Designation: A473 – 23

Standard Specification for Stainless Steel Forgings[1]

This standard is issued under the fixed designation A473; 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.

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

1. Scope*

1.1 This specification covers austenitic, austenitic-ferritic, ferritic, and martensitic stainless steel forgings for general use, and for low- or high-temperature service.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 Supplementary requirements from Specification A788/A788M may be specified when additional testing, inspection, or processing is required.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A751 Test Methods and Practices for Chemical Analysis of Steel Products

A788/A788M Specification for Steel Forgings, General Requirements

A1058 Test Methods for Mechanical Testing of Steel Products—Metric

E8/E8M Test Methods for Tension Testing of Metallic Materials

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 *SAE Standard:*[3]

SAE J1086 Numbering Metals and Alloys

3. Ordering Information

3.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements may include, but are not limited to, the following:

3.1.1 Quantity (weight or number of pieces);

3.1.2 Dimensions, including prints or sketches;

3.1.3 Name of material (stainless steel forgings);

3.1.4 Type or UNS designation (Table 1);

3.1.5 Condition (Table 2); and

3.1.6 ASTM designation and date of issue;

3.1.7 Test for magnetic permeability, if specified by customer purchase order when ordering Types 207 and 205; and

3.1.8 Special requirements.

3.2 If possible the intended end use of the item should be given on the purchase order especially when the item is ordered for a specific end use or uses.

NOTE 1—A typical ordering description is as follows: 5 stainless steel forgings, Type 410, Designation A, ASTM Specification A473 dated _____. End use: pump blocks for oil well equipment.

4. General Requirements

4.1 Material supplied to this specification shall conform to the requirements of Specification A788/A788M, which outlines additional ordering information, manufacturing requirements, testing and retesting methods and procedures, marking, certification, product analysis variations, and additional supplementary requirements.

4.2 If the requirements of this specification are in conflict with the requirements of Specification A788/A788M, the requirements of this specification shall prevail.

5. Manufacture

5.1 Material for forgings shall consist of ingots or blooms, billets, slabs, or bars, either forged or rolled from an ingot, and cut to the required length by a suitable process.

[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 A01.06 on Steel Forgings and Billets.

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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.

[3] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

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

TABLE 1 Chemical Requirements[A]

