...	...	...	...	...
CF-3MN	19 Chromium, 10 Nickel, with Molybdenum, and Nitrogen	0.03	1.50	1.50	0.040	0.040	17.0–22.0	9.0–13.0	2.0–3.0	...	...	...	...	...	0.10–0.20
CG6MMN		0.06	4.00–6.00	1.00	0.04	0.03	20.5–23.5	11.5–13.5	1.50–3.00	0.10–0.30	...	...	...	0.10–0.30	0.20–0.40
CG-3M (J92999)	19 Chromium, 11 Nickel, with Molybdenum	0.03	1.50	1.50	0.04	0.04	18.0–21.0	9.0–13.0	3.0–4.0	...	...	...	...	...	...
CG-8M	19 Chromium, 11 Nickel, with Molybdenum	0.08	1.50	1.50	0.04	0.04	18.0–21.0	9.0–13.0	3.0–4.0	...	...	...	...	...	...
CN-3M (J94652)		0.03	2.0	1.0	0.03	0.03	20.0–22.0	23.0–27.0	4.5–5.5	...	...	...	...	...	...
CN-3MN	21 Chromium, 24 Nickel with Molybdenum and Nitrogen	0.03	2.00	1.00	0.040	0.010	20.0–22.0	23.5–25.5	6.0–7.0	...	...	0.75 max	...	...	0.18–0.26
CN-7M	20 Chromium, 29 Nickel, with Copper and Molybdenum	0.07	1.50	1.50	0.04	0.04	19.0–22.0	27.5–30.5	2.0–3.0	...	...	3.0–4.0	...	...	...
CN-7MS	19 Chromium, 24 Nickel, with Copper and Molybdenum	0.07	1.00	2.50–3.50	0.04	0.03	18.0–20.0	22.0–25.0	2.5–3.0	...	...	1.5–2.0	...	...	...
CA-6NM	12 Chromium, 4 Nickel	0.06	1.00	1.00	0.04	0.03	11.5–14.0	3.5–4.5	0.40–1.0	...	...	...	...	...	...
CA6N	11 Chromium, 7 Nickel	0.06	0.50	1.00	0.02	0.02	10.5–12.5	6.0–8.0	...	...	...	...	...	...	...
CA-28MWV	12 Chromium, with Molybdenum, Tungsten and Vanadium	0.20–0.28	0.50–1.00	1.0	0.030	0.030	11.0–12.5	0.50–1.00	0.90–1.25	...	...	...	0.90–1.25	0.20–0.30	...
CK-3MCuN	20 Chromium 18 Nickel, with Copper and Molybdenum	0.025	1.20	1.00	0.045	0.010	19.5–20.5	17.5–19.5	6.0–7.0	...	...	0.50–1.00	...	...	0.180–0.240
CK-35MN	23 Chromium, 21 Nickel, with Molybdenum and Nitrogen	0.035	2.00	1.00	0.035	0.020	22.0–24.0	20.0–22.0	6.0–6.8	...	...	0.40	...	...	0.21–0.32
CB-6 (J91804)	16 Chromium, 4 Nickel	0.06	1.00	1.00	0.04	0.03	15.5–17.5	3.5–5.5	0.5 max	...	...	...	...	...	...

^A Grade CF-8C shall have a columbium content of not less than eight times the carbon content and not more than 1.0%. If a columbium-plus-tantalum alloy in the approximate Cb:Ta ratio of 3:1 is used for stabilizing this grade, the total columbium-plus-tantalum content shall not be less than nine times the carbon content and shall not exceed 1.1%.

^B For Grade CB-30 a copper content of 0.90 to 1.20% is optional.

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NOTE 2—Proper heat treatment of these alloys is usually necessary to enhance corrosion resistance and in some cases to meet mechanical properties. Minimum heat treat temperatures are specified; however, it is sometimes necessary to heat treat at higher temperatures, hold for some minimum time at temperature and then rapidly cool the castings in order to enhance the corrosion resistance and meet mechanical properties.

7. Chemical Requirements

7.1 The chemical requirements are shown in Table 2.

8. Repair by Welding

8.1 Repair welding of Grade CA-28MWV is not permitted unless by agreement between the manufacturer and the purchaser.

8.2 When methods involving high temperature are used in the removal of discontinuities, castings shall be preheated in accordance with Table 3. Weld repairs shall be subject to the same quality standards as are used to inspect the castings.

