



Designation: A 574M – 04<sup>ε1</sup>

## Standard Specification for Alloy Steel Socket-Head Cap Screws (Metric)<sup>1</sup>

This standard is issued under the fixed designation A 574M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

<sup>1</sup> NOTE—Sections 2.2 and 3.2.8 were editorially revised in October 2006.

### 1. Scope\*

1.1 This specification covers the requirements for quenched and tempered alloy steel socket-head cap screws 1.6 mm through 48 mm in diameter having a minimum ultimate tensile strength of 1220 MPa.

NOTE 1—This specification is the metric companion of Specification A 574.

1.2 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.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

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

**D 3951** Practice for Commercial Packaging

**E 3** Guide for Preparation of Metallographic Specimens

**E 18** Test Methods for Rockwell Hardness of Metallic Materials

**E 112** Test Methods for Determining Average Grain Size

**E 384** Test Method for Microindentation Hardness of Materials

**F 606M** Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets [Metric]

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

2.2 *ASME Standards:*<sup>3</sup>

**B18.3.1M** Metric Socket Head Cap Screws

**B18.24** Part Identifying Number (PIN) Code System Standard for B18 Fastener Products

### 3. Ordering Information

3.1 Orders for socket head cap screws under this specification shall include the following information:

3.1.1 Quantity (number of screws),

3.1.2 Dimensions, including nominal thread designation, thread, pitch, and nominal screw length (millimetres),

3.1.3 Name of the screw (SHCS),

3.1.4 ASTM designation and year of issue.

3.2 Orders for socket head cap 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 Certified Test Reports (see 9.2).

3.2.4 Additional Testing (see 9.3 and 11.1).

3.2.5 Special Packaging (see 14.1.2).

3.2.6 Supplementary Requirement (see S1).

3.2.7 Special Requirements.

3.2.8 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. In the event of controversy over grain size, referee tests on finished screws conducted in accordance with Test Methods **E 112** shall prevail.

4.2 Screws in sizes up to M20 inclusive, and with lengths up to ten times the nominal product size or 150 mm, whichever is shorter, shall be cold headed, except that they may be hot headed by agreement of the purchaser. Larger sizes and longer

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<sup>2</sup> 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.

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

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

lengths may be cold or hot headed. Screws M42 and larger may be machined. Sockets may be forged or machined at the option of the manufacturer.

4.3 Screws in sizes up to M24 inclusive, and product lengths up to 150 mm inclusive, shall be roll threaded, except by special agreement of the purchaser. Larger products may be rolled, cut, or ground at the option of the manufacturer.

4.4 Socket-head cap screws shall be heat treated by quenching in oil from above the transformation temperature and then tempered by reheating to at least 380°C to within the hardness range specified in **Table 1**.

4.4.1 The minimum tempering temperature may be verified by submitting screws to 370°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 20 DPH.

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 embrittlement shall be exercised.

### 5. Chemical Composition

5.1 The screws shall be alloy steel conforming to the chemical composition specified in **Table 2**. See Supplementary Requirement S1 when specific chemistry grades are required.

5.2 One or more of the following alloying elements: chromium, nickel, molybdenum, or vanadium shall be present in the steel in sufficient quantity to ensure 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 Product analyses may be made by the purchaser from finished screws representing each lot. The chemical composition thus determined shall conform to the requirements specified for the product analysis in **Table 2**.

**TABLE 1 Mechanical Requirements**

Property class	12.9 <sup>A</sup>
Full-size screws:	
Tensile or wedge strength, min, MPa	1220
Proof load (stress), min, MPa	970
Machined test specimen:	
Yield strength at 0.2 % offset, min, MPa	1100
Tensile strength, min, MPa	1220
Elongation in 5D, min, %	10 <sup>A</sup>
Reduction of area, min, %	35
Product hardness:	
Rockwell	38 to 44 HRC
Vickers	372 to 434 DPH

<sup>A</sup> Elongation is 2 percentage points higher than property class 12.9.

**TABLE 2 Chemical Requirements**

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

tion thus determined shall conform to the requirements specified for the product analysis in **Table 2**.

5.4 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, Practices, and Terminology **A 751**.

### 6. Mechanical Properties

6.1 Socket head cap screws shall be tested in accordance with the mechanical testing requirements specified in **Table 3**, and shall meet the mechanical requirements in **Table 1** and **Table 4**.

6.2 Screws in sizes 1.6 through 36-mm diameter shall be wedge tensile tested in accordance with **Table 3**, using wedge angles as specified in **Table 5**.

6.3 The hardness limits shall be met anywhere on the cross section through the threads, one diameter from the screw point as determined using Test Methods **E 18**.

### 7. Dimensions

7.1 Unless otherwise specified, the product shall conform to the requirements of ASME B18.3.1M.

### 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 **10.2**.

8.2 The depth of partial decarburization shall be limited to the values in **Table 6** when measured as shown in **Fig. 1**, and in accordance with **10.2**.

8.3 The surface discontinuities for these products shall conform to Specification F 788/F 788M and the additional limitations specified herein.