UNS Designation[B]	Type Number	Carbon, %	Manganese, %	Phosphorus, %	Sulfur, %	Silicon, %	Chromium, %	Nickel, %	Molybdenum, %	Nitrogen, %	Other Elements, %
					Austenitic Grades						
S20100	201	0.15	5.5–7.5	0.060	0.030	1.00	16.0–18.0	3.5–5.5	. . .	0.25	
S20200	202	0.15	7.5–10.0	0.060	0.030	1.00	17.0–19.0	4.0–6.0	. . .	0.25	
S20500	205	0.12–0.25	14.0–15.5	0.060	0.030	1.00	16.5–18.0	1.00–1.75	. . .	0.32–0.40	
S21900	XM-10	0.08	8.0–10.0	0.060	0.030	1.00	19.0–21.5	5.5–7.5	. . .	0.15–0.40	
S21904	XM-11	0.04	8.0–10.0	0.060	0.030	1.00	19.0–21.5	5.5–7.5	. . .	0.15–0.40	
S28200	. . .	0.15	17.0–19.0	0.045	0.030	1.00	17.0–19.0	. . .	0.75–1.25	0.40–0.60	Cu 0.75–1.25
S30200	302	0.15	2.00	0.045	0.030	1.00	17.0–19.0	8.0–10.0	. . .	0.10	
S30215	302B	0.15	2.00	0.045	0.030	2.00–3.00	17.0–19.0	8.0–10.0	. . .	. . .	
S30300	303	0.15	2.00	0.20	0.15 min	1.00	17.0–19.0	8.0–10.0	0.60[C]	. . .	
S30323	303 Se	0.15	2.00	0.20	0.06	1.00	17.0–19.0	8.0–10.0	. . .	. . .	Se 0.15 min
S30400	304	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	. . .	0.10	
S30403	304L	0.030	2.00	0.045	0.030	1.00	18.0–20.0	8.0–12.0	. . .	0.10	
S30500	305	0.12	2.00	0.045	0.030	1.00	17.0–19.0	10.5–13.0	. . .	. . .	
S30800	308	0.08	2.00	0.045	0.030	1.00	19.0–21.0	10.0–12.0	. . .	. . .	
S30815	. . .	0.10	0.80	0.040	0.030	1.40–2.00	20.0–22.0	10.0–12.0	. . .	0.14–0.20	Ce 0.03–0.08
S30900	309	0.20	2.00	0.045	0.030	1.00	22.0–24.0	12.0–15.0	. . .	. . .	
S30908	309S	0.08	2.00	0.045	0.030	1.00	22.0–24.0	12.0–15.0	. . .	. . .	
S31000	310	0.25	2.00	0.045	0.030	1.50	24.0–26.0	19.0–22.0	. . .	. . .	
S31008	310S	0.08	2.00	0.045	0.030	1.50	24.0–26.0	19.0–22.0	. . .	. . .	
S31254	. . .	0.020	1.00	0.030	0.010	0.80	19.5–20.5	17.5–18.5	6.0–6.5	0.18–0.25	Cu 0.50–1.00
S31400	314	0.25	2.00	0.045	0.030	1.50–3.00	23.0–26.0	19.0–22.0	. . .	. . .	
S31600	316	0.08	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	0.10	
S31603	316L	0.030	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	0.10	
S31700	317	0.08	2.00	0.045	0.030	1.00	18.0–20.0	11.0–15.0	3.0–4.0	0.10	
S32100	321	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	. . .	. . .	Ti 5×C min
S34700	347	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	Cb+Ta 10×C, min[D]
S34800	348	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	Cb+Ta 10×C, min[D] Ta 0.10 Co 0.20
					Austenitic-Ferritic Grades						
S32550[E]	. . .	0.04	1.50	0.040	0.030	1.00	24.0-27.0	4.5-6.5	2.9-3.9	0.10-0.25	Cu 1.50–2.50
S32760[E]	. . .	0.030	1.00	0.030	0.010	1.00	24.0–26.0	6.0–8.0	3.0–4.0	0.20–0.30	Cu 0.50–1.00 W 0.50–1.00
S32950	. . .	0.03	2.00	0.035	0.010	0.60	26.0–29.0	3.5–5.2	1.00–2.50	0.15–0.35	
					Ferritic Grades						
S40500	405	0.08	1.00	0.040	0.030	1.00	11.5–14.5	0.60	. . .	. . .	A1 0.10–0.30
S42900	429	0.12	1.00	0.040	0.030	1.00	14.0–16.0	0.75	. . .	. . .	
S43000	430	0.12	1.00	0.040	0.030	1.00	16.0–18.0	0.75	. . .	. . .	
S43020	430F	0.12	1.25	0.06	0.15 min	1.00	16.0–18.0	0.75	0.60[C]	. . .	
S43023	430F Se	0.12	1.25	0.06	0.06	1.00	16.0–18.0	0.75	. . .	. . .	Se 0.15 min
S44600	446	0.20	1.50	0.040	0.030	1.00	23.0–27.0	0.75	. . .	0.25	
					Martensitic Grades						
S40300	403	0.15	1.00	0.040	0.030	0.50	11.5–13.0	. . .	. . .	. . .	. . .
S41000	410	0.15	1.00	0.040	0.030	1.00	11.5–13.5	0.75	. . .	. . .	. . .
S41008	410S	0.08	1.00	0.040	0.030	1.00	11.5–13.5	0.75	. . .	. . .	. . .
S41400	414	0.15	1.00	0.040	0.030	1.00	11.5–13.5	1.25–2.50	. . .	. . .	. . .
S41425	. . .	0.05	0.50–1.00	0.020	0.005	0.50	12.0–15.0	4.0–7.0	1.50–2.00	0.06–0.12	Cu 0.30
S41500	[F]	0.05	0.5–1.0	0.030	0.030	0.60	11.5–14.0	3.5–5.5	0.40–0.80	. . .	
S41600	416	0.15	1.25	0.06	0.15 min	1.00	12.0–14.0	. . .	0.60[C]	. . .	
S41623	416 Se	0.15	1.25	0.06	0.06	1.00	12.0–14.0	. . .	. . .	. . .	Se 0.15 min
S42000	420	Over 0.15	1.00	0.040	0.030	1.00	12.0–14.0	. . .	. . .	. . .	. . .
S43100	431	0.20	1.00	0.040	0.030	1.00	15.0–17.0	1.25–2.50	. . .	. . .	. . .
S44002	440A	0.60–0.75	1.00	0.040	0.030	1.00	16.0–18.0	. . .	0.75	. . .	
S44003	440B	0.75–0.95	1.00	0.040	0.030	1.00	16.0–18.0	. . .	0.75	. . .	
S44004	440C	0.95–1.20	1.00	0.040	0.030	1.00	16.0–18.0	. . .	0.75	. . .	

