~~Designation:A574–04ε1~~ Designation: A 574 – 08

Standard Specification for Alloy Steel Socket-Head Cap Screws[1]

This standard is issued under the fixed designation A 574; 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.

~~ε[1] NOTE—Sections 2.2 and 4.2.8 were editorially revised in October 2006.~~

1. Scope*

~~1.1This specification covers the requirements for quenched and tempered alloy steel hexagon socket-head cap screws, 0.060 through 4 in. in diameter where high strength is required.~~

1.1 This specification covers the requirements for quenched and tempered alloy steel hexagon socket-head cap screws, 0.060 through 4 in. in diameter where high strength is required.

1.2 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

NOTE 1—A complete metric companion to Specification A 574 has been developed—A 574M; therefore no metric equivalents are presented in this specification.

~~1.2The following hazard caveat pertains only to the test method portion, Section~~

1.3 The following hazard caveat pertains only to the test method portions, sections 5.1, 5.6, 8, and 12, 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

~~D3951Practice for Commercial Packaging~~

~~E3Guide for Preparation of Metallographic Specimens~~

~~E~~ 112 Test Methods for Determining Average Grain Size ~~E384Test Method for Microindentation Hardness of Materials~~

F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

F 788/F 788M ~~Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series~~

~~2.2 *ASME Standards:*~~

~~B1.1Unified Screw Threads~~ Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series

F 1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

F 1789 Terminology for F16 Mechanical Fasteners

F 1940 Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners

F 2282 Specification for Quality Assurance Requirements for Carbon and Alloy Steel Wire, Rods, and Bars for Mechanical Fasteners

F 2328 Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws and Studs

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

Current edition approved ~~Aug.~~Dec. 1, ~~2004.~~2008. Published ~~August 2004.~~January 2009. Originally approved in 1967. Last previous edition approved in ~~2000~~2004 as A 574 – ~~04~~[ε1].

~~[2] For *ASME Boiler and Pressure Vessel Code* applications see related Specification SA-574 in Section II of that code.~~

[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.

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

2.2 *ASME Standards:*[3]
B18.3 Socket Cap, Shoulder, and Set Screws
B18.12 Glossary of Terms for Mechanical Fasteners
B18.24 Part Identifying Number (PIN) Code System Standard for B18 Fastener Products
~~2.3 *Federal Standard:*~~
~~H-28Handbook of Thread Dimensions~~

3. Terminology

~~3.1*Definitions:*~~
~~3.1.1Definitions of discontinuities covered by 10.2 follow:~~
~~3.1.2*crack*—clean crystalline break passing through the grain or grain boundary without inclusion of foreign elements.~~
~~3.1.3*inclusions*—particles of nonmetallic impurities, usually oxides, sulfides, silicates, and such, which are mechanically held in the steel during solidification.~~
~~3.1.4*nicks or pits*—depressions or indentations in the surface of the metal.~~
~~3.1.5*seam or lap*—noncrystalline break through the metal which is inherently in the raw material.~~
3.1 *Definitions of Terms Specific to This Standard*—The definition of terms used in this specification shall be as specified in Terminology F 1789, ASME B18.12, or the applicable referenced standards, unless otherwise defined herein. In the event that there are differences for a given term, ASTM definitions shall be used.

4. Ordering Information

4.1 Orders for socket head cap screws under this specification shall include the following information:
4.1.1 ASTM designation and year of issue.
~~4.1.2Quantities (number of pieces by size).~~
~~4.1.3Size and length.~~
~~4.2Orders for socket head cap screws may include the following optional requirements:~~
4.1.2 Name of the screw (SHCS).
4.1.3 Quantity (number of pieces by size).
4.1.4 Dimensions, including nominal thread designation, thread pitch, and nominal screw length.
4.2 Orders for socket head cap screws shall include the following optional requirements if specified by the purchaser:
4.2.1 Inspection at point of manufacture.
~~4.2.2Coating, if a protective finish other than black oxide (thermal or chemical) is required, it must be specified.~~
~~4.2.3Certified test reports (see 11.2~~
4.2.2 Coating, if a protective finish other than those, which are described in 5.5 is required, it must be specified (see 5.6).
~~4.2.4Additional testing (see 11.3~~
4.2.3 Certified test reports, as required (see Section 15).
~~4.2.5Special packaging (see 16.1.2~~
4.2.4 Additional testing (see 12.1).
4.2.5 Special packaging (see 18.1.2).
4.2.6 Supplementary requirements (see S1).
4.2.7 Special requirements.
~~4.2.8For~~4.2.8 For establishment of a part identifying system, see ASME B18.24.

5. Materials and Manufacture

~~5.1The screws shall be fabricated from a steel which has been made by the open-hearth, basic-oxygen, or electric-furnace process.~~
~~5.2The screws shall be fabricated from alloy steel made to a fine grain practice. In the event of controversy over grain size, referee tests on finished screws conducted in accordance with Test Methods E112~~
5.1 The screws shall be fabricated from alloy steel made to a fine grain practice. In the event of controversy over grain size, referee tests on finished screws conducted in accordance with Test Methods E 112 shall prevail.
~~5.3Unless otherwise specified, the heads of screws through 1.500-in. diameter shall be fabricated by hot or cold forging. Over 1.500-in. diameter, the heads may be fabricated by hot or cold forging or by machining. Sockets may be forged or machined.~~
~~5.4Unless otherwise specified, threads of screws shall be rolled for diameters through 0.625 in. and for screw lengths through 4 in. For diameters and lengths other than this, threads may be rolled, cut, or ground.~~

~~[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.~~
[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

~~5.5The screws shall be heat treated by oil quenching from above the transformation temperature and then tempering at a temperature not lower than 650°F.~~

~~5.6~~

5.2 Screws in sizes through 0.750 in. diameter, and with lengths through ten times the nominal product size or 6.0 inches, whichever is shorter, shall be cold headed, except that when specified by the purchaser the screws shall be hot headed. Larger sizes and longer lengths shall be cold or hot headed at the option of the manufacturer, unless otherwise specified by the purchaser. Screws larger than 1.500 in. nominal diameter shall be permitted to be machined. Sockets shall be forged or machined at the option of the manufacturer.

5.3 Screws in sizes through 0.625 in. diameter, and for product lengths through 4 in. shall be roll threaded, unless otherwise specified by the purchaser. Larger products shall be rolled, cut, or ground at the option of the manufacturer.

5.4 Screws shall be heat treated by quenching in oil from above the transformation temperature and then tempered by reheating to at least 700°F to achieve the mechanical properties specified in Section 7 and Table 1.

5.4.1 When specified by the purchaser, the minimum tempering temperature shall be verified by subjecting screws to 680°F for 30 minutes 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 hardness Rockwell C (HRC).

5.5 *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.

~~5.7~~

5.6 *Protective Coatings*:

5.7~~6~~.1 When a protective finish other than as specified in ~~5.6~~5.5 is required, it shall be specified on the purchase order with the applicable finish specification.

~~5.7.2When protective or decorative coatings are applied to the screws, precautions specified by the coating requirements to minimize embrittlement shall be exercised.~~

5.6.2 When protective or decorative coatings are applied to the screws, precautions specified by the coating requirements to minimize internal hydrogen embrittlement shall be exercised. Additional precautions such as the requirements in Test Method F 1940 and Test Methods F 606 shall be by agreement with the purchaser.

6. Chemical Composition

6.1 The screws shall be alloy steel conforming to the chemical composition specified in Table ~~1~~2 and the requirements in Specification F 2282. See Supplementary Requirement S1 when ~~specific chemistry~~ additional alloy steel grades are required.

6.2 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).

6.3 ~~P~~When product analyses ~~may be~~ are made by the purchaser from finished screws representing each ~~lot. The~~lot, the chemical composition, thus determined, shall conform to the requirements prescribed for product analysis in Table ~~1~~2.

