SPECIFICATION FOR STEEL CASTINGS, STAINLESS, PRECIPITATION HARDENING

SA-747/SA-747M

(Identical with ASTM Specification A747/A747M-04 except for the revision of the mandatory ordering requirements of para. 4.1.6 and the mandatory use of Supplementary Requirement S15 of SA-781/SA-781M.)

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1. Scope

1.1 This specification covers iron-chromium-nickel-copper corrosion-resistant steel castings, capable of being strengthened by precipitation hardening heat treatment.

1.2 These castings may be used in services requiring corrosion resistance and high strengths at temperatures up to 600°F [315°C]. They may be machined in the solution-annealed condition and subsequently precipitation hardened to the desired high-strength mechanical properties specified in Table S14.1 with little danger of cracking or distortion.

1.3 The material is not intended for use in the solution-annealed condition.

NOTE 1 — If the service environment in which the material is to be used is considered conducive to stress-corrosion cracking, precipitation hardening should be performed at a temperature that will minimize the susceptibility of the material to this type of attack.

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 the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:*

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

A 732/A 732M Specification for Castings, Investment, Carbon and Low Alloy Steel for General Application, and Cobalt Alloy for High Strength at Elevated Temperatures

A 781/A 781M Specification for Castings, Steel and Alloy, Common Requirements, for General Industrial Use

E 38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys

E 353 Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.2 *ASME Standard:*

ASME Boiler and Pressure Vessel Code, Supplementary Requirements S6, S14, and S27

3. General Conditions for Delivery

3.1 Material furnished to this specification shall be in accordance with the requirements of Specification A 781/A 781M, including any supplementary requirements that are indicated in 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:

4.1.1 Specification number and grade (Table 1),

4.1.2 Heat treatment condition (SA, H900, and so forth), Table 2,

4.1.3 Drawing or pattern,

4.1.4 Options in the specification, if any, in accordance with 5.2, 6.3, and Section 7, and

4.1.5 Supplementary requirements, if any, including the standards of acceptance.

4.1.6 Supplementary Requirements S6, S14, and S27 are mandatory, together with S15 from Specification

SA-781/SA-781M, and must be specified in the purchase order,

5. Materials and Manufacture

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

5.2 *Heat Treatment* — Castings may be given a homogenization heat treatment in accordance with 5.2.1 at the producer's option or when specified by the purchaser (see S26) prior to solution heat treatment. All castings, whether homogenized or not, shall be given a solution treatment in accordance with 5.2.2 and unless ordered in the solution-annealed condition shall be precipitation hardened to the ordered condition (Table 2).

5.2.1 Homogenization heat treatment shall consist of heating the castings and test material to a minimum of 1900°F [1040°], holding for a minimum of 1½ h, and cooling to below 90°F [30°C].

5.2.2 Solution annealing heat treatment shall consist of heating the castings and test material to 1925°F ± 50°F [1050°C ± 30°C], holding the 30 min/in. [1.2 min/mm] of section but not less than 30 min, and cooling to below 90°F [30°C].

5.2.3 Temperature used for precipitation hardening shall be maintained within the range of ± 25°F [± 15°C] of that listed in Table 2 for the heat-treatment condition ordered. (See Note 1).

5.2.4 When the order of contract specifies a minimum columbium content, the minimum precipitation hardening temperature shall be 925°F [495°C].

6. Chemical Composition

6.1 The steel shall be in accordance with the requirements as to chemical composition prescribed in Table 1.

6.2 When the H900 condition is ordered, the minimum columbium content (Table 1) shall not apply. It is recommended that columbium other than that in revert material not be added.

6.3 *Methods of Analysis* — Analytical procedures for nitrogen analysis are not included in Methods E 38 or Test Methods E 353, so if the contract or order specifies that the nitrogen content is to be reported, the method of analysis shall be agreed upon by purchaser and producer.

7. Repair by Welding

7.1 Repairs shall be made only in one of the following conditions: homogenized, solution annealed, H1100, H1150, H1150M, H1150DBL, or stress relieved at 1150°F ± 25°F [620°C ± 15°C] for a minimum of 4 h.

7.2 Castings welded in one of the aged conditions noted in 7.1 shall be post weld heat treated by the same aging treatment used prior to welding, or, where necessary to meet mechanical property requirements, shall be solution annealed and aged after welding. Castings welded in the stress-relieved condition shall receive the specification heat treatment after welding.

8. Keywords

8.1 precipitation hardening stainless steel; stainless steel; steel castings

TABLE 1
CHEMICAL REQUIREMENTS[A]

Grade UNS Type	CB7Cu-1 J92180 17-4	CB7Cu-2 J92110 15-5
Carbon	0.07	0.07
Manganese	0.70	0.70
Phosphorus	0.035	0.035
Sulfur	0.03	0.03
Silicon	1.00	1.00
Chromium	15.50–17.70	14.0–15.50
Nickel	3.60–4.60	4.50–5.50
Copper	2.50–3.20	2.50–3.20
Columbium	0.15–0.35[B]	0.15–0.35[B]
Nitrogen[C]	0.05	0.05

[A] Limits are percent maximum unless shown as a range or stated otherwise.

[B] See 6.2. When the H900 condition is ordered, the minimum columbium content shall not apply.

[C] To be determined and reported when specified by the order or contract.

