



Designation: A705/A705M – 17

Standard Specification for Age-Hardening Stainless Steel Forgings¹

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 specification² 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](#).

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:*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

⁴ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

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

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
S10120	...	0.02	0.25	0.015	0.010	0.25	11.00–12.50	9.00–10.50	0.80–1.10	1.75–2.25	0.20–0.50	...	E
S11100	...	0.02	0.25	0.015	0.010	0.25	11.00–12.50	10.25–11.25	1.35–1.75	1.75–2.25	0.20–0.50	...	E

^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.

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 ques-

tion 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

TABLE 2 Solution Heat Treatment

Type	Condition	Solution Treatment	Mechanical Test Requirements in Solution Treated Condition ^A							
			Tensile Strength, min		Yield Strength, min		Elongation in 2 in. [50 mm] or 4D, min. %	Reduction of Area, minute %	Hardness ^B	
			ksi	[MPa]	ksi	[MPa]			Rockwell C, max	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
S10120	A	1545 ± 25°F [840 ± 14°C] (cool rapidly below 90°F [32°C])	...	...	...	...	...	...	36	331
S11100	A	1545 ± 25°F [840 ± 14°C] (oil or water quench), hold for min. 8 h at minus 100°F [-73°C], ^F air warm	...	...	...	...	...	...	36	331

^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].

^F Required hold time at minus 100°F [-73°C] is not mandatory if product is under 2 in. [51 mm] thickness.

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**.

7.2 The yield strength shall be determined by the offset method as described in the current edition of Test Methods and Definitions **A370**. The limiting permanent offset shall be 0.2 % of the gage length of the specimen.

7.3 The impact strength shall be determined at 70 to 80°F [20 to 25°C], by Charpy V-notch specimen Type A as described in Test Methods and Definitions **A370**.

7.4 Material tensile tested and, when specified, impact tested in the transverse direction (perpendicular to the forging

flow lines) and meeting the requirements shown in **Table 3** need not be tested in the longitudinal direction.

7.5 Samples cut from forging shall conform to the mechanical properties of **Table 3** when heat treated as specified in **Tables 2 and 3** and tested in accordance with Test Methods and Definitions **A370**.

8. Prolongations for Tests

8.1 Subject to **Section 7**, the forgings shall be produced with prolongations for testing, unless otherwise specified. The producer may elect to submit an extra forging to represent each test lot instead of prolongations, or the test specimens can be taken from the forgings themselves.

9. Number of Tests

9.1 For all classes of forgings weighing from 5000 to 7000 lb [2300 to 3200 kg] each, at least one tension test shall be made from each forging.

9.2 For all classes of forgings weighing more than 7000 lb [3200 kg] each, one tension test shall be made from each end of each forging. In the case of ring forgings, the tension test specimen shall be removed from each of two locations on the periphery, approximately 180° apart, or insofar as practicable, from opposite ends of the forging.

9.3 For forgings weighing less than 5000 lb [2300 kg] each, one tension test shall be made from each size classification for each heat in each heat-treating charge. Where continuous heat-treating furnaces are used, tests shall be made on 10 % of the forgings of each size classification from each heat subjected to the same heat-treatment practice.

10. Keywords

10.1 age-hardening stainless steel; precipitation hardening stainless steel; stainless steel forgings



TABLE 3 Mechanical Test Requirements After Age Hardening Heat Treatment⁴

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]	Fockwell 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]	40	40	388	...		
					Over 3 in. [75 mm] to 8 in. incl [200 mm] (L)				35						
					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						
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.	4.0	air cool	155	[1070]	145	[1000]	12	45	35	331	15		
					145	[1000]	125	[860]	13	45	32	311	20		
					140	[965]	115	[795]	14	45	31	302	25		
					135	[930]	105	[725]	16	50	28	277	30		
					125	[860]	105	[725]	16	50	24	255	30		
					115	[795]	75	[520]	18	55	24	255	55		
					185	[1280]	150	[1030]	6	10	41	388	...		
632	RH950	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.	4.0	air cool	170	[1170]	140	[965]	6	25	38	352	...		
					200	[1380]	175	[1210]	7	25	...	415	...		
634 ^F	TH1050	Same as Type 631	1.0	air cool	180	[1240]	160	[1100]	8	25	...	375	...		
					170	[1170]	155	[1070]	12	25	37	341	...		
635	H900	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.	0.5	air cool	190	[1310]	170	[1170]	8	25	39	363	...		
					180	[1240]	160	[1100]	8	30	37	352	...		
					170	[1170]	150	[1035]	10	40	35	331	...		
XM-12	H900	900 [480]	1.0	air cool	190	[1310]	170	[1170]	10	35	40	388	...		
									6	15					
H925	H925	925 [495]	4.0	air cool	170	[1170]	155	[1070]	10	38	38	375	5		
									7	20					