



Designation: F2882/F2882M – 17

Standard Specification for Screws, Alloy Steel, Heat Treated, 170 ksi and 1170 MPa Minimum Tensile Strength (Inch and Metric)¹

This standard is issued under the fixed designation F2882/F2882M; 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 the requirements for quenched and tempered alloy steel screws 0.060 through 1½ in. and 1.6 through 48 mm in diameter having a minimum ultimate tensile strength of 170 KSI or 1170 MPa.

1.2 The values are stated in inch-pound units for inch fasteners and SI metric units for metric fasteners. 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 to the standard.

1.3 *The following hazard caveat pertains only to the test method portion, Section 10, of this specification: 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 and health practices and determine the applicability of regulatory limitations prior to use.*

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

- A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- E112 Test Methods for Determining Average Grain Size
- F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded

¹ This test method is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets and Washers.

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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.

- F788/F788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series
 - F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
 - F1940 Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners
 - F2282 Specification for Quality Assurance Requirements for Carbon and Alloy Steel Wire, Rods, and Bars for Mechanical Fasteners
 - F2328 Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws, Studs, and Nuts
 - F2328M Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws, Studs, and Nuts (Metric)
- ### 2.2 ASME Standards:³
- B18.2.1 Square and Hex Bolts and Screws
 - B18.2.3.3M Metric Heavy Hex Screws
 - B18.2.3.4M Metric Hex Flange Screws
 - B18.2.3.5M Metric Hex Bolts
 - B18.2.3.9M Metric Heavy Hex Hex Flange Screws
 - B18.2.5 12 Point Flange Screws
 - B18.2.5M Metric 12 Point Flange Screws
 - B18.2.7.1M Metric 12 Spline Flange Screws
 - B18.3 Socket Cap, Shoulder, and Set Screws, Hex and Spline Keys (Inch Series)
 - B18.3.1M Socket Head Cap Screws (Metric Series)
 - B18.24 Part Identifying Number (PIN) Code System Standard for B18 Fastener Products

3. Ordering Information

3.1 Orders for high strength screws under this specification shall include the following information:

- 3.1.1 Quantity (number of screws),
- 3.1.2 Nominal dimensions, including diameter, thread designation, thread, pitch, and nominal screw length,
- 3.1.3 Name of the screw including specification,

³ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

- 3.1.3.1 ASME B18.2.1, Square and Hex Bolts and Screws,
- 3.1.3.2 ASME B18.2.5, 12 Point Flange Screws,
- 3.1.3.3 ASME B18.3, Socket Cap, Shoulder, and Set Screws, Hex and Spline Keys (Inch Series),
- 3.1.3.4 ASME B18.2.3.3M, Metric Heavy Hex Screws,
- 3.1.3.5 ASME B18.2.3.4M, Metric Hex Flange Screws,
- 3.1.3.6 ASME B18.2.3.5M, Metric Hex Bolts,
- 3.1.3.7 ASME B18.2.3.9M, Metric Heavy Hex Flange Screws,
- 3.1.3.8 ASME B18.2.5M, Metric 12 Point Flange Screws,
- 3.1.3.9 ASME B18.2.7.1M, Metric 12-Spline Flange Screws,
- 3.1.3.10 ASME B18.3.1M, Socket Head Cap Screws (Metric Series),
- 3.1.4 ASTM designation and year of issue.
- 3.2 Orders for high strength screws may include the following optional requirements:
 - 3.2.1 Inspection at point of manufacture.
 - 3.2.2 Coating, if required (see 4.6).
 - 3.2.3 Additional Testing (see 11.1).
 - 3.2.4 Special Packaging (see 14.1.2).
 - 3.2.5 Supplementary Requirement (see S1).
 - 3.2.6 Special Requirements.
 - 3.2.7 For establishment of a part identifying system, see ASME B18.24.

4. Materials and Manufacture

4.1 The screws shall be fabricated from steel made to fine grain practice and shall have an austenitic grain size of 5 or finer. In the event of controversy over grain size, referee tests on finished screws conducted in accordance with Test Methods E112 shall prevail.

