Designation: A705/A705M – 95(Reapproved 2009)

Standard Specification for Age-Hardening Stainless Steel Forgings[1]

This standard is issued under the fixed designation A705/A705M; 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[2] covers age-hardening stainless steel forgings for general use.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 Unless the order specifies an "M" designation, the material shall be furnished to inch-pound units.

NOTE 1—Bar products are covered by Specification A564/A564M.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A484/A484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

A564/A564M Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

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

2.2 *Other Documents:*[4]

SAE J 1086 Recommended Practice for Numbering Metals and Alloys (UNS)

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 Name of material (age-hardening stainless steel forgings),

3.1.3 Dimensions, including prints or sketches,

3.1.4 Type or UNS designation (Table 1),

3.1.5 Heat-treated condition (Section 5),

3.1.6 Transverse properties when required (7.4),

3.1.7 ASTM designation and date of issue, and

3.1.8 Special requirements (5.3, 5.4).

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 2—A typical ordering description is as follows: 5 age-hardening stainless steel forgings, Type 630, solution-annealed, ASTM Specification A705 dated __ . End use: pump blocks for oil well equipment.

4. General Requirements

4.1 In addition to the requirements of this specification, all requirements of the current edition of Specification A484/A484M shall apply. Failure to comply with the general requirements of Specification A484/A484M, constitutes non-conformance with this specification.

5. Materials and Manufacture

5.1 Material for forgings shall consist of billets or bars, either forged, rolled or cast, or a section cut from an ingot. The cuts shall be made to the required length by a suitable process. This material may be specified to Specification A564/A564M.

5.2 The material shall be forged by hammering, pressing, rolling, extruding, or upsetting to produce a wrought structure throughout and shall be brought as nearly as possible to the finished shape and size by hot working.

5.3 When specified on the order, sample forging may be sectioned and etched to show flow lines and the condition in regard to 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.

[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 A01.17 on Flat-Rolled and Wrought Stainless Steel.

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-705/SA-705M 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 Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

TABLE 1 Chemical Requirements[A]

UNS Designation[B]	Type	Composition, % Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Aluminum	Molybdenum	Titanium	Copper	Other Elements
S17400	630	0.07	1.00	0.040	0.030	1.00	15.00–17.50	3.00–5.00	...	...	...	3.00–5.00	[C]
S17700	631	0.09	1.00	0.040	0.030	1.00	16.00–18.00	6.50–7.75	0.75–1.50	...	...	...	...
S15700	632	0.09	1.00	0.040	0.030	1.00	14.00–16.00	6.50–7.75	0.75–1.50	2.00–3.00	...	...	...
S35500	634	0.10–0.15	0.50–1.25	0.040	0.030	0.50	15.00–16.00	4.00–5.00	...	2.50–3.25	...	...	[D]
S17600	635	0.08	1.00	0.040	0.030	1.00	16.00–17.50	6.00–7.50	0.40	...	0.40–1.20	...	...
S15500	XM-12	0.07	1.00	0.040	0.030	1.00	14.00–15.50	3.50–5.50	...	...	...	2.50–4.50	[C]
S13800	XM-13	0.05	0.20	0.010	0.008	0.10	12.25–13.25	7.50–8.50	0.90–1.35	2.00–2.50	...	...	[E]
S45500	XM-16	0.03	0.50	0.015	0.015	0.50	11.00–12.50	7.50–9.50	...	0.50	0.90–1.40	1.50–2.50	[F]
S45503	...	0.010	0.50	0.010	0.010	0.20	11.00–12.50	7.50–9.50	...	0.50	1.00–1.35	1.50–2.50	[F]
S45000	XM-25	0.05	1.00	0.030	0.030	1.00	14.00–16.00	5.00–7.00	...	0.50–1.00	...	1.25–1.75	[G]

[A] Limits are in percent maximum unless shown as a range or stated otherwise.
[B] New designation established in accordance with Practice E527 and SAEJ1086, Recommended Practice for Numbering Metals and alloys (UNS).
[C] Columbium plus tantalum 0.15–0.45.
[D] Nitrogen 0.07–0.13.
[E] Nitrogen 0.01.
[F] Columbium plus tantalum 0.10–0.50.
[G] Columbium 8 times carbon minimum.