8.3 Post weld heat treatment, if required, shall be in accordance with Table 1.

8.3.1 The martensitic grades CA-6NM, CA-15, CA-15M, CB-6, and CA-40 shall be retempered after weld repairing, except that local tempering will be permitted if, in the opinion

of the manufacturer, furnace heat treating will be damaging to the finished surface of a machined casting. Heat treatment, other than tempering, of grades CA-6NM, CA-15, CA-15M, CB-6, and CA-40 after weld repairing shall be performed only when agreed upon between the manufacturer and the purchaser. Weld repair on Grade CA-40F is not recommended because of the risk of local hardening and possible cracking in the heat affected zone.

8.3.2 Post weld heat treatment is not required on the other grades of this specification. When post weld heat treatment is believed necessary for adequate corrosion resistance in the service environment, castings should be ordered in accordance with Specification A 744/A 744M.

9. Product Marking

9.1 Castings shall be marked for material identification with the ASTM specification number (A 743/A 743M) and grade symbol, that is, CF-8, CA-15, CB-30, etc. In addition, the manufacturer's name or identification mark and the pattern number shall be cast or stamped using the low-stress stamps on all castings. Small-size castings may be such that marking must be limited consistent with the available area. The marking of heat numbers on individual castings shall be agreed upon between the manufacturer and the purchaser. Marking shall be in such position as not to injure the usefulness of the casting.

10. Keywords

10.1 corrosion resistant; iron-chromium; iron-chromium-nickel; steel castings

TABLE 3 Minimum Preheat Temperatures

Grade	Minimum Preheat Temperatures	
	°F	°C
CA-15, CA-15M CA-40, CA-28MWV	400	[205]
Others	50	[10]

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall not apply unless specified in the purchase order. A list of standardized supplementary requirements for use at the option of the purchaser is included in Specification A 781/A 781M. Those which are ordinarily considered suitable for use with this specification are given below. Others enumerated in A781/A 781M may be used with this specification upon agreement between the manufacturer and purchaser.

S1. Magnetic Particle Examination

S2. Radiographic Examination

S3. Liquid Penetrant Examination

S4. Ultrasonic Examination

S5. Examination of Weld Preparation

S6. Certification

S7. Prior Approval of Major Weld Repairs

S11. Intergranular Corrosion Test

S11.1 An intergranular corrosion test shall be performed in accordance with the appropriate practice for the particular grade involved, as listed in Practices A 262, or as agreed upon with the purchaser. Intergranular corrosion tests on stabilized or 0.03 % carbon maximum grades (CF-3, CF-3M, CF-8C, and

CG-3M) shall be made on sensitized specimens. On all other grades of chromium-nickel steels, intergranular corrosion tests shall be made on specimens representative of the as-shipped condition.

S12 Tension Test

S12.1 Tensile properties shall be determined from material representing each heat. The bar from which the test specimen is taken shall be heat treated in production furnaces to the same procedure as the castings it represents. The results shall conform to the requirements specified in Table S12.1.

S12.2 Test bars shall be poured in separately cast keel blocks similar to Fig. 1 or Fig. 2 or Fig. 3 of A 781.

S12.3 Tension test specimens may be cut from heat-treated castings, or from as-cast castings if no heat treatment is specified for the castings, instead of from test bars, when agreed upon between the manufacturer and the purchaser.