[A] Maximum, unless range or minimum is indicated.
[B] New designation established in accordance with Practice E527 and SAE J1086.
[C] At manufacturer's option; reported only when intentionally added.
[D] Columbium (Cb) and Niobium (Nb) are alternate names for element 41 in the Periodic Table of the Elements.
[E] % Cr + 3.3 × % Mo + 16 × % N ≥ 40.
[F] Wrought version of CA6NM.

TABLE 2 Mechanical Property Requirements

Type	Condition	Yield Strength, min, ksi (MPa)[A]	Tensile Strength, min, ksi (MPa)	Elongation in 2 in. (50 mm) or 4D, min %	Reduction of Area, min, %	Brinell Hardness Number, max
		Austenitic Grades				
201, 302, 302B, 303, 303SE, 305, 308, 309, 309S, 310, 310S, 314, 317, 321, 347, 348	A	30 (205)	75 (515)	40	50	. . .
202	A	45 (310)	90 (620)	40	50	. . .
205	A	50 (345)	90 (620)	40	50	. . .
304 and 316, Sections 5 in. (127 mm) and Under	A	30 (205)	75 (515)	40	50	. . .
304 and 316, Sections Over 5 in. (127 mm)	A	30 (205)	70 (485)	40	50	. . .
304L and 316L	A	25 (170)	65 (450)	40	50	. . .
XM-10 and XM-11	A	50 (345)	90 (620)	45	60	. . .
S28200	A	60 (415)	110 (760)	40	55	. . .
S30815	A	45 (310)	87 (600)	40	50	. . .
S31254	A	44 (300)	95 (650)	35	50	. . .
		Austenitic-Ferritic Grades				
S32550	A	80 (550)	109 (750)	25.0	. . .	290
S32950	A	70 (480)	100 (690)	15	. . .	293
S32760	A	80 (550)	109 (750)	25	. . .	290
		Ferritic Grades				
430F, 430FSE, 446	A	40 (275)	70 (485)	20	45	223
405	A	30 (205)	60 (415)	20	45	207
429	A	35 (240)	65 450)	23	45	207
430	A	35 (240)	70 (485)	20	45	217
		Martensitic Grades				
403, 410, 416, 416SE	A	40 (275)	70 (485)	20	45	223
403, 410	1	40 (275)	70 (485)	20	45	223
	2	85 (585)	110 (760)	15	45	269
	3	100 (690)	130 (895)	12	35	331
410S	A	35 (240)	65 (450)	22	45	217
414	A	. . . . .	. . . . .	. . .	. . .	298
	T	90 (620)	115 (795)	15	45	321
	H	100 (690)	125 (860)	15	45	321
S41425	T	95 (655)	120 (825)	15	45	321
S41500	normalized and tempered	90 (620)	115 (795)	15	45	295
420	A	. . . . .	. . . . .	. . .	. . .	223
431	A	. . . . .	. . . . .	. . .	. . .	277[B]
	T	90 (620)	115 (795)	15	. . .	321
	H	135 (930)	175 (1210)	13	. . .	440
440A, 440B, 440C	A	. . . . .	. . . . .	. . .	. . .	269

[A] Yield strength shall be determined by the 0.2 % offset method in accordance with Test Methods and Definitions A370. An alternative method of determining yield strength may be used based on a total extension under load of 0.5 %.

[B] Type 431 forgings of designation *A*, when specified, shall be capable of meeting the above mechanical property requirements of designation *T* after oil quenching from 1800 °F to 1900 °F (980 °C to 1038 °C) and tempering at not less than 1100 °F (595 °C), or designation *H* when oil quenched from 1850 °F to 1950 °F (1010 °C to 1065 °C) and tempered at not more than 700 °F (370 °C).

5.2 The material shall be forged by hammering, pressing, rolling, extruding, or upsetting. It shall be brought as nearly as possible to the finished shape and size by hot-working; and shall be processed, if practicable, so as to cause metal-flow during the hot-working operation in the direction most favorable for resisting the stresses encountered in service as may be indicated to the manufacturer by the purchaser.

5.3 When specified on the order, a sample forging may be sectioned and etched to show flow lines and the condition as regards internal imperfections. When so specified, the question of acceptable and unacceptable metal-flow shall be subject to agreement between the manufacturer and the purchaser prior to order entry.

5.4 When specified on the order, the manufacturer shall submit for approval of the purchaser a sketch showing the shape of the rough forging before machining, or before heat treating for mechanical properties.