8.3.1 Forging defects that connect the socket to the periphery of the head are not permissible. Defects originating on the periphery and with a traverse indicating a potential to intersect and are not permissible. Other forging defects are permissible provided those located in the bearing area, fillet, and top surfaces shall not have a depth exceeding 0.03D or 0.13 mm, whichever is greater. For peripheral discontinuities, the maximum depth may be 0.06D, but not to exceed 1.6 mm (see **Fig. 2**).

8.3.2 Forging defects located in the socket wall within 0.1 times the actual key engagement (*T*) from the bottom of the socket are not permissible. Discontinuities located elsewhere in the socket shall not have a length exceeding 0.25 *T*, or a maximum depth of 0.03D not to exceed 0.13 mm (see **Fig. 3**).

8.3.3 Seams in the shank shall not exceed a depth of 0.03D or 0.2 mm, whichever is greater.

**TABLE 3 Mechanical Testing Requirements**

Item	Description	Tensile Load, min, kN	Product Length	Hardness, max	Hardness, min	Decarburization	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	Reduction of Area
1	All short lengths	...	≤3D <sup>A</sup>	<sup>B</sup>	<sup>B</sup>	<sup>B</sup>	...	...	...	...	...	...	...
2	Smaller SHCS	≤1200	3D to 300 mm	<sup>B</sup>	...	<sup>B</sup>	Z <sup>C</sup>	X <sup>C</sup>	...	...	...	...	...
3	Smaller SHCS	≤1200	Over 300 mm	<sup>B</sup>	...	<sup>B</sup>	...	X <sup>C</sup>	...	Y <sup>C</sup>	Y <sup>C</sup>	Y <sup>C</sup>	Y <sup>C</sup>
4	Larger SHCS	≥1200	>3D	<sup>B</sup>	...	<sup>B</sup>	Z <sup>C</sup>	...	X <sup>C</sup>	Y <sup>C</sup>	Y <sup>C</sup>	Y <sup>C</sup>	Y <sup>C</sup>

<sup>A</sup> D denotes nominal diameter of product.

<sup>B</sup> Denotes mandatory test.

<sup>C</sup> 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 test denoted Z shall be conducted when purchaser requests the test in inquiry and order.

**TABLE 4 Minimum Ultimate Tensile Loads**

NOTE 1—All values are rounded to 3 significant digits.

Thread Size	Stress Area, mm <sup>2</sup>	Tensile Load, min, kN	Proof Load, kN
M1.6 × 0.35	1.27	1.55	1.23
M2 × 0.4	2.07	2.53	2.01
M2.5 × 0.45	3.39	4.14	3.2
M3 × 0.5	5.03	6.14	4.88
M4 × 0.7	8.78	10.7	8.52
M5 × 0.8	14.2	17.3	13.8
M6 × 1	20.1	24.5	19.5
M8 × 1.25	36.6	44.6	35.5
M10 × 1.5	58.0	70.8	56.3
M12 × 1.75	84.3	103	81.8
M14 × 2	115	140	112
M16 × 2	157	192	152
M20 × 2.5	245	299	238
M24 × 3	353	431	342
M30 × 3.5	561	684	544
M36 × 4	817	997	792
M42 × 4.5	1120	1370	1090
M48 × 5	1470	1790	1430

**TABLE 5 Wedge Test Angle**

Product	Diameter, mm	degree
Socket-head cap screws threaded 2D and closer to underside of head	through 20	6
	over 20 to 36	4
All other socket-head cap screws	through 12	10
	over 12 to 16	8
	over 16 to 36	6

8.3.4 No transverse discontinuities shall be permitted in the head-to-shank fillet area.

8.3.5 Threads shall have no laps at the root or on the flanks, as shown in Fig. 4. Laps are permitted at the crest (Fig. 4C) that do not exceed 25 % of the basic thread depth, and on the flanks outside the pitch cylinder. Longitudinal seams rolled beneath the root of the thread and across the crests of cut threads are acceptable within the limits of 8.3.3.

**TABLE 6 Decarburization Limits for Threads<sup>A</sup>**

Thread Pitch P, mm	Basic Thread Height h = 0.6135P mm	N = 3 / 4 h, min, mm
0.7	0.429	0.322
0.8	0.491	0.368
1	0.613	0.460
1.25	0.767	0.575
1.5	0.920	0.690
1.75	1.074	0.806
2	1.227	0.920
2.5	1.534	1.151
3	1.840	1.380
3.5	2.147	1.610
4	2.454	1.841
4.5	2.761	2.071
5	3.068	2.301

<sup>A</sup> See Fig. 4.

8.3.6 Quench cracks of any depth, any length, or in any location are not permitted.

## 9. Number of Tests

9.1 The requirements of this specification shall be met in continuous mass production for stock, and the manufacturer shall make sample inspections to ensure that the product conforms to the specified requirements. Additional tests of individual shipments of material are not ordinarily contemplated. A record of individual heats of steel in each test lot shall be maintained. The container shall be coded to permit identification of the lot.

9.2 When specified in the order, the manufacturer shall furnish a test report certified to be the last complete set of mechanical tests for each stock size in each shipment.

9.3 When additional tests are specified on the purchase order, a lot, for purposes of selecting test samples, shall consist of all screws offered for inspection at one time of one diameter and length. From each lot, the number of samples for each requirement shall be as follows: