METRIC
Designation: F 568M – ~~98~~02

Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners[1]

This standard is issued under the fixed designation F 568M; 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 Department of Defense.

1. Scope*

1.1 This specification covers chemical and mechanical requirements for nine property classes of carbon and alloy steel externally threaded metric fasteners in nominal thread diameters M1.6 through M100 suited for use in general engineering applications.

1.2 This specification does not cover dimensional requirements for fasteners of any property class. When referencing this specification for procurement purposes, it is mandatory that size, type, style, and any special dimensions of the product be additionally specified.

1.2.1 In case of any conflict in requirements, the requirements of the individual product specification shall take precedence over those of this general specification.

1.2.2 The purchaser may specify additional requirements which do not negate any of the provisions of this general specification or of the individual product specification. Such additional requirements, the acceptance of which are subject to negotiation with the supplier, must be included in the order information (see Section 3).

1.3 Requirements for seven of the nine property classes, 4.6, 4.8, 5.8, 8.8, 9.8, 10.9, and 12.9, are essentially identical with requirements given for these classes in ISO ~~898/1.~~ 898-1. The other two, 8.8.3 and 10.9.3, are not recognized in ISO standards.

1.4 Classes 8.8.3 and 10.9.3 bolts, screws, and studs have atmospheric corrosion resistance and weathering characteristics comparable to those of the steels covered in Specification A 588. The atmospheric corrosion resistance of these steels is substantially better than that of carbon steel with or without copper addition. See 5.2. When properly exposed to the atmosphere, these steels can be used bare (uncoated) for many applications.

1.5 When agreed on by the purchaser, Class 5.8 fasteners may be supplied when either Classes 4.6 or 4.8 are ordered; Class 4.8 may be supplied when Class 4.6 is ordered; Class 8.8.3 may be supplied when Class 8.8 is ordered; and Class 10.9.3 may be supplied when Class 10.9 is ordered.

1.6 The product size range for which each property class is applicable is given in Table 1 and Table 2 on chemical composition requirements, and the mechanical requirements table (see Table 3).

1.7 Appendix X1 gives conversion guidance to assist designers and purchasers in the selection of a suitable property class.

1.8 Appendix X2 explains the significance of the property class designation numerals.

2. Referenced Documents

2.1 *ASTM Standards:*

A 153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware[2]

---

[1] This specification is under the jurisdiction of ASTM Committee F~~=~~16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets and Washers.

Current edition approved ~~Dec.~~ Oct. 10, ~~1998.~~ 2002. Published ~~February 1999.~~ November 2002. Originally published as F 568 – 79. Last previous edition F 568 – 9~~8~~8.

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

TABLE 1 Chemical Composition Requirements

Property Class	Nominal Product Diameter, mm	Material and Treatment	Product Analysis Element (% by weight)						Tempering Temperature, °C
			C		Mn	B	P	S	
			Min	Max	Min	Min	Max	Max	Min
4.6	M5–M100	low or medium carbon steel	. . .	0.55	. . .	. . .	0.048	0.058	. . .
4.8	M1.6–M16	low or medium carbon steel, partially or fully annealed as required	. . .	0.55	. . .	. . .	0.048	0.058	. . .
5.8	M5–M24	low or medium carbon steel, cold worked	0.13	0.55	. . .	. . .	0.048	0.058[A]	. . .
8.8	M20–M80	medium carbon steel, product is quenched and tempered[B]	0.25	0.55	. . .	. . .	0.048	0.058[C]	425
8.8	M20–M36	low carbon martensite steel, product is quenched and tempered[D]	0.15	0.40	0.74	0.0005	0.048	0.058	425
8.8.3	M20–M36	atmospheric corrosion resistant steel, product is quenched and tempered				see Table 2			425
9.8	M1.6–M16	medium carbon steel, product is quenched and tempered	0.25	0.55	. . .	. . .	0.048	0.058	425
9.8	M1.6–M16	low carbon martensite steel, product is quenched and tempered[D]	0.15	0.40	0.74	0.0005	0.048	0.058	425
10.9	M5–M20	medium carbon steel, product is quenched and tempered[E,F]	0.25	0.55	. . .	. . .	0.048	0.058	425
10.9	M5–M100	medium carbon alloy steel, product is quenched and tempered[E]	0.20	0.55	. . .	. . .	0.040	0.045	425
10.9	M5–M36	low carbon martensite steel, product is quenched and tempered[E,F]	0.15	0.40	0.74	0.0005	0.048	0.058	340
10.9.3	M16–M36	atmospheric corrosion resistant steel, product is quenched and tempered[E]				see Table 2			425
12.9	M1.6–M100	alloy steel, product is quenched and tempered[E,G]	0.31	0.65	. . .	. . .	0.045	0.045	380

[A] For studs only, sulfur content may be 0.33 %, max.
[B] At the manufacturer's option, medium-carbon-alloy steel may be used for nominal thread diameters over M24.
[C] For studs only, sulfur content may be 0.13 %, max.
[D] Products made using this material shall be specially identified as specified in Section 12.
[E] Steel for Classes 10.9, 10.9.3, and 12.9 products shall be fine grain and have a hardenability that will achieve a structure of approximately 90 % martensite at the center of a transverse section one diameter from the threaded end of the product after oil quenching.
[F] Carbon steel may be used at the option of the manufacturer for products of nominal thread diameters M12 and smaller. When approved by the purchaser, carbon steel may be used for products of diameters larger than M12 through M20, inclusive.
[G] Alloy steel shall be used. Steel is considered to be alloy by the American Iron and Steel Institute when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: manganese, 1.65 %; silicon, 0.60 %; copper, 0.60 %; or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum, chromium up to 3.99 %, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying elements added to obtain a desired alloying effect.

