INCH-POUND

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30 MARCH 2020
SUPERSEDING
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FEDERAL SPECIFICATION

SCREW, CAP, SLOTTED AND HEXAGON HEAD

The General Services Administration has authorized the use of this federal specification by all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the types and styles of slotted and hexagon head cap screws, classified in 1.2.1 (see 6.1).

1.2 Classification.

1.2.1 Types and styles. Cap screws shall be of the following types and styles(see 6.2).

Type I - Slotted head.
  Style 1s - Round head (see fig. 5)
  Style 2s - Flat countersunk head, 82° (see fig. 5).
  Style 4s - Fillister head (see fig. 5).

Type II - Plain head.
  Style 10p - Hexagon head (see fig. 5).

1.2.2 Grades. Cap screws of steel material shall be of the following grades(see 6.2).

Grade 2 - Low carbon steel.
Grade 5 - Medium carbon steel.
Grade 8 - Alloy steel.
Grade 9 - Optional alloy steel.

1.2.3 Sizes. The sizes of cap screws shall be classified by the nominal body diameter from 1/4 inch thru 3 inches as specified (see 6.2).

2. APPLICABLE DOCUMENTS

2.1 Government Publications. The following documents of the issues in effect on date of invitation for bids, or request for proposal, form a part of this specification to the extent specified herein.

Comments, suggestions, or questions on this document should be addressed to: Defense Supply Center Philadelphia, ATTN: DSCP-ITAA, 700 Robbins Avenue, Philadelphia, PA 19111-5096 or emailed to dscpg&ispeccomments@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

Federal Specifications:

QQ-N-281 - Nickel-Copper Alloy Bar, Plate, Rod, Sheet, Strip, Wire, Forgings and Structural and Special Shaped Sections.
QQ-N-286 - Nickel-Copper-Aluminum Alloy, Wrought.

Federal Standards:

FED-STD-H28/2 - Screw-thread standards for Federal Services Section 2 Unified Inch Screw Threads - UN and UNR Thread Forms.

Military Specifications:

MIL-F-495 - Finish, Chemical, Black, for Copper Alloys.
MIL-A-8625 - Anodic Coatings for Aluminum and Aluminum Alloys.
MIL-DTL-16232 - Phosphate Coatings, Heavy, Manganese or Zinc Base (for Ferrous Metals).
MIL-DTL-18240 - Fastener Element, Self-Locking, Threaded Fastener, 250°F Maximum

Military Standards:

MS35295 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Medium Carbon Steel, Plain Finish, UNC-2A
MS35302 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Alloy Steel, Plain Finish, UNF-2A
MS35309 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Naval Brass, Plain Finish, UNC-2A
MS35310 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Naval Brass, Plain Finish, UNF-2A
MS35311 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Nickel-Copper Alloy, Plain Finish, UNC-2A
MS35312 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Nickel-Copper Alloy, Plain Finish, UNF-2A
MS51099 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Head Drilled for Locking Wire, Steel, Corrosion Resisting, Passivated, UNC-2A
MS51100 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Head Drilled for Locking Wire, Steel, Corrosion Resisting, Passivated, UNF-2A
MS51107 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Shank Drilled for Cotter Pin, Alloy Steel, Grade 8, Phosphate Coated, UNC-2A
MS51108 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Shank Drilled for Cotter Pin, Alloy Steel, Grade 8, Phosphate Coated, UNF-2A

(Copies of the above documents are available online at https://quicksearch.dla.mil)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

American Society of Mechanical Engineers (ASME)

ASME B18.2.1 - Square and Hex Bolts and Screws (Inch Series)

ASME B18.6.2 - Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws (Inch Series)

ASME B46.1 - Surface Texture (Surface Roughness, Waviness and Lay)

(Copies can be purchased from ASME. Two Park Avenue, New York, NY 10016-5990 or http://www.asme.org/)