TABLE 1 ~~Ch~~Mem~~e~~chanical Requirements

~~El~~Prope~~mer~~rty	~~Compos~~≤0.500 ~~ition, %.Heat~~ ~~Analys~~ Nom. Di~~s~~ a.	~~Product~~>0.500 in.~~ Analys~~ Nom. Di~~s~~ a.
Full-size screws:		
~~Carb on, min~~	~~0.33~~	~~0.31~~
Tensile or wedge tensile strength, min, ksi	180	170
~~Phosphorus, max~~	~~0.035~~	~~0.040~~
Proof load (stress), ksi	140	135
~~Sulfur, max~~	~~0.040~~	~~0.045~~
Product hardness:		
~~Alloy (HRC)~~	~~39–45~~	~~37–45~~
Rockwell (HRC)	39–45	37–45
~~Machinged test specimen:~~		
Machined test specimen:		
~~Yiele min., ksi~~	~~153~~	~~153~~
Yield strength at 0.2% offset, min., ksi	153	153
~~TentsSi~~	~~180~~	~~170~~
Tensile strength, min., ksi	180	170
Elongation in 5D, min.	10 %	10 %
~~Rec 6.2~~	~~35 %~~	~~35 %~~
Reduction of area, min.	35 %	35 %

6.4Application of heats of steel6.4 Steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted.

6.5 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology A 751.

7. Mechanical Properties

7.1The hardness of finished screws shall be 39 to 45 HRC for 0.500 in. and smaller and 37 to 45 HRC for 0.625 in. and larger. This shall be only the mechanical requirements for screws that are shorter than three times the diameter or that have insufficient threads for tension testing.

7.2Screws, other than those exempted in 7.1 and 7.3, shall meet the proof load and tensile requirements in Table 2 and Mechanical Properties

7.1 Socket head cap screws shall be tested in accordance with the mechanical testing requirements specified in Table 3. The screws shall be tension tested with a wedge of the angle specified in , and shall meet the mechanical requirements in Table 1, and

TABLE 2 T Chensmicale Requirements for Coarse Thread Screws

ScrElew Dia (D), imen.	t ThreadCompos/ition.		, %
	THensile at Load, miAn, albf [A]	Streyss Area,in.2 [B] s	Proof Loaduct (Le Angth Mealysure-ment Method), min, lbf [C]
			s
0.073	64	473 0.00263368	
Carbon, min	0.33	473 0.31	
0.086	56	666 0.00370	518
Phosphorus, max	0.035	666 0.040370	518
0.099	48	877 0.00487	682
Sulfur, max	0.040	877 0.0487	682 5
0.112	40	1 090 0.	00Alloying elements
0.125	40	1 430 0.	00796
0.25	40	1 430 0.	00796
0.138	32	1 640 0.	00909
0.164	32	2 520 0.	0140
0.190	24	3 150 0.	0175
0.250	20	5 730 0.	0318
0.3125	18	9 440 0.	0524
0.375	16	13 900 0.	0775
0.4375	14	19 100 0.	1063
0.500	13	25 500 0.	1419
0.625	11	38 400 0.	226
0.750	10	56 800 0.	334
0.875	9	78 500 0.	462
1.000	8	103 000 0.	606
1.125	7	129 000 0.	763
1.250	7	165 000 0.	969
1.375	6	196 000 1.	155
1.500	6	239 000 1.	405
1.750	5	323 000 1.	90
2.000	4½	425 000 2.	50
2.250	4½	552 000 3.	25
2.500	4	680 000 4.	00
2.750	4	838 000 4.	93
3.000	4	1 010 000 5.	97
3.250	4	1 210 000 7.	10
3.500	4	1 420 000 8.	33
3.750	4	1 640 000 9.	66
4.000	4	1 880 000 11.	08

[A] Values based on 180 ksi for 0.500 and smaller and 170 ksi for sizes larger than 0.500 in. and stress area in accordance with Footnote B.