A 307 Specification for Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength[3]
A 325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength[3]
A 325M Specification for High-Strength Bolts for Structural Steel Joints [Metric][3]
A 354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners[3]
A 449 Specification for Quenched and Tempered Steel Bolts and Studs[3]
A 490 Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength[3]
A 490M Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric][3]
A 574 Specification for Alloy Steel Socket-Head Cap Screws[3]
A 588/A588M Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4 in. [100 mm] Thick[4]
A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[5]
B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel[6]
D 3951 Practice for Commercial Packaging[7]
F 606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets [Metric][3]
F 788/F788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series[3]
F 1470 Guide for Fastener Sampling for Specified Mechanical Properties and Performance Requirements[5]
G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels[8]

2.2 *ISO Standard:*[9]
ISO 898/1-1, Mechanical Properties of Fasteners, Part I, Bolts, Screws, and Studs

2.3 *ANSI/ASME Standards:*[9]
B 18.2.3.1M Metric Hex Cap Screws
B 18.2.3.2M Metric Formed Hex Screws

[2] *Annual Book of ASTM Standards*, Vol 01.06.
[3] *Annual Book of ASTM Standards*, Vol 01.08.
[4] *Annual Book of ASTM Standards*, Vol 01.04.
[5] *Annual Book of ASTM Standards*, Vol 01.03.
[6] *Annual Book of ASTM Standards*, Vol 02.05.
[7] *Annual Book of ASTM Standards*, Vol 15.09.
[8] *Annual Book of ASTM Standards*, Vol 03.02.
[9] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

TABLE 2 Chemical Composition Requirements for Classes 8.8.3 and 10.9.3

Element	Composition, %[A]					
	A	B	C	D	E	F
Carbon:						
Heat analysis	0.33–0.40	0.38–0.48	0.15–0.25	0.15–0.25	0.20–0.25	0.20–0.25
Product analysis	0.31–0.42	0.36–0.50	0.14–0.26	0.14–0.26	0.18–0.27	0.19–0.26
Manganese:						
Heat analysis	0.90–1.20	0.70–0.90	0.80–1.35	0.40–1.20	0.60–1.00	0.90–1.20
Product analysis	0.86–1.24	0.67–0.93	0.76–1.39	0.36–1.24	0.56–1.04	0.86–1.24
Phosphorus:						
Heat analysis	0.040 max	0.06–0.12	0.035 max	0.040 max	0.040 max	0.040 max
Product analysis	0.045 max	0.06–0.125	0.040 max	0.045 max	0.045 max	0.045 max
Sulfur:						
Heat analysis	0.050 max	0.050 max	0.040 max	0.050 max	0.040 max	0.040 max
Product analysis	0.055 max	0.055 max	0.045 max	0.055 max	0.045 max	0.045 max
Silicon:						
Heat analysis	0.15–0.35	0.30–0.50	0.15–0.35	0.25–0.50	0.15–0.35	0.15–0.35
Product analysis	0.13–0.37	0.25–0.55	0.13–0.37	0.20–0.55	0.13–0.37	0.13–0.37
Copper:						
Heat analysis	0.25–0.45	0.20–0.40	0.20–0.50	0.30–0.50	0.30–0.60	0.20–0.40
Product analysis	0.22–0.48	0.17–0.43	0.17–0.53	0.27–0.53	0.27–0.63	0.17–0.43
Nickel:						
Heat analysis	0.25–0.45	0.50–0.80	0.25–0.50	0.50–0.80	0.30–0.60	0.20–0.40
Product analysis	0.22–0.48	0.47–0.83	0.22–0.53	0.47–0.83	0.27–0.63	0.17–0.43
Chromium:						
Heat analysis	0.45–0.65	0.50–0.75	0.30–0.50	0.50–1.00	0.60–0.90	0.45–0.65
Product analysis	0.42–0.68	0.47–0.83	0.27–0.53	0.45–1.05	0.55–0.95	0.42–0.68
Vanadium:						
Heat analysis	. . .	. . .	0.020 min	. . .	. . .	. . .
Product analysis	. . .	. . .	0.010 min	. . .	. . .	. . .
Molybdenum:						
Heat analysis	. . .	0.06 max	. . .	0.10 max	. . .	. . .
Product analysis	. . .	0.07 max	. . .	0.11 max	. . .	. . .
Titanium:						
Heat analysis	. . .	. . .	. . .	0.05 max	. . .	. . .
Product analysis	. . .	. . .	. . .	. . .	. . .	. . .

[A] A, B, C, D, E, and F are types of material used for Property Classes 8.8.3 and 10.9.3 bolts, screws, and studs. Selection of a composition shall be at the option of the product manufacturer except that sizes M20 and larger shall conform to Composition A or B only.