ASTM International

ASTM A342/A342M - Permeability of Weakly Magnetic Materials, Standard Test Methods for
ASTM B21/B21M - Naval Brass Rod, Bar, and Shapes, Standard Specification for
ASTM B138/B138M - Manganese Bronze Rod, Bar, and Shapes, Standard Specification for
ASTM B139/B139M - Phosphor Bronze Rod, Bar and Shapes, Standard Specification for
ASTM B150/B150M - Aluminum Bronze Rod, Bar, and Shapes, Standard Specification for
ASTM B154/B154M - Mercurous Nitrate Test for Copper and Copper Alloys, Standard Test Method for
ASTM B633 - Electrodeposited Coatings of Zinc on Iron and Steel, Standard Specification for
ASTM D3951 - Commercial Packing, Standard Practice for
ASTM E10 - Brinell Hardness of Metallic Materials, Standard Test Method for
ASTM E18 - Rockwell Hardness of Metallic Materials, Standard Test Methods for
ASTM E1282 - Specifying the Chemical Compositions and Selecting Sampling Practices and Quantitative Analysis Methods for Metals, Ores, and Related Materials, Standard Guide for
ASTM E1417/E1417M - Liquid Penetrant Examination, Standard Practice for
ASTM E1444/E1444M - Magnetic Particle Testing, Standard Practice for
ASTM F468/F468M - Nonferrous Bolts, Hex Cap crews, Socket Head Cap Screws and Studs for General Use, Standard Specification for
ASTM F606/F606M - Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators and Rivets, Standard Test Methods for
ASTM F2328 - Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws, Studs and Nuts, Standard Test Methods for

(Applications for copies should be addressed to ASTM, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959 or https://www.astm.org)

American Society for Quality Control (ASQ)

ASQ Z1.4 - Sampling Procedures and Tables for Inspection by Attributes

(Application for copies should be addressed to the American Society for Quality Control, 60 North Plankinton Ave., Milwaukee, WI 53203 or http://asq.org).

National Aerospace Standards Committee (NASC)

NASM 1312-6 - Fastener Test Methods - Method 6, Hardness
NASM35307 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Steel Corrosion Resisting, Passivated, UNC-2A
NASM35308 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Steel Corrosion Resisting, Passivated, UNF-2A

NASM51095 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Head Drilled for Locking Wire, Steel, Grade 5, Cadmium Plated, UNC-2A, Plain and Self-locking
NASM51096 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Head Drilled for Locking Wire, Steel, Grade 5, Cadmium Plated, UNF-2A, Plain and Self-locking
NASM51105 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Shank Drilled for Cotter Pin, Steel, Grade 5, Cadmium Plated, UNC-2A
NASM51106 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Shank Drilled for Cotter Pin, Steel, Grade 5, Cadmium Plated, UNF-2A
NASM51109 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Shank Drilled for Cotter Pin, Steel, Corrosion Resisting, Passivated, UNC-2A
NASM51110 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt, Shank Drilled for Cotter Pin, Steel, Corrosion Resisting Passivated, UNF-2A
NASM90725 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Steel, Grade 5, Cadmium Plated, UNC-2A
NASM90726 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Steel, Grade 5, Cadmium Plated, UNF-2A

(Copies of these documents may be purchased from the Aerospace Industries Association, 100 Wilson Blvd., Suite 1700, Arlington, VA, 22209-3928 or at aia@aia-aerospace.org)

Society of Automotive Engineers (SAE)

SAE-AMS2700 - Steel, Passivation of Corrosion Resistant
SAE-AMS-STD-66 - Steel: Chemical Composition and Hardenability
SAE-AMS-QQ-A-225/6 - Aluminum Alloy, 2024, Bar, Rod, and Wire; Rolled, Drawn, or Cold Finished- UNS A92024
SAE-AMS-QQ-A-225/8 - Aluminum Alloy, 6061, Bar, Rod, and Wire, and Special Shapes; Rolled, Drawn, or Cold Finished- UNS A96061
SAE-AMS-QQ-P-416 - Plating, Cadmium (Electrodeposited)
SAE J429 - Mechanical and Material Requirements for Externally Threaded Fasteners

(Copies of these documents may be purchased from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, Pa 15096-0001. http://www.sae.org/) .)

3. REQUIREMENTS

3.1 Material. Unless otherwise specified in the invitation for bids, contract or order, cap screws shall be made of materials specified in 3.1.1 through 3.1.5 and Table IA (see 6.2).