5.5 The grain size shall be as fine as practicable and precautions shall be taken to minimize grain growth.

6. Heat Treatment

6.1 Except for S31254, the austenitic steels shall receive a solution heat treatment, consisting of heating the material to a minimum temperature of 1900 °F (1040 °C), followed by water quenching or rapid cooling by other means sufficient to prevent the formation of grain boundary carbides.

6.2 S31254 shall receive a solution heat treatment, consisting of heating the material to a minimum temperature of 2100 °F (1150 °C) followed by water quenching or rapid cooling by other means sufficient to prevent the formation of grain boundary carbides.

6.3 When specified, Types 347, 348, and 321 shall receive a stabilization heat treatment in addition to the solution heat treatment specified in 6.1, which shall consist of holding the forgings at 1550 °F to 1750 °F (845 °C to 955 °C) for at least 1 h for each inch of section thickness with a minimum holding time of 2 h, followed by air-cooling or water quenching. The stabilization heat treatment is not usually specified, unless these steels are intended for severely corrosive environments in the temperature range from 800 °F to 1600 °F (425 °C to 870 °C). When specified, the stabilization heat treatment shall be the final heat treatment and may be performed before machining.

6.4 S32950 shall receive an annealing treatment, consisting of heating the material to a temperature of 1825 °F (995 °C) to 1875 °F (1025 °C) for an appropriate time followed by water quenching or rapid cooling by other means.

6.5 S32760 shall receive an annealing treatment consisting of heating the material to a minimum temperature of 2010 °F (1100 °C), followed by water quenching or rapid cooling by other means.

6.6 The ferritic grades shall be properly annealed:

6.7 Except for S41425 and S41500, the martensitic grades shall be annealed, or hardened and tempered as specified. Liquid quenching shall be permitted only by agreement with the purchaser.

6.8 For S41425, heat to 1700 °F (925 °C) minimum and hold for 1 h at temperature minimum. Air cool to below 90 °F (32 °C) and temper at 1100 °F (595 °C) minimum for 1 h/in. of cross-sectional thickness minimum.

6.9 For S41500 heat to 1750 °F (955 °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).

6.10 Types 420, 440A, 440B, and 440C should be used by the purchaser in the hardened and tempered condition. In response to heat treatment, these materials shall be capable of meeting the minimum hardness requirements as specified in Table 3.

6.11 Types 403 and 410 tempered material shall be normalized, or shall be liquid quenched from 1700 °F (925 °C), minimum, followed by being held at the tempering temperature for at least 1 h/in. (25.4 mm) of cross section in accordance with 6.11.1, 6.11.2 or 6.11.3.

6.11.1 *Condition 1*—1250 °F (675 °C) minimum, 1400 °F (760 °C) maximum.

6.11.2 *Condition 2*—1100 °F (595 °C) minimum, 1400 °F (760 °C) maximum.

6.11.3 *Condition 3*—1050 °F (565 °C) minimum, 1400 °F (760 °C) maximum.

6.12 Type S32550 shall receive an annealing treatment consisting of heating the material to a minimum temperature of 1940 °F (1060 °C), followed by water quenching of rapid cooling by other means.

7. Chemical Composition

7.1 The steel shall conform to the requirements for chemical composition specified in Table 1.

7.2 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods and Practices A751.

8. Mechanical Properties Requirements

8.1 The material shall conform to the room temperature mechanical requirements specified in Table 2.

8.2 Instead of tension tests, hardness requirements, in accordance with Table 2, may be specified by the purchaser for the ferritic and the martensitic steels.

TABLE 3 Response to Heat Treatment

Type[A]	UNS	Heat Treatment[B] Temperature °F (°C)	Quenchant	Hardness HRC, min
403	S40300	1750 (955)	Air	35
410	S41000	1750 (955)	Air	35
410S	S41008	1750 (955)	Oil or Polymer[C]	25 max
414	S41400	1750 (955)	Oil or Polymer[C]	42
416	S41600	1750 (955)	Air	35
416 Se	S41623	1750 (955)	Air	35
420	S42000	1825 (955)	Air	50
431	S43100	1875 (1020)	Oil or Polymer[C]	40
440A	S44002	1875 (1020)	Air	55
440B	S44003	1875 (1020)	Air	56
440C	S44004	1875 (1020)	Air	58

[A] Samples for testing shall be in the form of a section not exceeding ⅜ in. (9.50 mm) in thickness.
[B] Temperature tolerance is ±25 °F (14 °C).
[C] Polymer selected should have a cooling rate similar to oil to prevent cracking.