TABLE 3 Mechanical Requirements for Bolts, Screws, and Studs

Property Class	Nominal Diameter of Product	Full Size Bolts, Screws, and Studs			Machined Test Specimens of Bolts, Screws, and Studs				Surface Hardness	Product Hardness			
		Proof Load[A]		Tensile Strength, MPa[A]	Yield Strength, MPa[B]	Tensile Strength, MPa	Elongation, %	Reduction of Area, %	Rockwell 30N	Rockwell		Vickers	
		Length Measurement Method, MPa	Yield Strength Method, MPa	Min	Min	Min	Min	Min	Max	Min	Max	Min	Max
4.6	M5–M100	225	240	400	240[C]	400	22	35	. . .	B67	B95	120	220
4.8	M1.6–M16	310	340	420	340	420	14	35	. . .	B71	B95	130	220
5.8	M5–M24[D]	380	420	520	420	520	10	35	. . .	B82	B95	160	220
8.8	M20–M80	600	660	830	660	830	12	35	53	C23	C34	255	336
8.8.3	M20–M36	600	660	830	660	830	12	35	53	C23	C34	255	336
9.8	M1.6–M16	650	720	900	720	900	10	35	56	C27	C36	280	360
10.9	M5–M100	830	940	1040	940	1040	9	35	59	C33	C39	327	382
10.9.3	M16–M36	830	940	1040	940	1040	9	35	59	C33	C39	327	382
12.9[E]	M1.6–M100	970	1100	1220	1100	1220	8	35	63	C38	C44	372	434

[A] Proof load and tensile strength values for full size products of each property class are given in Table 5.
[B] Yield strength is stress at which a permanent set of 0.2 % of gage length occurs.
[C] Yield point shall apply instead of yield strength at 0.2 % offset for Class 4.6 products.
[D] Class 5.8 applies only to bolts and screws with lengths 150 mm and shorter and to studs of all lengths.
[E] Caution is advised when considering the use of Class 12.9 bolts, screws, and studs. Capability of the bolt manufacturer, as well as the anticipated in-use environment, should be considered. High-strength products of Class 12.9 require rigid control of heat-treating operations and careful monitoring of as-quenched hardness, surface discontinuities, depth of partial decarburization, and freedom from carburization. Some environments may cause stress corrosion cracking of nonplated as well as electroplated products.

B 18.2.3.3M Metric Heavy Hex Screws
B 18.2.3.4M Metric Hex Flange Screws

B 18.2.3.5M Metric Hex Bolts
B 18.2.3.6M Metric Heavy Hex Bolts
B 18.5.2.1M Metric Round Head Short Square Neck ~~Bolts~~
~~2.4 *ANSI/ASME Standard:*[9]~~
~~B18.5.2.2M Metric~~ Bolts
B 18.5.2.2M Metric Round Head Square Neck Bolts

3. Ordering Information

3.1 Orders for products referencing this specification shall include the following:
3.1.1 Quantity (number of pieces),
3.1.2 Name of product (that is, type and style of bolt, screw, or stud),
3.1.3 Dimensions, including nominal thread diameter, thread pitch, and length,
3.1.4 Property class,
3.1.5 *Zinc Coating*—Specify the zinc coating process required, for example, hot dip, mechanically deposited, or no preference (see 4.5),
3.1.6 *Other Finishes*—Specify other protective finish, if required,
3.1.7 ASTM designation and year of issue, and
3.1.8 Any special requirements (for example, mechanical requirements, see ~~Table 3, or proof load testing, see Table 4~~ Tables 3 and 4, or proof load testing, see Tables 5 and 6; stud marking, see 12~~4~~.2.3; additional testing, see ~~8.3).~~

TABLE 4 Mechanical Testing Requirements for Bolts, Screws, and Studs [A]

Item	Product	Property Class	Specified Min Tensile Strength of Product (See Table 5) kN	Length of Product[B]	Product Hardness		Surface Hardness[C]	Tests Conducted Using Full-Size Products			Tests Conducted Using Machined Test Specimens			
					Max	Min	Max	Proof Load	Wedge Tensile Strength[D]	Axial Tensile Strength	Yield Strength	Tensile Strength	Elongation	Reduction of Area
1	short length bolts and screws	all	all	less than *x*	●	●	●	...	...	...	...	...	...	...
2	special head bolts and screws[E]	all	all	all	●	●	●	...	...	...	...	...	...	...
3	bolts and screws with hex or hex flange heads except items 1 and 2	all	450 and less	*x* to 8D or 200 mm, whichever is greater	●	...	●	○	●	...	...	...	...	...
				over 8D or 200 mm, whichever is greater through and incl 300 mm	●	...	●	○	●	...	...	...	...	...
				over 300 mm	●	...	●	○	A	...	B	B	B	B
			over 450	*x* and longer	●	...	●	○	A	...	B	B	B	B
4	all bolts and screws except items 1, 2, and 3	all	450 and less	*x* to 8D or 200 mm, whichever is greater	●	...	●	○	...	●	...	...	...	...
				over 8D or 200 mm, whichever is greater	●	...	●	○	...	A	B	B	B	B
			over 450	*x* and longer	●	...	●	○	...	A	B	B	B	B
5	short length studs	all	all	less than *x*	●	●	●	...	...	...	...	...	...	...
6	all studs except item 5	all	450 and less	*x* to 8D or 200 mm, whichever is greater	●	...	●	○	●	...	...	...	...	...
				over 8D or 200 mm, whichever is greater	●	...	●	○	A	...	B	B	B	B
			over 450	*x* and longer	●	...	●	○	A	...	B	B	B	B
Tests to be conducted in accordance with the following paragraph of Method F 606M:					3.1			3.2.1	3.5	3.4	3.6			

[A] ● denotes a mandatory test. For each product all mandatory tests (●) shall be performed. In addition, either all tests denoted A (which apply to full-size products) or all tests denoted B (which apply to machined test specimens) shall be performed. ○ denotes tests to be performed when specifically required in the original inquiry and purchase order. In case arbitration is necessary, A tests and proof load test shall be performed. Leaders (. . .) indicate tests that are not required.