3.1.1 Low carbon steel. Unless otherwise specified (see 6.2) grade 2 cap screws shall be made of low carbon steel as shown in Table I. The chemical composition shall contain a maximum of 0.28 percent carbon, a maximum of 0.04 percent phosphorus, and a maximum of 0.05 percent sulfur.

3.1.2 Medium carbon steel. Grade 5 cap screws shall be made of medium carbon steel as shown in Table I and conforming to the requirements of SAE-AMS-STD-66. The chemical composition shall contain 0.28 to 0.55 percent carbon, a maximum of 0.04 percent phosphorus and a maximum of 0.05 percent sulfur. It shall be quenched and tempered at a minimum temperature of 800°F. Cap screws of the following standards shall be made in accordance with the

specification: MS35295, NASM51095, NASM51096, NASM51105, NASM51106, NASM90725, and NASM90726.

3.1.3 Alloy steels.

3.1.3.1 Alloy steel, Grade 8. Grade 8 cap screws shall be made of alloy steel as shown in Table I and conforming to the requirements of SAE-AMS-STD-66. The chemical composition shall contain 0.28 to 0.55 percent carbon, a maximum of 0.04 percent phosphorus, and a maximum of 0.05 percent sulfur. Cap screws of the following standards shall be made in accordance with the specification: MS35302, MS51107, and MS51108.

TABLE I. Grades and Mechanical Properties of Steel Cap Screws 1/4 thru 3 Inch Diameters

Grade Designation	Nominal Size Dia., Inch	Proof Load p.s.i.	Tensile Strength p.s.i. (Min	Hardness			
				Brinell No.		Rockwell	
				Min	Max	Min	Max
2	1/4 thru 3/4 *	55,000	74,000	149	241	B80	B100
	Over 3/4 thru 1-1/2**	33,000	60,000	121	241	B70	B100
5	1/4 thru 1	85,000	120,000	255	321	C25	C34
	Over 1 thru 1-1/2	74,000	105,000	223	285	C19	C30
	Over 1-1/2 thru 3	55,000	90,000	183	235	B90	C21.7
8	1/4 thru 1-1/2	120,000	150,000	302	352	C33	C39
	Over 1-1/2 thru 3	85,000	120,000	302	352	C33	C39
9 (Option Alloy)	1/4 thru 1-1/2	130,000	170,000	336	386	C36	C45

* 6" and less in length.
** All diameters if length exceeds 6".

3.1.3.2 Optional alloy steel. The optional alloy steel shown in Table I shall be grade 8 conforming to the requirements of SAE-AMS-STD-66, except that it shall modified to meet the requirements specified in Table 1.

3.1.3.3 Alloy steels. Alloy steels shall be oil-quenched and tempered at a minimum temperature of 800°F.

3.1.4 Corrosion resisting steels.

3.1.4.1 Austenitic. Austenitic corrosion resisting steel screws shall be manufactured from 300 series corrosion steel as specified in SAE-AMS-STD-66 and meet the mechanical properties specified in 3.2.2.1. Cap screws of NASM35307 and NASM35308 shall be made in accordance with the specification.

3.1.4.2 Ferritic and martensitic. Ferritic and martensitic corrosion resisting steel cap screws shall be manufactured from a steel composition such as steel numbers 410, 416, and 430 as specified in SAE-AMS-STD-66 and meets the mechanical properties specified in 3.2.2.2. Cap screws of NASM51099, NASM51100, NASM51109, and NASM51110 shall be made in accordance with the specification.

3.1.5 Non-ferrous material. Non-ferrous cap screws shall be manufactured from alloys specified in Table IA (see 6.2). Cap screws of MS35309, MS35310, MS35311, and MS35312 shall be made in accordance with the specification.

3.1.5.1 Stress relief. Cold worked naval brass screws shall be stress relieved by heating the screws to a temperature of 600°F, and holding at that temperature for a minimum of one hour.