[B] Stress areas based on Handbook H-28 (U.S. Department of Commerce) as follows:

$$A_s = 0.7854[D - (0.9743/n)]^2$$

where:

A_s = stress area,
D = nominal screw size, and
n = threads/in.

[C] Values based on 140 ksi for 0.500 and smaller and 135 ksi for sizes larger than 0.500 in. and stress area in accordance with Footnote B.

TABLE 3 Mechanical Testing Requirements for Fine Thread Screws

Item	Description	Tensile Load, Dmin, lbf (D)n, lb	Product Length	Hardness, max	Thread Hardness, min	Decarb/ Carburization	Test Conducted Using Full Size Product			Test Conducted Using Machined Test Specimen	
							Proof Load	Wedge Tensile Strength	Proof Load Axial Tensile (Full Strength	Yield Strength at 0.2% Offset	Tensile Strength
0.060	80	324	0.00180	252							
0.060gth	Elongation	324	0% Red.	252							
0.073	72	500	0.00278	389							
1	All short lengths	…	Less than 3D[A]	389							
0.086	64	709	0.00394	552							
0.086[B]	[B]	[B]	…	552							
0.099	56	941	0.00523	732							
0.099…	…	…	…	732							
0.112	48	1 190	0.00661	925							
0.112…	48	1 190	0.00661	925	…						
0.125	44	1 490	0.00830	1 160							
2	≤0.500 in. D	≤270,000	3D to 1.5 in.	1 160							
0.138	40	1 830	0.01015	1 420							
0.138[B]	…	[B]	Z[C]	1 420							
0.164	36	2 650	0.01474	2 060							
0.164X[C]	…	…	…	2 060							
0.190	32	3 600	0.0200	2 800							
0.190…	32	3 600	0.0200	2 800	…						
0.250	28	6 500	0.0 364	5 100							
3	≤0.500 in. D	≤270,000	Over 3D	5 100							
0.3125	24	10 400	0.0580	8 120							
0.3125[B]	…	[B]	…	8 120							
0.375	24	15 800	0.0878	12 300							
0.375X[C]	…	Y[C]	Y[C]	12 300							
0.4375	20	21 400	0.1187	16 600							
0.4375Y[C]	20	21 400	0.1187	16 600	Y[C]						
0.500	20	28 800	0.1599	22 400							
4	>0.500 in. D	>270,000	Over 3D	22 400							
0.625	18	43 500	0.256	34 600							
0.625[B]	…	[B]	Z[C]	34 600							
0.750	16	63 400	0.373	50 400							
0.750…	X[C]	Y[C]	Y[C]	50 400							
0.875	14	86 500	0.509	68 700							
0.875Y[C]	14	86 500	0.509	68 700							
1.000	12	113 000	0.663	89 500							
1.125	12	146 000	0.856	116 000							
1.250	12	182 000	1.073	145 000							
1.375	12	224 000	1.315	178 000							
1.500	12	269 000	1.581	213 000							
1.500	12	269 000	1.581	213 000	Y[C]						

[A] Values based on 180 ksi for 0.500 and smaller and 170 ksi for sizes larger than 0.500 in. and stress area in accordance with Footnote *B*.

[B] Stress areas based on H-28 as follows:

$$A_s = 0.7854[D - (0.9743/n)]^2$$

where:

A_s = stress area,

D = nominal screw size, and

n = number of threads per inch.

[C] Either

either Table 4 under the head. To meet the requirements of the wedge test, there must be a tensile failure in the body or thread section. For the purpose of this test, failure means separation into two pieces. Screws threaded to the head shall pass the requirements for this test if the fracture that caused failure originated in the thread area, even though it may have propagated into the fillet area or the head before separation.

7.3Screws having a diameter larger than 1.500 in. shall be preferably tested in full size and shall meet the requirements of Table 2 and Table 3. When equipment of sufficient capacity is not readily available, screws shall meet 170 ksi, min, tensile strength, 153 ksi, min, yield strength at 0.2% offset, and 10% elongation on specimens machined in accordance with Test Methods F606or Table 5.

8.

7.2 The screws that are tested for wedge tensile strength shall utilize a wedge of the angle specified in Table 6 under the head. To meet the requirements of the wedge test, there must be a tensile failure in the body or thread section. For the purpose of this

TABLE 4 Wedge Test Angsile Requirements for Coarse Thread Screws

Screw Size, Dia (*D*), in. Wedge Aingle, Deg.	Body Threads/ 2*D* or Lessin. or	Threadnsiled to Load, min, lbf[A]	Stress thAre Head, in.[2B]	BProdyof Lengthsoad Gr(Leangter than 2*D* Measurement Method), min, lbf[C]
0.073	64	473	0.00263	368
0.112	6	666	0.00370	518
– 0.500, incl				
0.086	56	666	0.00370	518
0.099	48	877	0.00487	682
0.112	40	1 090	0.00604	846
0.125	40	1 430	0.00796	1110
0.138	32	1 640	0.00909	1270
0.164	32	2 520	0.0140	1960
0.190	24	3 150	0.0175	2450
0.250	20	5 730	0.0318	4450
0.3125	18	9 440	0.0524	7340
0.375	16	13 900	0.0775	10800
0.4375	14	19 100	0.1063	14900
0.500	13	25 500	0.1419	19900
0.625	11	38 400	0.226	30500
0.750	10	56 800	0.334	45100
0.625 –	6	8 500	0.462	62400
0.750, incl				
0.875	9	78 500	0.462	62400
0.875	4	103 000	0.606	81800
to1.500, incl				
1.000	8	103 000	0.606	81800
1.125	7	129 000	0.763	103000
1.250	7	165 000	0.969	131000
1.375	6	196 000	1.155	156000
1.500	6	239 000	1.405	190000
1.750	5	323 000	1.90	256000
2.000	4½	425 000	2.50	338000
2.250	4½	552 000	3.25	439000
2.500	4	680 000	4.00	540000
2.750	4	838 000	4.93	666000
3.000	4	1 010 000	5.97	806000
3.250	4	1 210 000	7.10	958000
3.500	4	1 420 000	8.33	1120000
3.750	4	1 640 000	9.66	1300000
4.000	4	1 880 000	11.08	1500000

[A] Values based on 180 ksi for 0.500 and smaller and 170 ksi for sizes larger than 0.500 in. and stress area in accordance with Footnote *B*.

[B] Stress areas based on Handbook H-28 (U.S. Department of Commerce) as follows:

$$A_s = 0.7854[D - (0.9743/n)]^2$$

where:

A_s = stress area,
D = nominal screw size, and
n = threads/in.

[C] Values based on 140 ksi for 0.500 and smaller and 135 ksi for sizes larger than 0.500 in. and stress area in accordance with Footnote *B*.

test, failure means separation into two pieces. Screws threaded to the head shall pass the requirements for this test if the fracture that caused failure originated in the thread area, even though it may have propagated into the fillet area or the head before separation.

8. Metallurgical Requirement

8.1 *Carburization or Decarburization* :

8.1.1 There shall be no evidence of carburization or total decarburization on the surfaces of the heat-treated screws when measured in accordance with Test Method F 2328~~12.3~~ (Class 3 Product).

8.1.2 The depth of partial decarburization shall be limited to the values in ~~Table 5~~Test Method F 2328 (Class 3 Product) when measured as ~~shown in Fig. 1 and in accordance with 12.3.~~ described therein.

9. Dimensions

9.1 Unless otherwise specified, the product shall conform to the requirements of ASME B18.3.

~~9.2Unless otherwise specified, threads shall be Unified standard: Class 3A, UNRC and UNRF series for screw sizes 0.060 through 1 in. inclusive; Class 2A, UNRC and UNRF series for sizes over 1 in. to 1.500 in. inclusive; and Class 2A UNRC series~~