[B] D equals nominal diameter of product. *x* equals the minimum length of product subject to tensile testing. Values of *x* are as follows:

Nominal Product Diameter	*x*, mm
M5	12
M6	14
M8	20
M10	25
M12	30
M14	35
M16	40
M20	45
M24 and larger	3D

[C] Surface hardness requirements apply only to Property Classes 8.8, 8.8.3, 9.8, 10.9, 10.9.3, and 12.9.

[D] Tensile test wedge angles are specified in Table 6.

[E] Special head bolts and screws are those with special configurations or with drilled heads which are weaker than the threaded section.

TABLE 5 Proof Load and Tensile Strength Values, kN[A]

Nominal Product Diameter and Thread Pitch	Stress Area,[B] mm²	Class 4.6			Class 4.8			Class 5.8			Class 8.8 and 8.8.3			Class 9.8			Classes 10.9 and 10.9.3			Class 12.9		
		Proof Load[C]		Tensile Strength, min	Proof Load		Tensile Strength, min	Proof Load		Tensile Strength, min	Proof Load		Tensile Strength, min	Proof Load		Tensile Strength, min	Proof Load		Tensile Strength, min	Proof Load		Tensile Strength, min
		Method 1	Method 2		Method 1	Method 2		Method 1	Method 2		Method 1	Method 2		Method 1	Method 2		Method 1	Method 2		Method 1	Method 2	
M1.6 × 0.35	1.27	...	...	...	0.39	0.43	0.53	...	...	...	...	...	...	0.83	0.91	1.14	...	...	...	1.23	1.40	1.55
M2 × 0.4	2.07	...	...	...	0.64	0.70	0.87	...	...	...	...	...	...	1.35	1.49	1.86	...	...	...	2.01	2.28	2.53
M2.5 × 0.45	3.39	...	...	...	1.05	1.15	1.42	...	...	...	...	...	...	2.20	2.44	3.05	...	...	...	3.29	3.73	4.14
M3 × 0.5	5.03	...	...	...	1.56	1.71	2.11	...	...	...	...	...	...	3.27	3.62	4.53	...	...	...	4.88	5.53	6.14
M3.5 × 0.6	6.78	...	...	...	2.10	2.31	2.85	...	...	...	...	...	...	4.41	4.88	6.10	...	...	...	6.58	7.13	8.27
M4 × 0.7	8.78	...	...	...	2.72	2.99	3.69	...	...	...	...	...	...	5.71	6.32	7.90	...	...	...	8.52	9.66	10.7
M5 × 0.8	14.2	3.20	3.41	5.68	4.40	4.83	5.96	5.40	5.96	7.38	...	...	...	9.23	10.2	12.8	11.8	13.3	14.8	13.8	15.6	17.3
M6 × 1	20.1	4.52	4.82	8.04	6.23	6.83	8.44	7.64	8.44	10.5	...	...	...	13.1	14.5	18.1	16.7	18.9	20.9	19.5	22.1	24.5
M8 × 1.25	36.6	8.24	8.78	14.6	11.3	12.4	15.4	13.9	15.4	19.0	...	...	...	23.8	26.4	32.9	30.4	34.4	38.1	35.5	40.3	44.7
M10 × 1.5	58.0	13.1	13.9	23.2	18.0	19.7	24.4	22.0	24.4	30.2	...	...	...	37.7	41.8	52.2	48.1	54.5	60.3	56.3	63.8	70.8
M12 × 1.75	84.3	19.0	20.2	33.7	26.1	28.7	35.4	32.0	35.4	43.8	...	...	...	54.8	60.7	75.9	70.0	79.2	87.7	81.8	92.7	103
M14 × 2	115	25.9	27.6	46.0	35.7	39.1	48.3	43.7	48.3	59.8	...	...	...	74.8	82.8	104	95.5	108	120	112	127	140
M16 × 2	157	35.3	37.7	62.8	48.7	53.4	65.9	59.7	65.9	81.6	[D]	[D]	[D]	102	113	141	130	148	163	152	173	192
M20 × 2.5	245	55.1	58.8	98.0	...	...	...	93.1	103	127	147	162	203	...	...	...	203	230	255	238	270	299
M22 × 2.5[E]	303	...	...	...	...	...	...	...	...	...	182	200	251	...	...	...	251	285	315	...	...	...
M24 × 3	353	79.4	84.7	141	...	...	...	134	148	184	212	233	293	...	...	...	293	332	367	342	388	431
M27 × 3[E]	459	...	...	...	...	...	...	...	...	...	275	303	381	...	...	...	381	431	477	...	...	...
M30 × 3.5	561	126	135	224	...	...	...	...	...	...	337	370	466	...	...	...	466	527	583	544	617	684
M36 × 4	817	184	196	327	...	...	...	...	...	...	490	539	678	...	...	...	678	763	850	792	899	997
M42 × 4.5	1120	252	269	448	...	...	...	...	...	...	672	739	930	...	...	...	930	1050	1160	1090	1230	1370
M48 × 5	1470	331	353	588	...	...	...	...	...	...	882	970	1220	...	...	...	1220	1380	1530	1430	1620	1790
M56 × 5.5	2030	457	487	812	...	...	...	...	...	...	1220	1340	1680	...	...	...	1680	1910	2110	1970	2230	2480
M64 × 6	2680	603	643	1070	...	...	...	...	...	...	1610	1790	2220	...	...	...	2220	2520	2790	2600	2850	3270
M72 × 6	3460	779	830	1380	...	...	...	...	...	...	2080	2280	2870	...	...	...	2870	3250	3600	3360	3810	4220
M80 × 6	4340	977	1040	1740	...	...	...	...	...	...	2600	2860	3600	...	...	...	3600	4080	4510	4210	4770	5290
M90 × 6	5590	1260	1340	2240	...	...	...	...	...	...	...	...	...	...	...	...	4640	5250	5810	5420	6150	6820
M100 × 6	6990	1570	1680	2800	...	...	...	...	...	...	...	...	...	...	...	...	5800	6570	7270	6780	7690	8530