3.1.6 Self-locking element. Non-metallic, self-locking elements shall be in accordance with MIL-DTL-18240.

3.2 Mechanical properties.

3.2.1 Steel. Grades and mechanical properties of low carbon, medium carbon, alloy steel, and optional alloy steel cap screws shall conform to Table I, as applicable (see 6.2).

3.2.2 Corrosion resisting steel.

3.2.2.1 Austenitic. Unless otherwise specified in the invitation for bids, contract or order, mechanical properties of austenitic corrosion-resisting steel cap screws shall conform to the following for diameters through 5/8 inch:

a.	Ultimate tensile strength	80,000 p.s.i. min.
b.	Yield strength (0.2 percent offset)	30,000 p.s.i. min.
c.	Rockwell Hardness	B80 min.
d.	Elongation	30 percent min.
e.	Reduction in area	40 percent min.

For diameters over 5/8 inch, ultimate tensile strength shall be 70,000 p.s.i. min. and have a hardness of Rockwell B74 min.

3.2.2.2 Ferritic and martensitic. Unless otherwise specified in the invitation for bids, contract or order, mechanical properties of ferritic and martensitic corrosion-resisting steel cap screws shall conform to the following:

a.	Ultimate tensile strength	70,000 p.s.i. min.
b.	Yield strength (0.2% offset)	40,000 p.s.i. min.
c.	Brinell hardness	B235 max
d.	Elongation	15
e.	Reduction in area	45

3.2.3 Non-ferrous cap screws. Unless otherwise specified in the invitation for bids, contract or order, mechanical properties of non-ferrous cap screws shall conform to Table IA, as specified (see 6.2).

TABLE IA. Mechanical Properties of Screws of the Non-Ferrous Materials.

Material	Applicable specifications	UNS No. or Class	Temper code or Condition	Tensile strength p.s.i. minimum	Yield strength at 0.2 percent offset or at extension indicated		Elongation minimum
					minimum p.s.i	extension under load	
Manganese bronze	ASTM B138/ B138M	C67500	O60	55,000	22,000	0.5 percent	20
Aluminum bronze	ASTM B150/ B150M	C63200	TQ55 O20 O25	90,000	37,000	0.5 percent	18
Phosphor bronze	ASTM B139/ B139M	C51000	H04	60,000	33,000	--	15
Silicon bronze	ASTM F468/ F468M	C65100	-	60,000	40,000	0.5 percent	10
Naval brass	ASTM B21 /B21M	C46200 or C46400	H04 or O50	60,000	27,000	0.5 percent	25 2/
Aluminum alloy 2024	SAE-AMS- QQ-A-225/6	-	Solution heat-treated temper T4	62,000	40,000	0.0058 inch per inch	10 3/
Aluminum alloy 6061	SAE-AMS- QQ-A-225/8	-	Age hardened temper T6	42,000	35,000	0.0055 inch per inch	10 3/
Nickel-copper alloy	QQ-N-281	Class A		80,000	40,000	0.0071 inch in 2 inches	20 1/
Nickel-copper-aluminum alloy	QQ-N-286	Class A	Form 1	130,000	90,000	0.0109 inch in 2 inches	20 1/

1/ In 2 inches (min)
2/ In 4 times diameter or thickness (min)
3/ In 2 inches or 4 times diameter (min)

3.3 Dimensions and tolerances. Cap screws shall conform to the dimensions and tolerances of ASME B18.2.1 and B18.6.2 except as specified herein.

3.3.1 Lengths. Unless otherwise specified (see 6.2), cap screws shall be furnished in the following length increments:

Lengths up to 1/2 inch incl - 1/16 inch increments.
over 1/2 to 1 inches incl - 1/8 inch increments.
over 1 to 5 inches incl - 1/4 inch increments.
over 5 inches - 1/2 inch increments.

3.3.2 Thread series, class, lengths, and hand. Unless otherwise specified (see 6.2), cap screws shall be right - hand of the UNC (coarse thread) or UNF (fine thread) series, Class 2A, in accordance with FED-STD-H28/2.

3.3.3 Threads protectively coated. Unless otherwise specified (see 6.2), threads protectively coated shall meet the dimensions of FED-STD-H28/2 after the coating has been applied.

