Designation: A1082/A1082M – 16 (Reapproved 2021)

Standard Specification for High Strength Precipitation Hardening and Duplex Stainless Steel Bolting for Special Purpose Applications[1]

This standard is issued under the fixed designation A1082/A1082M; 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 covers high strength stainless steel bolting materials and bolting components for special purpose applications such as pressure vessels. Several grades of precipitation-hardened and duplex (ferritic-austenitic) stainless steels are covered. Selection will depend upon design, service conditions, mechanical properties and characteristics related to the application.

1.2 The following referenced general requirements are indispensable for application of this specification: Specification A962/A962M.

1.3 Supplementary Requirements are provided for use at the option of the purchaser. The Supplementary Requirements shall only apply when specified individually by the purchaser in the purchase order or contract.

1.4 This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable "M" specification designation (SI units), the inch-pound units shall apply.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. 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.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *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]

A276/A276M Specification for Stainless Steel Bars and Shapes

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A479/A479M Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels

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

A959/A959M Guide for Specifying Harmonized Standard Grade Compositions for Wrought Stainless Steels

A962/A962M Specification for Common Requirements for Bolting Intended for Use at Any Temperature from Cryogenic to the Creep Range

2.2 *ASNT Documents:*[3]

ASNT SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

3. Ordering Information

3.1 The inquiry and order shall indicate the following, as required, to describe the desired material adequately:

3.1.1 Quantity (weight or number of pieces),

3.1.2 Description of item (bars, bolts, nuts, etc.),

3.1.3 UNS Designation or Type (see Table 1),

3.1.4 Heat-Treat Condition (see 7.1.1),

3.1.5 Dimension/Threads, etc. (see the section in Specification A962/A962M titled "Workmanship, Finish, and Appearance"), and

3.1.6 Supplementary Requirements, if any.

[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 A01.22 on Steel Forgings and Wrought Fittings for Piping Applications and Bolting Materials for Piping and Special Purpose Applications.

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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 American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

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

TABLE 1 Chemical Requirements[A]

UNS Designation[B]	Type[B]	Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen	Other Elements
Duplex (Ferritic-Austenitic) Grades											
S31100	...	0.06	1.00	0.045	0.030	1.00	25.0-27.0	6.0-7.0	...	...	Ti 0.25
S31260	...	0.030	1.00	0.030	0.030	0.75	24.0-26.0	5.5-7.5	2.5-3.5	0.10-0.30	Cu 0.20-0.80, W 0.10-0.50
S31803	...	0.030	2.00	0.030	0.020	1.00	21.0-23.0	4.5-6.5	2.5-3.5	0.08-0.20	...
S32101	...	0.040	4.0-6.0	0.040	0.030	1.00	21.0-22.0	1.35-1.70	0.10-0.80	0.20-0.25	Cu 0.10-0.80
S32202	...	0.030	2.00	0.040	0.010	1.00	21.5-24.0	1.0-2.80	0.45	0.18-0.26	...
S32205	2205	0.030	2.00	0.030	0.020	1.00	22.0-23.0	4.5-6.5	3.0-3.5	0.14-0.20	
S32304	2304	0.030	2.50	0.040	0.030	1.00	21.5-24.5	3.0-5.5	0.05-0.60	0.05-0.20	Cu 0.05-0.60
S32506	...	0.030	1.00	0.040	0.015	0.90	24.0-26.0	5.5-7.2	3.0-3.5	0.08-2.0	W 0.05-0.30
S32550	255	0.040	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
S32750	2507	0.030	1.20	0.035	0.020	0.80	24.0-26.0	6.0-8.0	3.0-5.0	0.24-0.32	Cu 0.50
S32760	...	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, %Cr+3.3x%Mo +16x%N≥40
S32906	...	0.030	0.80-1.50	0.030	0.030	0.50	28.0-30.0	5.8-7.5	1.50-2.60	0.30-0.40	Cu 0.80
S32950	...	0.030	2.00	0.035	0.010	0.60	26.0-29.0	3.5-5.2	1.00-2.50	0.15-0.35	
S39277	...	0.025	0.80	0.025	0.002	0.80	24.0-26.0	6.5-8.0	3.0-4.0	0.23-.033	Cu 1.20-2.00, W 0.80-1.20
Precipitation Hardening Grades											
S15700	632	0.09	1.00	0.040	0.030	1.00	14.0-16.0	6.5-7.7	2.00-3.00	...	Al 0.75-1.50
S17400	630	0.07	1.00	0.040	0.030	1.00	15.0-17.0	3.0-5.0	...	...	Cu 3.0-5.0, Cb +Ta 0.15-0.45
S17600	635	0.08	1.00	0.040	0.030	1.00	16.0-17.5	6.0-7.5	...	...	Al 0.40, Ti 0.40-1.20
S17700	631	0.09	1.00	0.040	0.030	1.00	16.0-18.0	6.5-7.7	...	...	Al 0.75-1.50
S35500	634	0.10-0.15	0.50-1.25	0.040	0.030	0.50	15.0-16.0	4.0-5.0	2.5-3.2	0.07-0.13	Cb 0.10-0.50