[A] Proof loads and tensile strengths are computed by multiplying the stresses given in Table 3 by the stress area of the thread.

[B] Stress area, $mm^2 = 0.7854\ (D - 0.9382\ P)^2$, where D = nominal product size, mm, and P = thread pitch, mm.

[C] Proof load, Method 1, is the length measurement method as described in 3.2.3 of Test Methods F 606. Proof load, Method 2, is the yield strength method as described in 3.2.5 of Test Methods F 606.

[D] For Classes 8.8 and 8.8.3 sizes M16 and smaller are not covered by Specification F 568M. Class 9.8 may be suitable for applications requiring sizes M16 and smaller after consideration of design parameters, application and service environment.

[E] M22 and M27 are standard sizes for high-strength structural bolts only as covered in Specifications A 325M and A 490M.

TABLE 6 Tension Test Wedge Angle

Product	Property Class	Nominal Product Diameter, (*D*)	Wedge Angle,°
Hex bolts and screws threaded 1*D* or closer to underside of head	4.6, 4.8, 5.8	through M24	10
		over M24	6
	8.8, 8.8.3, 9.8, 10.9, 10.9.3	through M20	6
		over M20	4
Hex bolts and screws with unthreaded length greater than 1*D*	4.6, 4.8, 5.8, 8.8, 8.8.3, 9.8, 10.9, 10.9.3	through M24	10
		over M24	6
Hex bolts and screws threaded 2*D* or closer to underside of head	12.9	all	4
Hex bolts and screws with unthreaded length greater than 2*D*	12.9	through M20	6
		over M20	4
Hex flange screws	5.8, 9.8, 10.9	all	6
Studs	all	through M20	6
		over M20	4

~~3.2 *Government Provisioning*—Government procurement and design selection criteria shall be specified in accordance with ANSI (or ANSI/ASME) B18.2.3.1M, B18.2.3.2M, B18.2.3.3M, B18.2.3.4M, B18.2.3.5M, B18.2.3.6M, B18.5.2.1M, or B18.5.2.2M, as appropriate.~~ 8).

3.1.9 Test reports if required, see section 13.

4. Materials and Manufacture

4.1 Steel for bolts, screws, and studs shall be made by the open-hearth, basic-oxygen, or electric-furnace process.

4.2 *Heading Practice*:

4.2.1 Methods other than upsetting or extrusion, or both, are permitted only by special agreement between purchaser and producer.

4.2.2 Class 4.6 may be hot or cold headed at the option of the manufacturer.

4.2.3 Classes 4.8, 5.8, 8.8, 8.8.3, 9.8, 10.9, 10.9.3, and 12.9 bolts and screws in nominal thread diameters up to M20 inclusive with lengths up to 10 times the nominal product size or 150 mm, whichever is shorter, shall be cold headed, except that they may be hot headed by special agreement with the purchaser. Larger diameters and longer lengths may be cold or hot headed at the option of the manufacturer.

4.3 *Threading Practice*:

4.3.1 Threads on Class 4.6 bolts and screws and on all classes of studs may be cut, rolled, or ground at the option of the manufacturer.

4.3.2 Threads on Classes 4.8, 5.8, 8.8, 8.8.3, 9.8, 10.9, 10.9.3, and 12.9 bolts and screws in nominal thread diameters up to M20 inclusive, and product lengths up to 150 mm inclusive, shall be roll threaded, except by special agreement with the purchaser. Threads of these classes on bolts and screws larger than M20 or longer than 150 mm or both, may be rolled, cut, or ground at the option of the manufacturer.

4.4 *Heat Treatment*:

4.4.1 Class 4.6 bolts and screws and Classes 4.6, 4.8, and 5.8 studs need not be heat treated.

4.4.2 Classes 4.8 and 5.8 bolts and screws shall be stress relieved if necessary to assure the soundness of the head to shank junction. When stress relieving is specified by the purchaser, Class 5.8 bolts and screws shall be stress relieved at a minimum stress-relief temperature of 470°C. Where higher stress-relief temperatures are necessary to relieve stresses in severely upset heads, mechanical requirements shall be agreed upon between the purchaser and producer.