3.3.4 Bearing surface. Bearing surface of cap screw heads, except flat head, shall be at right angles to the axis of the body within a tolerance of 2 degrees and of hex head within a tolerance of 2 degrees for 1 inch size and smaller, and 1 degree for sizes larger than 1 inch. The axis of the head shall be concentric with the axis of the body (determined by one diameter length of body under head)

within a tolerance equal to 3 percent (6 percent TIR) of maximum width across flats. Any mutilation of the bearing surface sufficient to prevent proper seating of the screw shall be cause for rejection.

3.4 Protective coatings.

3.4.1 Coatings. Cap screws shall be furnished uncoated, passivated, or coated as specified herein (see 6.2).

3.4.2 Passivation. Corrosion resistant steel cap screws shall be passivated in accordance with SAE-AMS2700, Method 1.

3.4.3 Cadmium plating. When specified (see 6.2), cap screws shall be cadmium plated in accordance with SAE-AMS-QQ-P-416, Type II, Class 2.

3.4.4 Zinc plating. When specified (see 6.2), cap screws shall be zinc plated as specified in ASTM B633, type II, class FE/ZN 5.

3.4.5 Anodizing. Unless otherwise specified, aluminum alloy cap screws shall be electrolytically treated in conformance to MIL-A-8625, type II, class 1, non-dyed (see 6.2).

3.4.6 Phosphate. When specified (see 6.2), cap screws shall be treated in conformance to MIL-DTL-16232, type Z, class 2.

3.4.7 Black chemical. When specified (see 6.2), brass cap screws shall be treated with a black chemical finish in accordance with MIL-F-495.

3.4.8 Hydrogen embrittlement. Alloy steel cap screws required to be electroplated or phosphate coated (see 3.4.3 thru 3.4.6) shall be subjected to a relief treatment in accordance with the methods specified in the applicable plating or coating specification, immediately after the plating or coating operation to minimize the embrittlement that results from these processes.

3.5 Metallographic requirements.

3.5.1 Decarburization. When specified (see 6.2), results shall be in accordance with the requirements of ASTM F2328.

3.5.2 Grain size of copper alloy. When specified (see 6.2), grain size of copper alloy in cap screws shall be an option of the contracting officer in accordance with the material specification.

3.6 Surface roughness. Unless otherwise specified (see 6.2), cap screws shall have a maximum arithmetical average surface roughness on the bearing surface of the head and shank of 125 microinches. Hot headed cap screws over 3/4 inch in diameter are excepted and shall have a maximum surface roughness of 250 microinches. Threads shall have a maximum surface roughness of 63 microinches. Normally, it will be sufficient to ascertain that these surfaces on screws have the equivalent of a smooth machined finish by visual comparison with known surface standards. However, then it is deemed necessary to measure these surfaces with commercially available equipment, roughness measurements shall be taken axially on the body and fillet surfaces, and circumferentially on the bearing surface in accordance with ASME B46.1.

3.7 Method of manufacture. Unless the method of manufacture is specifically stated (see 6.2), the method employed for the production of screw threads on cap screws shall be at the option of the manufacturer.

3.8 Head markings. Steel cap screws shall be permanently marked with the grade identification symbol conforming to SAE J429, and applicable documents. In addition, all cap screws shall be marked with the manufacturer's identification

symbol. Markings shall be located on the top of the head, and may be either raised or depressed, at the option of the manufacturer.

3.9 Defects.

3.9.1 Discontinuities. Cap screws shall not contain discontinuities which equal or exceed the following limitations. Care must be exercised not to confuse cracks with discontinuities, as described herein. When visual inspection discloses discontinuities which show cause for further examination, magnetic particle or penetrant inspection as applicable, shall be as specified in 4.4.9.

3.9.1.1 Laps and seams. Cap screws may possess laps and seams except in locations specified in 3.9.2. The depth shall not exceed that permitted in 3.9.2. They shall be examined as specified in 4.4.9. Typical lap and seam discontinuities are shown in figure 5.