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.

5.6 Material of types other than XM-9 shall be furnished in the solution-annealed condition, or in the equalized and over-tempered condition, as noted in Table 2, unless otherwise specified by the purchaser.

5.6.1 Types 630, XM-16, and XM-25 may be furnished in the solution-annealed or age-hardened condition.

6. Chemical Composition

6.1 The steel shall conform to the chemical composition limits specified in Table 1.

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

7. Mechanical Properties

7.1 The material, as represented by mechanical test specimens, shall conform to the mechanical property requirements specified in Table 2 and shall be capable of developing the properties in Table 3 when heat treated as specified in Table 3.

TABLE 2 Solution Heat Treatment

Type	Condition	Solution Treatment	Mechanical Test Requirements in Solution Treated Condition[A] Tensile Strength, min ksi	Tensile Strength, min [MPa]	Yield Strength, min ksi	Yield Strength, min [MPa]	Elongation in 2 in. [50 mm] or 4D, min. %	Reduction of Area, minute %	Hardness[B] Rockwell C, max	Hardness[B] Brinell, max
630	A	1900 ± 25°F [1040 ± 15°C] (cool as required to below 90°F [32°C])	...	...	...	...	...	...	38	363
631	A	1900 ± 25°F [1040 ± 15°C] (water quench)	...	...	...	...	...	...	Rb89	229
632	A	1900 ± 25°F [1040 ± 15°C] (water quench)	...	...	...	...	...	...	Rb100	269[C]
634[D]	A	1900 ± 25°F [1040 ± 15°C] quench, hold not less than 3 h at minus 100°F or lower	...	...	...	...	...	...	...	363[D]
635	A	1900 ± 25°F [1040 ± 15°C] (air cool)	120	[825]	75	[515]	10	45	32	302
XM-12	A	1900 ± 25°F [1040 ± 15°C] (cool as required to below 90°F [32°C])	...	...	...	...	...	...	38	363
XM-13	A	1700 ± 25°F [925 ± 15°C] (cool as required to below 60°F [16°C])	...	...	...	...	...	...	38	363
XM-16	A	1525 ± 25°F [830 ± 15°C] (cool rapidly)	...	...	...	...	...	...	36	331
S45503	A	1525 ± 25°F [830 ± 15°C] (cool rapidly)	...	...	...	...	...	...	36	331
XM-25	A	1900 ± 25°F [1040 ± 15°C] (cool rapidly)	125[E]	[860]	95	[655]	10	40	33	311

[A] See 6.1.
[B] Either Rockwell C hardness or Brinell is permissible. On sizes of ½ in. (12.70 mm) and smaller, Rockwell C is preferred.
[C] 321 BHN for rounds cold drawn after solution treating.
[D] Equalization and over-tempering treatment 1425 ± 50°F [775 ± 30°C] for not less than 3 h, cool to room temperature, heat to 1075 ± 25°F [580 ± 15°C] for not less than 3 h.
[E] 125 – 165 ksi [860 – 1140 MPa] for sizes up to ½ in. [13 mm].

TABLE 3 Mechanical Test Requirements After Age Hardening Heat Treatment[A]