4.4.3 Classes 8.8, 8.8.3, and 9.8 bolts, screws, and studs shall be heat treated by quenching in a liquid medium from above the transformation temperature and reheating to the tempering temperature given in Table 1.

4.4.4 Classes 10.9, 10.9.3, and 12.9 bolts, screws, and studs shall be heat treated by quenching in oil from above the transformation temperature and reheating to the tempering temperature given in Table 1.

4.4.5 *Tempering-Temperature-Audit Test*— This test is a means for checking whether products were tempered at the specified temperature. The hardness (mean hardness of three hardness readings) of a bolt, screw, or stud as manufactured shall be measured. The product shall then be retempered for a minimum of 30 min per 25 mm of nominal diameter, but not less than 30 min, at a temperature 10°C less than the minimum tempering temperature specified for the property class and material in Table 1. The hardness of the retempered product shall then be measured. The difference between the hardness of the product before and after retempering shall not exceed 20 HV points.

4.5 *Zinc Coatings, Hot-Dip, and Mechanically Deposited*:

4.5.1 When zinc-coated fasteners are required, the purchaser shall specify the zinc coating process, for example, hot dip, mechanically deposited, or no preference.

4.5.2 When hot-dip is specified, the fasteners shall be zinc coated by the hot-dip process in accordance with the requirements of Class C of Specification A 153.

4.5.3 When mechanically deposited is specified, the fasteners shall be zinc coated by the mechanical deposition process in accordance with the requirements of Class 50 of Specification B 695.

4.5.4 When no preference is specified, the supplier may furnish either a hot dip zinc coating in accordance with Specification A 153, Class C, or a mechanically deposited zinc coating in accordance with Specification B 695, Class 50. All components of mating fasteners (for example, bolts, nuts, and washers) shall be coated by the same zinc coating process, and the suppliers option is limited to one process per item with no mixed processes in a lot.

4.6 Bolts, screws, and studs of Classes 10.9 and 12.9 should not be hot-dip zinc-coated.

NOTE 1—Research conducted on bolts with properties equivalent to Class 10.9 indicated that hydrogen-stress corrosion cracking may occur in hot-dip zinc-coated fasteners of Classes 10.9 and 12.9.

5. Chemical Composition

5.1 For all classes except 8.8.3 and 10.9.3, the bolts, screws, and studs shall conform to the chemical composition specified in Table 1.

5.2 *Classes 8.8.3 and 10.9.3*:

5.2.1 Sizes M20 and smaller shall conform to any one of the compositions (A, B, C, D, E, or F) specified in Table 2, at the suppliers option.

5.2.2 Sizes larger than M20 shall conform to Compositions A or B specified in Table 2, at the suppliers option.

5.2.3 See Guide G 101 for methods of estimation corrosion resistance of low alloy steels.

5.3 Material analyses may be made by the purchaser from finished products representing each lot. The chemical composition thus determined shall conform to the requirements specified for the product analysis in Table 1 and Table 2.

5.4 Use of heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted.

5.5 Chemical analyses shall be performed in accordance with Test Methods A 751.

6. Mechanical Properties

6.1 Bolts, screws, and studs shall be tested in accordance with the mechanical testing requirements for the applicable type, property class, size, and length of product as specified in Table 4, and shall meet the mechanical requirements specified for that product in Tables 3-5.

6.2 For products on which both hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence over low readings of hardness tests.

7. Workmanship

7.1 Surface discontinuity limits shall be in accordance with Specification F 788/F 788M.

8. Number of ~~Tests and Retests~~

~~8.1 The requirements of this specification~~ Tests

8.1 *Testing Responsibility*:

8.1.1 Each lot shall be tested by the manufacturer prior to shipment in ~~continuous mass~~ accordance with the production lot identification-control quality assurance plan in 8.2-8.5.

8.1.2 When fasteners are furnished by a sourc~~k;~~e other than the manufacturer, the responsible party, as defined in 11.1 shall ~~inspect to ensure~~ be responsible for ensuring that all tests have been performed and the ~~product conforms to~~ fasteners comply with the ~~specified requirements. Additional tests~~ requirements of ~~individual shipments~~ this specification.

8.2 *Purpose ~~of product are not ordinarily required. Individual heats~~ Lot Inspection*—The purpose of ~~steel are not identified in~~ a lot inspection program is to ensure that each lot conforms to the ~~finished product.~~

~~8.2 When specified in the order, the manufacturer shall furnish~~ requirements of this specification. For such a ~~test report certified~~ plan to be fully effective, it is essential that secondary processors, distributors, and purchasers maintain the ~~last completed set~~ identification and integrity of ~~mechanical tests for~~ each lot until the product is installed.

8.3 *Lot Prockessizng*—All fasteners shall be processed in ~~each shipment.~~

~~8.3 When testing of~~ accordance with a ~~specific~~ lot identification-control quality assurance plan. The manufacturer, secondary processors, and di~~f~~stributors shall identify and ~~o~~ maintain the ~~purchase order, a lot, for purposes~~ integrity of each lot of fasteners from raw material selection through all processing operations and treatments to final packing and shipment. Each lot shall be assigned its own lot identification number, each lot shall be tested, and the inspection test ~~samples,~~ reports for each lot shall ~~consist~~ be retained.