TABLE S12.1 Tensile Requirements

Grade	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. [50 mm], min, % ^A	Reduction of Area, min, %
		ksi	[MPa]	ksi	[MPa]		
CF-8	19 Chromium, 9 Nickel	70 ^B	[485] ^B	30 ^B	[205] ^B	35	...
CG-12	22 Chromium, 12 Nickel	70	[485]	28	[195]	35	...
CF-20	19 Chromium, 9 Nickel	70	[485]	30	[205]	30	...
CF-8M	19 Chromium, 10 Nickel, with Molybdenum	70	[485]	30	[205]	30	...
CF-8C	19 Chromium, 10 Nickel with Columbium	70	[485]	30	[205]	30	...
CF-16F and CF-16Fa	19 Chromium, 9 Nickel, Free Machining	70	[485]	30	[205]	25	...
CH-20 and CH-10	25 Chromium, 12 Nickel	70	[485]	30	[205]	30	...
CK-20	25 Chromium, 20 Nickel	65	[450]	28	[195]	30	...
CE-30	29 Chromium, 9 Nickel	80	[550]	40	[275]	10	...
CA-15 and CA-15M	12 Chromium	90	[620]	65	[450]	18	30
CB-30	20 Chromium	65	[450]	30	[205]	...	...
CC-50	28 Chromium	55	[380]	...	...	...	...
CA-40	12 Chromium	100	[690]	70	[485]	15	25
CA-40F	12 Chromium, Free Machining	100	[690]	70	[485]	12	...
CF-3	19 Chromium, 9 Nickel	70	[485]	30	[205]	35	...
CF10SMnN	17 Chromium, 8.5 Nickel with Nitrogen, 9 Nickel	85	[585]	42	[290]	30	...
CF-3M	19 Chromium, 10 Nickel, with Molybdenum	70	[485]	30	[205]	30	...
CF-3MN	19 Chromium, 10 Nickel, with Molybdenum, and Nitrogen	75	[515]	37	[255]	35	...
CG6MMN	Chromium-Nickel-Manganese-Molybdenum	85	[585]	42	[290]	30	...
CG-3M (J92999)	19 Chromium, 11 Nickel, with Molybdenum	75	[515]	35	[240]	25	...
CG-8M	19 Chromium, 11 Nickel, with Molybdenum	75	[520]	35	[240]	25	...
CN-3M (J94652)	19 Chromium, 11 Nickel, with Molybdenum	63	[435]	25	[170]	30	...
CN-3MN	21 Chromium, 24 Nickel, with Molybdenum, and Nitrogen	80	[550]	38	[260]	35	...
CN-7M	20 Chromium, 29 Nickel, with Copper and Molybdenum	62	[425]	25	[170]	35	...
CN-7MS	19 Chromium, 24 Nickel, with Copper and Molybdenum	70	[485]	30	[205]	35	...
CA-6NM	12 Chromium, 4 Nickel	110	[755]	80	[550]	15	35
CA-6N (J91541)	11 Chromium, 7 Nickel	140	[965]	135	[930]	15	50
CA-28MWV ^C	12 Chromium, with Molybdenum, Tungsten, and Vanadium	140	[965]	110	[760]	10	24
CK-3MCuN	20 Chromium, 18 Nickel, with Copper and Molybdenum	80	[550]	38	[260]	35	...
CK-35MN	23 Chromium, 21 Nickel, with Molybdenum and Nitrogen	83	[570]	41	[280]	35	...
CB-6 (J91804)	16 Chromium, 4 Nickel	115	[790]	85	[580]	16	35

^A When ICI test bars are used in tensile testing as provided for in this specification, the gage length to reduced section diameter ratio shall be 4:1.

^B For low ferrite or nonmagnetic castings of this grade, the following values shall apply: tensile strength, min, 65 ksi [450 MPa]; yield point, min, 28 ksi [195 MPa].

^C These mechanical properties apply only when heat-treatment (1) has been used.

S12.4 Test specimens shall be machined to the form and dimensions of the standard round 2-in. [50-mm] gage length specimen shown in Fig. 4 and 5 of Test Methods and Definitions A 370, and shall be tested in accordance with Test Methods and Definitions A 370.

S12.5 If the results of the mechanical tests for any heat, lot, or casting do not conform to the requirements specified, retests are permitted as outlined in Test Methods and Definitions A 370. At the manufacturer's option, castings may be reheat-treated and retested. When castings are reheat-treated, they may not be re-austenitized more than three times without the approval of the purchaser. Testing after reheat treatment shall consist of the full number of specimens taken from locations complying with the specification or order.

S12.6 If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted from the same heat.

S13. Post Weld-Heat Treatment

S13.1 Weld repairs shall be considered major in the case of a casting which has leaked on hydrostatic test or when the

depth of the cavity after preparation for repair exceeds 20 % of the actual wall thickness, or 1 in. [25 mm], whichever is smaller, or when the extent of the cavity exceeds approximately 10 in.²[65 cm²]. All other weld repairs shall be considered minor.

S13.2 Grades CF-8, CG-3M, CG-8M, CG-12, CF-20, CF-8M, CF-8C, CF-16F, CF-16Fa, CH-10, CH-20, CE-30, CK-20, CF-3, CF-3M, CF-3MN, CN-7M, CN-7MS, CN-3MN, CB-30, CC-50, CA-6N, and CK-3MCuN shall be heat treated after major weld repairs, but it is not required after minor repairs except by agreement between the manufacturer and the purchaser.

S14. Hardness Tests

S14.1 Brinell tests on non-austenitic grades shall be conducted. Grades CA-15, CA-15M, CB-30, and CC-50 shall have a Brinell hardness of 241 HB maximum. Grade CA-6NM shall have a Brinell hardness of 285 HB maximum, Grade CA-40 and CA-40F, 269 HB maximum, and Grade CA-28MWV, 302–352 HB, except for the annealed condition, when the Brinell hardness of this grade shall not exceed 269 HB.

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S14.2 The location where the Brinell hardness reading is to be taken and the frequency of such Brinell hardness inspection of the castings shall be established by agreement between the manufacturer and the purchaser.

fraction of ferrite as determined by S 31, A 890/A 890M, shall be by agreement between the manufacturer and the purchaser.

S15. Low Ferrite in CF-8

S15.1 When low ferrite or non-magnetic properties are required, the mechanical property requirements and volume

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