Type	Condition	Suggested Hardening or Aging Treatment, or both[BCD]			Applicable Thickness, in. and Test Direction[E]	Tensile Strength, min		Yield Strength, min[F]		Elongation in 2 in. [50 mm] or 4D, min. %	Reduction of area, min, %	Hardness[G]		Impact Charpy-V, min	
		Temperature, °F [°C]	Time, h	Quench		ksi	[MPa]	ksi	[MPa]			Rockwell C, min	Brinell, min	ft·lbf	J
630	H900	900 [480]	1.0	air cool	Up to 3 in. incl [75 mm] (L)	190	[1310]	170	[1170]	10	40	40	388	. . .	. . .
					Over 3 in. [75 mm] to 8 in. incl [200 mm] (L)						35				
	H925	925 [495]	4.0	air cool	Up to 3 min. incl [75 mm] (L)	170	[1170]	155	[1070]	10	44	38	375	5	6.8
					Over 3 in. [75 mm] to 8 in. incl [200 mm] (L)						38				
	H1025	1025 [550]	4.0	air cool		155	[1070]	145	[1000]	12	45	35	331	15	20
	H1075	1075 [580]	4.0	air cool		145	[1000]	125	[860]	13	45	32	311	20	27
	H1100	1100 [595]	4.0	air cool	Up to 8 in. incl [200 mm] (L)	140	[965]	115	[795]	14	45	31	302	25	34
	H1150	1150 [620]	4.0	air cool		135	[930]	105	[725]	16	50	28	277	30	41
	H1150M	1400 [760] for 2 h, air cool plus 1150 [620] for 4 h, air cool.				115	[795]	75	[520]	18	55	24	255	55	75
631	RH950	1750°F [955°C] for not less than 10 min, but not more than 1 h, cool rapidly to room temperature. Cool within 24 h to minus 100 ± 10°F [75°C], hold not less than 8 h. Warm in air to room temperature. Heat to 950°F [510°C], hold 1 h, air cool.			Up to 4 in. incl. [100 mm] (L)	185	[1280]	150	[1030]	6	10	41	388	. . .	. . .
	TH1050	Alternative treatment: 1400°F [760°C] hold 90 min, cool to 55 ± 5°F [15 ± 3°C] within 1 h. Hold not less than 30 min, heat to 1050°F [565°C] hold for 90 min, air cool.			Up to 6 in. incl [150 mm] (L)	170	[1170]	140	[965]	6	25	38	352	. . .	. . .
632	RH950	Same as Type 631			Up to 4 in. incl [100 mm] (L)	200	[1380]	175	[1210]	7	25	. . .	415	. . .	. . .
	TH1050				Up to 6 in. incl [150 mm] (L)	180	[1240]	160	[1100]	8	25	. . .	375	. . .	. . .
634[H]	H1000	1750 [955] for not less than 10 min, but not more than 1 h. Water quench. Cool to not higher than minus 100°F [75°C]. Hold for not less than 3 h. Temper at 1000°F [540°C], holding for not less than 3 h.				170	[1170]	155	[1070]	12	25	37	341	. . .	. . .
635	H950	950 (510)	0.5	air cool		190	[1310]	170	[1170]	8	25	39	363	. . .	. . .
	H1000	1000 [540]	0.5	air cool		180	[1240]	160	[1100]	8	30	37	352	. . .	. . .
	H1050	1050 [565]	0.5	air cool		170	[1170]	150	[1035]	10	40	35	331	. . .	. . .
XM-12	H900	900 [480]	1.0	air cool	Up to 12 in. incl [300 mm][I] (L)	190	[1310]	170	[1170]	10	35	40	388	. . .	. . .
					Up to 12 in. incl [300 mm][I] (T)					6	15				
	H925	925 [495]	4.0	air cool	Up to 12 in. incl [300 mm][I] (L)	170	[1170]	155	[1070]	10	38	38	375	5	6.8
					Up to 12 in. incl [300 mm][I] (T)					7	20			. . .	. . .
	H1025	1025 [550]	4.0	air cool	Up to 12 in. incl [300 mm][I] (L)	155	[1070]	145	[1000]	12	45	35	331	15	20
					Up to 12 in. incl [300 mm][I] (T)					8	27			10	14
	H1075	1075 [580]	4.0	air cool	Up to 12 in. incl [300 mm][I] (L)	145	[1000]	125	[860]	13	45	32	311	20	27
					Up to 12 in. incl [300 mm][I] (T)					9	28			15	20
	H1100	1100 [595]	4.0	air cool	Up to 12 in. incl [300 mm][I] (L)	140	[965]	115	[795]	14	45	31	302	25	34
					Up to 12 in. incl [300 mm][I] (T)					10	29			15	20