8.4 *Lot Definition*:

8.4.1 *Standard Lot*—A lot shall be a quantity of ~~all products~~ uniquely identified fastener product of the same nominal size and length produced consecutively at the initial operations from a single mill heat of material and heat treatment lot and processed at one time by the same proce~~,~~ss in the same manner so that ~~is, bolts, screws,~~ statistical sampling is valid. The identity of the lot and lot integrity shall be maintained throughout all subsequent operations and packaging.

8.4.2 *Lots of 2000 Pieces or ~~studs having~~ Fewer*—Orders for 2000 pieces or fewer of the same nominal diameter~~,~~ but varying in length~~,~~ that has been processed essentially under the same conditions from the same mill heat of material and ~~property class, offered~~ submitted for inspection at one ~~time. Unless otherwise specified, the~~ time are considered a lot for purposes of preparing a single test report.

8.5 *Number of Tests*—The minimum number of tests ~~for~~ from each lot for the tests specified ~~property~~ below shall be as follows:

Tests	Number of Tests in Accordance With
~~Number of Pieces in Lot~~	~~Number of Samples~~
Hardness and Tensile Strength	Guide F 1470
-	
Proof Load[A]	Guide F 1470
~~800 and less~~	~~1~~
Coating Weight/Thickness	The referenced coating specification[B]
~~over 800 to 8 000, incl~~	~~2~~
Surface Discontinuities	2
~~over 8 000 to 22 000, incl~~	~~3~~
~~over 22 000~~	~~5~~
over 22 000	5Guide F 1470

~~8.4 If any test specimen shows defective machining, it may be discarded~~

[A] Proof load tests required only when specified on the original inquiry and ~~another specimen substituted.~~ purchase order. See Table 4.
[B] Use Guide F 1470 if the coating specification does not specify a testing frequency.

9. Test Methods

9.1 Bolts, screws, and studs shall be tested in accordance with the methods described in Test Methods F 606M, with tension test wedge angles as specified in Table ~~6.~~ 6.

10. Inspection

10.1 If the inspection described in 10.2 is required by the purchaser, it shall be specified in the inquiry, order, or contract.

10.2 The inspector representing the purchaser shall have free entry to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy the inspector that the material is being furnished in accordance with this specification. All tests and inspection shall be made prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the work.

11. Responsibility

11.1 The party responsible for the fastener shall be the organization that supplies the fastener to the purchaser and certifies that the fastener was manufactured, sampled, tested and inspected in accordance with this specification and meets all of its requirements.

12. Rejection and Rehearing

12.1 Disposition of nonconforming material shall be in accordance with Guide F 1470 section titled "Disposition of Nonconforming Lots."

13. Certification

13.1 When specified on the purchase order, the manufacturer or supplier, whichever is the responsible party in accordance with Section 11, shall furnish the purchaser a test report that includes the following:

13.1.1 Product description, grade, quantity, ASTM specification number, and issue date;

13.1.2 Heat analysis and heat number;

13.1.3 Results of the hardness and tensile tests;

13.1.4 Statement of compliance with protective coating specification;

13.1.5 Statement of compliance with the surface discontinuity requirements of Specification F 788/F 788M;

13.1.6 Statement of compliance with dimensional and thread fit specifications;

13.1.7 Report, describe, or illustrate manufacturer markings;

13.1.8 Lot number, purchase order number, and date shipped;

13.1.9 Complete mailing address of responsible party; and

13.1.10 Title and signature of the individual assigned certification responsibility by the company officers.

13.2 Failure to include all the required information on the test report shall be cause for rejection.

14. Product Marking

1~~2~~4.1 *Bolts and Screws*:

1~~2~~4.1.1 Bolts and screws of nominal thread diameters smaller than M5 need not be marked. Additionally, slotted and recessed screws of nominal thread diameters M5 and larger need not be marked.

12~~4~~.1.2 Bolts and screws, except those covered in 12~~4~~.1.1, shall be marked permanently and clearly to identify the property class and the manufacturer. The property class symbols shall be as given in Table 7. The manufacturer's identification symbol shall be of his design.

12~~4~~.1.3 For Classes 8.8.3 and 10.9.3, the manufacturer may add other distinguishing marks indicating that the bolt or screw is atmospheric corrosion resistant and of a weathering grade of steel.

12~~4~~.1.4 Markings shall be located on the top of the head with the base of the property class symbols positioned toward the closest periphery of the head. Markings may be either raised or depressed at the option of the manufacturer. Alternatively, for hex head products, the markings may be indented on the side of the head with the base of the property class symbols positioned toward the bearing surface.

12~~4~~.1.5 Metric bolts and screws shall not be marked with radial line symbols.

12~~4~~.2 *Studs*:

12~~4~~.2.1 Studs shall be marked permanently and clearly to identify the property class. The property class symbols and sizes to be marked shall be as given in Table 7.

12~~4~~.2.2 Markings shall be located on the extreme end of the stud and may be raised or depressed at the option of the manufacturer. For studs with an interference-fit thread, the markings shall be located on the nut end.

12~~4~~.2.3 When ordered by the purchaser, studs shall be marked on both ends.