TABLE 2
PRECIPITATION HARDENING HEAT TREATMENT[A,B]

Condition	PH[C] Temperature, °F [°C]	Time, h and min	Cooling Treatment
SA	Not precipitation hardened (see 5.2.3)		
H900	900 [480]	1.5	air cool
H925	925 [495]	1.5	air cool
H1025	1025 [550]	4.0	air cool
H1075	1075 [580]	4.0	air cool
H1100	1100 [595]	4.0	air cool
H1150	1150 [620]	4.0	air cool
H1150M	1400 [760]	2.0	air cool
	1150 [620]	4.0	air cool
H1150 DBL	1150 [620]	4.0	air cool
	1150 [620]	4.0	air cool

[A] The furnace and controls used shall be calibrated and capable of uniformity of heating in order to ensure consistent results.

[B] See Note 1.

[C] ±25°F [15°C].

SUPPLEMENTARY REQUIREMENTS

A list of standardized supplementary requirements for use at the option of the purchaser is described in Specification A 781/A 781M. Those that are considered suitable for use with this specification are listed below by title only. Additional supplementary requirements suitable for use with this specification at the option of the purchaser are described below. One or more of the supplementary requirements indicated below may be included in the purchaser's order or contract. When so included, a supplementary requirement shall have the same force as if it were in the body of the specification. Supplementary requirements details not fully described shall be agreed upon between the purchaser and the supplier, but shall not negate any of the requirements in the body of the specification.

S1. Magnetic Particle Examination

NOTE — When CB7CU-1 alloy is inspected by magnetic particle method, false indications may be caused by ferrite stingers or traces of retained austenite in the microstructure. Liquid penetrant methods may be used to confirm the presence or absence of a discontinuity when such indications are noted.

S2. Radiographic Examination

S3. Liquid Penetrant Examination

S5. Examination of Weld Preparation

S6. Certification

S13. Hardness Test

S13.1 Brinell hardness test shall be made from each heat-treatment load for each heat. The results shall be in accordance with the requirements in Table S14.1 and shall be reported to the purchaser or his representative.

S13.2 The test may be made on the end of the tension specimen unless the order requires it to be made on a casting, in which case, where possible, the test shall be made on a boss or extension located on the casting suitable for testing in the Brinell tester.

S13.3 The test shall be conducted in accordance with Test Methods and Definitions A 370.

S14. Tension Test

S14.1 Tensile properties shall be determined from material representing each heat. The bar from which the test specimen is taken shall be heat treated with production castings to the same procedure as the castings it represents, unless the castings are ordered in the solution-annealed condition (5.2.2). The results shall be in accordance with the requirements specified in Table S14.1 and shall be reported to the purchaser or his representative.

S14.2 When the contract or order specifies that the castings are to be furnished in the solution-annealed condition, the manufacturer shall test specimens representing the castings that have been given the precipitation heat treatment specified by the purchaser in accordance with Table 2.

S14.3 Test coupons and tests shall be made in accordance with Test Methods and Definitions A 370. Where possible, the standard 2 in. [50 mm] gage length specimens shall be used, unless the purchase order is for investment castings. Standard subsize specimens may be used when a 2 in. gage length specimen is not feasible. When subsize specimens are used, the gage length shall be four times the gage diameter. When investment castings are ordered, the specimens shall be prepared in accordance with S3.2 of Specification A 732/A 732M.

S14.4 If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted from the same lot. A retest shall be allowed if the percentage elongation of any tension test specimen is less than that specified in Table S14.1, or if any part of the fracture is more than $\frac{3}{4}$ in. [19 mm] from the center of a standard 2 in. [50 mm] gage length established by scribe scratches on the untested specimen.

S26. Homogenization Heat Treatment

S26.1 The homogenization heat treatment shall consist of heating the castings and test material to a minimum of 1900°F [1040°C], holding for a minimum of $1\frac{1}{2}$ h, and cooling to below 90°F [30°C].

S27. Product Marking

S27.1 The manufacturer's name or identification mark and the pattern number shall be cast or stamped on all castings except those of such small size as to make such marking impractical. To minimize small defects caused by

dislodged particles of molding sand, the number of cast identification marks should be minimized. When further specified, the heat numbers shall be marked on individual castings.

S27.2 When the castings are too small to mark individually, a symbol traceable to the lot shall be placed on the castings and the required identification then placed on a tag affixed to the container in which these castings are shipped.

TABLE S14.1
MECHANICAL PROPERTIES

Alloy Type	PH Heat Treatment	Hardness, HB	Yield Strength 0.2% Offset, min, ksi [MPa]	Tensile Strength, ksi [MPa]	Elongation in 2 in. [51 mm], min, %[A]
CB7Cu-1	H900	375 min	145 [1000]	170 [1170]	5
	H925	375 min	150 [1035]	175 [1205]	5
	H1025	311 min	140 [965]	150 [1035]	9
	H1075	277 min	115 [795]	145 [1000]	9
	H1100	269 min	110 [760]	135 [930]	9
	H1150	269 min	97 [670]	125 [860]	10
	H1150M	310 max	...	...	
	H1150 DBL	310 max	...	...	...
CB7Cu-2	H900	375 min	145 [1000]	170 [1170]	5
	H925	375 min	150 [1035]	175 [1205]	5
	H1025	311 min	140 [965]	150 [1035]	9
	H1075	277 min	115 [795]	145 [1000]	9
	H1100	269 min	110 [760]	135 [930]	9
	H1150	269 min	97 [670]	125 [860]	10
	H1150M	310 max	...	...	...
	H1150 DBL	310 max	...	...	...

[A] If sub-size tension test bars are used, the gage length/gage diameter ratio must be 4 to 1 to assure elongation values comparable to those of the standard test specimen.