3.9.1.2 Inclusions. Cap screws shall show no evidence of surface or subsurface inclusions at the thread root when examined as specified in 4.4.9. Small inclusions in other parts of the cap screws not indicative of unsatisfactory quality, shall not be cause for rejection.

3.9.1.3 Tool marks. Tool marks or undercuts of depths not exceeding those shown in table II and figure 7 are acceptable. Surface discontinuities such as nicks, gouges, dents, scratches, and scrapes are permissible if they do not impair the functionability of the product.

TABLE II. Limits of tool marks or undercuts.

Size	Depth (Inch Max.)
Up to 3/8 inch	0.003
Over 3/8 to 5/8 inch	0.004
Over 5/8 to 7/8 inch	0.005
Over 7/8 inch	0.006

3.9.1.4 Voids. Voids are permissible discontinuities if in the limits specified in 4.4.9.2.Typical voids are shown in figure 7.

3.9.1.5 Folds. Folds may occur at or near the intersection of diameter changes. Folds at exterior corners are permissible discontinuities if within the limits specified in 4.4.9.3. Typical folds are shown in figure 6.

3.9.1.6 Bursts. Cap screws may possess bursts that occur at the flat of the head of screws if within the limits specified in 4.4.9.4. Typical bursts are shown in figure 6.

3.9.2 Thread discontinuities. (Laps, seams, and surface irregularities). Threads shall have no laps at the root or along the flanks as shown in figure 5. Laps are permissible at the crest but shall not exceed 25 percent of the basic thread depth. Slight deviation from the thread contour is permissible at the crest of the thread as shown in figure 5. Magnetic inspection techniques may be used in accordance with 4.4.9.

3.9.3 Cracks. Cap screws shall be free from cracks in any direction or location.

3.9.3.1 Quench cracks. Quench cracks may occur during heat treatment and usually traverse an irregular and erratic course on the surface of the screw. They shall be examined as specified in 4.4.9. Typical quench cracks are as shown

in figure 6.

3.9.3.2 Forging cracks. Forging cracks may occur during the cut-off or forging operations and are located on the top of the head of screws. They shall be examined as specified in 4.4.9. Typical forging cracks are shown in figure 6.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. The contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may use his own or any other facilities suitable for the inspection requirements specified herein, unless disapproved by the Government. Inspection records of the examination and tests with itemized results shall be kept complete at the manufacturer's facility, available to the Government throughout the duration of the contract, or a minimum of two years, whichever is longer.The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this document shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in this document shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing requirements, is an acceptable practice to certain conformance to requirements, however, this does not authorize submission of known defective material either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Component and material inspection. Components and materials shall be inspected in accordance with all the requirements specified herein and in application referenced documents.

4.1.3 Examination of preparation for delivery. An examination shall be made to determine that the packaging, packing and marking comply with the requirements in Section 5 of this specification.

4.2 Sampling for lot acceptance.

4.2.1 Inspection lot. A lot shall consist of cap screws of the same type, made from the same heat of material, heat treatment, protective coating, surface finish, size, length, and threads produced and manufactured at the same time by the same manufacturer's facility and offered for acceptance at the same time. Where the length of the lot of fasteners is too short to support mechanical testing of full size fasteners, the lot shall include longer length fasteners solely for the purposes of mechanical testing. The longer test fasteners shall be made from the same heat of rod, bar or wire used for the production fasteners; have the same type, style and diameter as the production fasteners; and shall be processed and heat treated with the production fasteners.

4.2.2 Sampling for examination of cap screws. A random sample of cap screws shall be selected from each lot in accordance with ASQ Z1.4, Inspection Level S-4. The Acceptable Quality Level (AQL) shall be as indicated in table III. Unless otherwise specified, the AQLs listed in this inspection shall be used to establish the sample size, however, the acceptance number shall be zero.

TABLE III. Classification of defects.