[A] Maximum or range unless otherwise indicated.
[B] See Guide A959/A959M.

TABLE 2 Solution Treatment and Mechanical Property Requirements for PH Grades[A]

UNS Designation	Type	Solution Treatment[B,C] °F [°C]	Mechanical Property Requirements in the Solution Treated Condition					
			Tensile Strength ksi [MPa]	Yield Strength ksi [MPa]	Elongation in 2" [50 mm] or 4D, min. %	Reduction of Area, min. %	Hardness[D]	
							Rockwell, maximum	Brinell, maximum
S15700	632	...	...	...	...	...	100 HRB	269
S17400	630	Cool to below 90 [32]	...	...	...	...	38 HRC	363
S17600	635	Air Cool	120 [825]	75 [515]	10	45	32 HRC	302
S17700	631	...	...	...	...	...	98 HRB	229
S35500	634	Hold at ≤ -100 [-73] for at least 3 hours	...	...	...	...	...	363

[A] Values shown are minimums or ranges unless maximum is indicated.
[B] 1900 [1040] ± 25°F [15°C].
[C] Quenched in water unless the table specifies another media.
[D] Either Rockwell or Brinell testing is permitted unless thickness is below ½ " in which case Rockwell is preferred.

4. Common Requirements

4.1 Bolting materials and components supplied to this specification shall conform to the requirements of Specification A962/A962M. These requirements include test methods, finish, thread dimensions, marking, terminology, testing, certification, optional supplementary requirements, and others. Failure to comply with the requirements of Specification A962/A962M constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification A962/A962M, this specification shall prevail.

5. Materials and Manufacture

5.1 Bars shall be produced in accordance with Specifications A276/A276M, A479/A479M or A564/A564M as applicable. Finish (hot or cold, ground, rough turned, drawn, etc.) shall be at the option of the manufacturer unless otherwise specified in the purchase order or contract.

5.2 Bolting components shall be produced in accordance with this specification and the requirements of Specification A962/A962M.

6. Chemical Composition

6.1 Each alloy shall conform to the chemical composition requirements prescribed in Table 1.

7. Heat Treatment

7.1 *Precipitation Hardening (PH) Stainless Steels:*

7.1.1 Bolting materials ordered to a Type or UNS designation only shall be furnished in the solution treated condition in accordance with Table 2 or Table 3. Age hardened bolting materials ordered to both a Type and Condition shall meet the requirements of Table 3.

7.2 *Duplex (Ferritic-Austenitic) Stainless Steels:*

7.2.1 Duplex Stainless (Ferritic-Austenitic) Steels shall be furnished in the solution-annealed condition as noted in Table 4.

8. Mechanical Properties

8.1 Samples taken from product (see the section in Specification A962/A962M titled "Mechanical Properties") shall conform to the mechanical properties of Tables 2-4.

8.2 Age hardened bolting material shall be capable of meeting the requirements prescribed in Table 3. Impact testing is required when S1 is invoked in the purchase order or contract.

8.3 *Number of Tests:*

8.3.1 *Bolting Material*—See 8.4 for hardness testing of bar. See the section in Specification A962/A962M titled "Number of Tests" for all other tests except those covered in 8.3.2.

8.3.2 *Full Size Bolting Components*—Headed bolts with a 1½ in. [37 mm] body diameter and smaller, with a body length three times the diameter or longer and a required maximum tensile load of 160 000 lb/f [705 kN], produced by upsetting or forging (hot or cold) shall be subjected to full size testing. The testing shall be in addition to the tensile testing specified in 8.3.1. The lot size shall be as shown in Specification A962/A962M (see the section titled Number of Tests). Failure shall occur in the body or threaded section with no failure, or indications of failure, such as cracks, at the junction of the head and shank. Wedge tensile testing is not required for flat countersunk head or socket button products.

8.4 *Hardness Test:*

TABLE 3 Age Hardening Heat Treatment and Mechanical Property Requirements for PH Grades[A]

Type	Condition	Suggested Hardening and/or Aging Temperatures, Time at Temperature, and Quench Media °F [°C][B,C,D,E]	Maximum Thickness inch [mm] inclusive	Mechanical Properties					
				Tensile Strength ksi [MPA]	Yield Strength ksi [MPA]	Elongation in 2" [50 mm] or 4D %	Reduction of Area, %	Hardness[F]	Impact Ft-lbf [J]
								Rockwell, HRC	Brinell	
630	H900	900 [480], 1 hour	8	190 [1310]	170 [1170]	10	35	40	388	…
630	H925	925 [495], 4 hours	8	170 [1170]	155 [1070]	10	38	38	375	5 [6.8]
630	H1025	1025 [550], 4 hours	8	155 [1070]	145 [1000]	12	45	35	331	15 [20]
630	H1075	1075 [580], 4 hours	8	145 [1000]	125 [860]	13	45	32	311	20 [27]
630	H1100	1100 [595], 4 hours	8	140 [965]	115 [795]	14	45	31	302	25 [34]
630	H1150	1150 [620], 4 hours	8	135 [930]	105 [725]	16	50	28	277	30 [41]
630	H1150D	1150 [620] for 4 hrs., air cool plus 1150 [620] for 4 hrs., air cool	8	125 [860]	105 [725]	16	50	24-33	255-311	30 [41]
630	H1150M	1400 [760] for 2 hrs., air cool plus 1150 [620] for 4 hrs., air cool	8	115 [795]	75 [520]	18	55	24	255	55 [75]
631	RH950	1750 [955] for 10 min. to 1 h, rapidly cool to room temperature. Cool within 24 hrs. to -100 ± 10 [-75 ± 5], hold 8 hrs. min. Warm in air to room temperature. Heat to 950 [510] hold 1 h, air cool.	4	185 [1280]	150 [1030]	6	10	41	388	…
631	TH1050	1400 [760] for 90 min. Cool to 55 ± 5 [15 ± 3] within 1 h, hold ½ h min., heat to 1050 [565], hold for 90 min., air cool	6	170 [1170]	140 [965]	6	25	38	352	…
632	RH950	Same as Type 631	4	200 [1380]	175 [1210]	7	25	44	415	…
632	TH1050	Same as Type 631	6	180 [1240]	160 [1100]	8	25	38	375	…
634	H1000	1750 [955] for 10 min. to 1 h, water quench. Cool to -100 [75] min., hold 3 hrs. min. Temper at 1000 [540] hold for 3 h min, air cool.	…	170 [1170]	155 [1070]	12	25	37	341	…
635	H950	950 [510], ½ h	…	190 [1310]	170 [1170]	8	25	39	363	…
635	H1000	1000 [540], ½ h	…	180 [1240]	160 [1100]	8	30	37	352	…
635	H1050	1050 [565], ½ h	…	170 [1170]	150 [1035]	10	40	35	331	…

[A] Values shown are minimums or ranges unless maximum is indicated.
[B] ± 25°F [15°C]
[C] Temperatures are suggested and may be varied to obtain the required tensile properties.
[D] Time refers to the minimum time the material is at temperature and may be extended to obtain required ductility properties.
[E] Quenching shall be accomplished using air or gas cooling unless the table specifies another media.
[F] Either Rockwell or Brinell testing is permitted unless thickness is below ½ " in which case Rockwell is preferred.

TABLE 4 Heat Treatment and Mechanical Property Requirements for Duplex Grades[A]

UNS Designation	Solution Temperature, °F [°C][B,C]	Size Range	Mechanical Properties				
			Tensile Strength, ksi [MPA]	Yield Strength, ksi [MPA]	Elongation in 2" [50 mm] or 4D %	Hardness[D]	
						Rockwell, HRC maximum	Brinell, maximum
S31100	1900 [1040]	...	90 [620]	65 [450]	20	30	290
S31260	1870 to 2010 [1020 to 1100]	...	100 [690]	70 [485]	20	31	297
S31803	1900 [1040]	...	90 [620]	65 [450]	25	30	290
S32101	1870 [1020]	...	94 [650]	65 [450]	30	30	290
S32202	1800 to 1975 [980 to 1080]	...	94 [650]	65 [450]	30	30	290
S32205	1900 [1040]	...	95 [655]	65 [450]	25	30	290
S32304	1800 [980]	...	90 [620]	65 [450]	18	32	302
S32506	1870 – 2050 [1020 – 1120]	...	90[620]	65 [450]	18	32	302
S32550	1900 [1040]	...	110[760]	80 [550]	15	31	297
S32750	1880 – 2060 [1025 – 1125]	2 in. and under	116[800]	80 [550]	15	33	310
		>2 in.	110 [760]	75 [515]	15	33	310
S32760	2010 [1100]	...	109 [750]	80 [550]	25	30	290
S32900	1750 [955]	...	90 [620]	70 [485]	15	30	290
S32906	1830 to 2100 [1000 to 1150]	...	109 [750]	80 [550]	25	33	310

[A] Values shown are minimums or ranges unless maximum is indicated.
[B] ± 25°F [15°C].
[C] Quenched in water.
[D] Either Rockwell or Brinell testing is permitted unless thickness is below ½ " in which case Rockwell is preferred.

8.4.1 *Bolting Material Bars 2 in. [50 mm] and Over*—One test on each mill-treated length.

8.4.2 *Bolting Material Bars Under 2 in. [50 mm]*—One test on at least 10 % of the mill treated lengths.

9. Nuts

9.1 Nuts made from the grades listed in this specification shall be furnished when specified in the purchase order. The mechanical test requirements of Section 8 apply in addition to requirements specified in the purchase order or contract. Hardness testing shall be done following the completion of all production heat treatment operations. See S5 for proof load testing and S6 for cross-sectional hardness testing.

10. Certification

10.1 Certification is required. In addition to the requirements of A962/A962M (see the section in A962/A962M titled "Certification"), the report shall include results of the chemical analysis, mechanical tests and state the method of heat treatment employed.

11. Product Marking

11.1 See A962/A962M. The grade symbol shall be as shown in Table 5.

12. Keywords

12.1 age-hardening stainless steel; bolts–stainless steel; duplex stainless steel; bolting components–stainless steel; high strength stainless steels; marking; nuts; precipitation hardening stainless steel; stainless steel bars; stainless steel bolting components

TABLE 5 Marking

UNS Designation	Type	Condition	Grade Symbol
Duplex (Ferritic-Austenitic) Grades			
S31100	...	...	31100
S31260	...	...	31260
S31803	...	...	31803
S32101	...	...	32101
S32202	...	...	32202
S32205	2205	...	32205
S32304	2304	...	32304
S32506	...	...	32506
S32550	255	...	32550
S32750	2507	...	32750
S32760	...	...	32760
S32900	...	...	
S32906	...	...	32906
Precipitation Hardening Grades			
S15700	632	...	157
S15700	632	RH95	157A
S15700	632	TH1050	157B
S17400	630	...	174
S17400	630	H900	174A
S17400	630	H925	174B
S17400	630	H1025	174C
S17400	630	H1075	174D
S17400	630	H1100	174E
S17400	630	H1150	174G
S17400	630	H1150D	174H
S17400	630	H1150M	174J
S17600	635	...	176
S17600	635	H950	176A
S17600	635	H1000	176B
S17600	635	H1050	176C
S17700	631	...	177
S17700	631	RH95	177A
S17700	631	TH1050	177B
S35500	634	...	355
S35500	634	H1000	355A