13~~5~~. Packaging and Package Marking

13~~5~~.1 *Packaging:*

13~~5~~.1.1 Unless otherwise specified, packaging shall be in accordance with Practice D 3951.

13~~5~~.1.2 When special packaging requirements are required, they shall be defined at the time of the inquiry and order.

13~~5~~.2 *Package Marking:*

13~~5~~.2.1 Each shipping unit shall include or be plainly marked with the following information:

13~~5~~.2.1.1 ASTM designation and type,

13~~5~~.2.1.2 Size,

13~~5~~.2.1.3 Name and brand or trademark of the manufacturer,

13~~5~~.2.1.4 Number of pieces,

13~~5~~.2.1.5 Purchase order number, and

13~~5~~.2.1.6 Country of origin.

14~~6~~. Keywords

14~~6~~.1 alloy steel; bolts; carbon steel; metric; screws; steel; structural; weathering steel

APPENDIXES

(Nonmandatory Information)

X1. CONVERSION GUIDANCE

TABLE 7 Property Class Identification Symbols

Property Class	Identification Symbol					
	Specification A 325M Bolts	Specification A 490M Bolts	Other Bolts and Screws	Studs		
				M4 and Smaller	M5 to M10 incl.	M12 and Larger
4.6	[A]	[A]	4.6	[A]	[A]	4.6
4.8	[A]	[A]	4.8	[A]	[A]	4.8
5.8	[A]	[A]	5.8	[A]	[A]	5.8
8.8[B]	8S	[A]	8.8	[A]	[A]	8.8
8.8.3	8S3	[A]	8.8.3	[A]	[A]	8.8.3
9.8[B]	[A]	[A]	9.8	[A]	+	9.8
10.9[B]	[A]	10S	10.9	[A]	□	10.9
10.9.3	[A]	10S3	10.9.3	[A]	[A]	10.9.3
12.9	[A]	[A]	12.9	[A]	Δ	12.9

[A] Not applicable.

[B] Products made of low-carbon martensite steel shall be additionally marked by underlining the property class symbol.

X1.1 For guidance purposes only, to assist designers and purchasers in the selection of a property class, the following conversion guidance is provided:

X1.1.1 Class 4.6 mechanical properties are approximately equivalent to those of Specification A 307, Grade A.

X1.1.2 Class 8.8 mechanical properties are approximately equivalent to those of Specification A 449, and Specification A 325, Types 1 and 2.

X1.1.3 Class 8.8.3 mechanical properties are approximately equivalent to those of Specification A 325, Type 3.

X1.1.4 Class 9.8 mechanical properties are approximately 9 % higher than those of Specification A 449.

X1.1.5 Class 10.9 mechanical properties are approximately equivalent to those of Specification A 354, Grade BD and Specification A 490, Types 1 and 2.

X1.1.6 Class 10.9.3 mechanical properties are approximately equivalent to those of Specification A 490, Type 3.

X1.1.7 Class 12.9 mechanical properties are approximately equal to those of Specification A 574.

X1.2 Class 9.8 is applicable to fasteners of nominal thread diameters M16 and smaller; Class 8.8 is applicable to fasteners larger than M16, except for Specification A 325M bolts where M16 and larger bolt diameters are Class 8.8.

X2. SIGNIFICANCE OF PROPERTY CLASS DESIGNATION

X2.1 Property classes are designated by numbers where increasing numbers generally represent increasing tensile strengths. The designation symbol has the following significance:

X2.1.1 The one or two numerals preceding the first decimal point approximates ~~1~~1000⁄100 of the minimum tensile strength in MPa.

X2.1.2 The numeral following the first decimal point approximates ~~1~~ 10⁄10 of the ratio, expressed as a percentage, between minimum yield stress and minimum tensile strength.

X2.1.3 The numeral 3, following the second decimal point, is an indicator that the material has atmospheric corrosion resistance and weathering characteristics comparable to steels covered in Specification A 588/A 588M.–

SUMMARY OF CHANGES

This section identifies the location of selected changes to this standard that have been incorporated since the ~~–96~~ –98 issue. For the convenience of the user, Committee F~~-~~16 has highlighted those changes that may impact the use of this standard. This section may also include descriptions of the changes or reasons for the changes, or both.

~~(1) Table 5, Classes 8.8~~
(1) Deleted 3.2, “Government Provisioning,” because it is no longer applicable.
(2) Revised section 8, “Number of Tests,” as follows:
Required lot control,
Referenced Guide F 1470 for mechanical property and ~~8.8.3, deleted~~ surface discontinuity testing,
Referenced the ~~M16 size~~ coating specification for coating test frequency, and ~~a~~
Added paragraph 8.4.2 providing for a ~~footnote indicating sizes M16 and smaller are not covered by Specification F 568M and suggesting Class 9.8 be used.~~
~~(2) Table 5, Classes 8.8 and 8.8.3, increased the size range to add M42 — M80.~~
~~(3) Table 5, Classes 10.9 and 10.9.3, increased the size range to add M64 — M100.~~
~~(4) Tables 1 and 2, revised the Nominal Product Diameter column to align with the changes~~ single test report for lots of 2000 pieces or fewer varying only in ~~Table 5.~~ length.
(3) Added section 12, “Rejection and Rehearing.”
(4) Added section 13, “Certification,” on a when-specified basis.