4.2 High strength screws shall be heat treated by quenching in oil from above the transformation temperature and then tempered by reheating to at least 797°F or 425°C to achieve the mechanical properties specified in Section 6 and Table 1.

4.2.1 The minimum tempering temperature may be verified by submitting screws to 777°F or 415°C for 30 min at temperature. The mean cross-section hardness of three readings on the screw before and after retempering shall not differ by more than 2 points HRC.

TABLE 1 Mechanical Requirements

	Grade 170	Property Class 11.9
Full-size screws:		
Tensile or wedge strength, min,	170 KSI ^A	1170 MPa
Proof load (stress), min,	135 KSI	930 MPa
Machined test specimen:		
Yield strength at 0.2 % offset, min,	153 KSI	1055 MPa
Tensile strength, min, KSI	170 KSI	1170 MPa
Elongation in 5D, min, %	10	10
Reduction of area, min, %	35	35
Product hardness:		
Rockwell	37 to 42 HRC	37 to 42 HRC
Vickers	372 to 434 DPH	372 to 434 DPH

^A Not applicable to fasteners with reduced loadability due to head configuration such as flat countersunk or button head screws. See Table 4 or Table 5 for full-size tensile requirements.

4.3 Re-heat-treatment of screws for the purpose of carbon restoration is not permitted except for set screws.

4.4 Unless otherwise specified, threads of screws shall be rolled for diameters through 0.625 in. or M20 and for screw lengths through 6 in. or 150 mm. For diameters and lengths other than this, threads may be rolled, cut, or ground with the exception of socket set screws. Set screws with thread diameters up to and including #5 or M 3.5, and all other diameters with lengths less than seven thread pitches may be rolled, cut, or ground. Thread diameters #6 or M4 and larger with a minimum of seven thread pitches in length shall be rolled.

4.5 *Standard Finishes*—Unless otherwise specified, the screws shall be furnished with one of the following “standard surfaces as manufactured,” at the option of the manufacturer; (1) bright uncoated, (2) thermal black oxide, or (3) chemical black oxide. Hydrogen embrittlement tests shall not be required for screws furnished in these conditions.

4.6 Protective Coatings:

4.6.1 When a protective finish other than as specified in 4.5 is required, it shall be specified on the purchase order with the applicable finish specification.

4.6.2 When protective or decorative coatings are applied to the screws, precautions specified by the coating requirements to minimize internal hydrogen embrittlement shall be exercised. When specified in the purchase order, testing shall be conducted in accordance with Test Methods F606/F606M or F1940. In the event that hardness reductions occur in test specimens due to coating curing times and temperatures, testing shall be conducted alternatively in accordance with Test Method F1624.

5. Chemical Composition

5.1 The screws shall be alloy steel conforming to the chemical composition specified in Table 2 and the requirements in Specification F2282. See Supplementary Requirement S1 when additional alloy steel grades are required.

5.2 One or more of the following alloying elements: chromium, nickel, molybdenum, or vanadium shall be present in sufficient quantity to ensure that the specified strength properties are met after oil quenching and tempering. As a guide for selecting material, an alloy steel should be capable of meeting the specified mechanical requirements if the “as oil quenched” core hardness one diameter from the point is equal to or exceeds 25 HRC + (55 × carbon content).

5.3 When product analyses are made by the purchaser from finished screws representing each lot, the chemical composition shall conform to the requirements for product analysis in Table 2.

TABLE 2 Chemical Requirements

Element	Composition, %	
	Heat Analysis	Product Analysis
Carbon	0.33 to 0.48	0.31 to 0.50
Manganese, max	1.25	1.25
Phosphorus, max	0.035	0.040
Sulfur, max	0.040	0.045
Alloying elements	See 5.2	

5.4 Steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted for cold headed parts.

5.5 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology **A751**.

6. Mechanical Properties

6.1 Screws shall be tested in accordance with mechanical testing requirements specified in **Table 3**, and shall meet the mechanical requirements in **Table 1**, and either **Table 4**, **Table 5** or **Table 6**.

6.2 The screws that are tested for wedge tensile strength shall utilize a wedge of the angle specified in **Table 7**.

6.3 The hardness limits shall be met anywhere on the cross section through the threads, one diameter from the screw point.

6.4 Mechanical properties shall be determined using Test Methods **F606/F606M**.

7. Dimensions

7.1 Unless otherwise specified, the product shall conform to the dimensional specification detailed in the purchase order.

8. Workmanship, Finish, and Appearance

8.1 There shall be no evidence of carburization or gross decarburization on the surfaces of the heat-treated screws when measured in accordance with **F2328** for inch products and **F2328M** for metric products.

8.2 The depth of partial decarburization shall be limited to **F2328** Class 3 for inch products or **F2328M** Class 4 for metric products.

8.3 The surface discontinuities for these products shall conform to Specification **F788/F788M**.

9. Sampling and Number of Tests

9.1 Practice **F1470** shall be used to determine the necessary sampling plan and the number of tests that must be performed to demonstrate that all of the requirements of this standard are met for each lot.

10. Test Methods

10.1 Conduct tests for proof load, wedge tensile, and ultimate tensile strength in accordance with Test Method **F606/F606M**.

10.2 Decarburization and carburization tests shall be conducted in accordance with Test Method **F2328** for inch products and **F2328M** for metric products.

10.3 Surface discontinuities including thread lap inspection shall be conducted in accordance with Standard **F788/F788M**.

11. Inspection

11.1 If the additional tests described in **11.2** are required by the purchaser, it shall be specified in the inquiry, order, or contract.

11.2 The inspector representing the purchaser, upon reasonable notice, 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 him that the material is being furnished in accordance with this specification. All tests and inspection required by the specification that are requested by the purchaser's representative shall be made before shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

12. Product Marking

12.1 All screws with nominal diameters of 0.2 in. or 5 mm and larger shall be permanently marked to identify the material grade, "170" for inch series or "11.9" for metric and the manufacturer's or private label distributor's identification symbol.

12.2 Material grade and manufacturer's or private label distributor's identification shall be separate and distinct. Marks shall preferably be in different locations and, when on the same level, shall be separated by a distinctive mark such as a forward or backward slash, colon, dash, dot, or space.

TABLE 3 Mechanical Testing Requirements

Item	Nom. Dia.	Product Length	Hardness, max	Hardness, min	Test Conducted Using Full Size Product			Test Conducted Using Machined Test Specimen			
					Proof Load	Wedge Tensile Strength	Axial Tensile Strength	Yield Strength at 0.2% Offset	Tensile Strength	Elongation	% Red. of Area
1	All short lengths	Less than 3D ^A	<i>B</i>	<i>B</i>	...	...	...	...	...	...	...
2	≤1.0 in. or M24	Over 3D ^A	<i>B</i>	...	Z ^C	<i>B</i>	...	...	...	...	...
3	>1.0 in. or M24 and ≤ M36	Over 3D ^A	<i>B</i>	...	Z ^C	X ^C	...	Y ^C	Y ^C	Y ^C	Y ^C
4	> M36	Over 3D ^A	<i>B</i>	...	Z ^C	...	X ^C	Y ^C	Y ^C	Y ^C	Y ^C
5 ^D	...	Over 3D ^A	<i>B</i>	...	...	...	X ^C	...	...	...	...

^A D denotes nominal diameter of product.

^B B Denotes mandatory test.

^C C Either all tests denoted by X or all tests denoted by Y shall be performed. In case of arbitration full-size tests, denoted X, shall be decisive. Proof load test denoted Z shall be conducted when purchaser requests the test in inquiry and order.

^D Item 5 would include socket set screws and screws with reduced loadability due to head configuration such as flat countersunk or button head screws.