Categories	Defects	Inspection method
Critical	AQL = 1.0 percent	
1	Cracks (3.9.3)	Microscope or S.I.E.*
Major	AQL = 2.5 percent	
101	Thread, size and form (3.3.1 and 3.3.2)	Thread ring gauge Go and No Go
102	Thread lengths (3.3.2)	S.I.E.*
103	Discontinuities (3.9.1)	S.I.E.*
104	Self-locking element missing, when applicable (3.1.6)	Visual
Minor	AQL = 4.0 percent	
201	Length (3.3.1)	S.I.E.*
202	Surface roughness (3.6)	Visual
203	Coated threads (when applicable) (3.3.3)	Visual
204	Head marking (3.8)	Visual

*Standard Inspection Equipment

4.2.3 Sampling for mechanical properties and metallographic tests. A random sample of cap screws shall be selected from each lot in accordance with ASQ Z1.4, Inspection Level S-1. The AQL shall be 0 percent defective.

4.2.3.1 Samples selected as specified in 4.2.3 may be used when practicable. Three quarter inch and larger test specimens processed with the lot may be used for destructive testing.

4.2.4 Chemical analysis. Chemical analysis shall be made in accordance with ASTM E1282. When a certificate covering these requirements can be furnished, it will be acceptable.

4.2.5 Sampling for packaging and packing. Sampling for inspection of packaging and packing shall be in accordance with ASTM D3951.

4.2.6 Sampling for mercurous nitrate test. When specified (see 6.2), a random sample shall be taken from each lot of cold-worked naval brass screws in accordance with ASQ Z1.4, Inspection Level S-1.Any one defect shall cause rejection of the represented lot.

4.3 Examination.

4.3.1 Visual and dimensional inspection. Each cap screw selected as specified in 4.2.2 shall be examined to verify conformance with this specification. Examination shall be conducted in accordance with table III. Any screw having one or more defects shall be rejected and if the number of defective screws in any sample exceed the acceptance number of the sample, the lot represented by the sample shall be rejected. Retests shall be in accordance with ASQ Z1.4.

4.3.2 Inspection of packaging and packing. Inspection of packaging and packing including preservation and marking of packages and containers shall be in accordance with ASTM D3951.

4.4 Test procedure.

4.4.1 The test specified in 4.4.2 through 4.4.13 are all required. If wedge testing Is desired, see Appendix 1.

4.4.2 Hardness. Hardness test for cap screw shall be conducted in accordance with ASTM E10 and ASTM E18 on transverse section through the threaded portion of the screw, taken one nominal diameter from the point, or when too short, halfway between the bearing surface and the point. Hardness shall be measured at a point on the section, one quarter diameter from the axis of the screw. For screws three quarter inch and larger, test may be made on a test specimen.

4.4.3 Tensile. Tensile test shall be conducted in accordance with ASTM F606/F606M. Unless otherwise specified (see 6.2), Grade 2, low carbon steel screws shall not be subjected to this test.

4.4.3.1 Full size specimens. When testing equipment is available cap screws shall be tested full size, preferably using apparatus similar to that illustrated in figure 1.

4.4.3.2 Turned shank specimens. For testing cap screws having tensile properties greater than can be measured on available test equipment, the shank or test specimen shall be turned down around the axis, to gage dimensions specified in ASTM F606/F606M. For testing cap screws or test specimens too large for full size testing, the specimen shall be turned, have its axis midway between the axis of the shank and the surface of the shank, as illustrated in figure 3.

4.4.3.3 Ductility test specimens. Test for elongation and reduction in area shall be conducted on turned shank specimens (figure 2) having dimensions to the largest practical specimens (see 4.4.3).

4.4.3.4 Screws too short to be tensile strength tested as defined in ASTM F606/F606M shall be hardness tested in accordance with NASM1312-6. If the hardness limits are not specified, screws shall meet the minimum hardness requirement of the material from which they were made.

4.4.3.5 Sampling for fasteners too long for testing. For lots of fasteners too long for testing in accordance with ASTM F606/F606M, standard length fasteners manufactured with the same lot to support mechanical testing shall be utilized to support proof, yield, axial and wedge strength testing, but shall not be used for evaluation of overall screw length, thread length or grip length.

Metallographic tests.

4.4.3.5 Decarburization. When required (see 6.2), tests for decarburization shall be performed in accordance with ASTM F2328.

4.4.3.6 Grain size of copper alloys. Determination of grain size of copper alloy shall be made in accordance with ASTM E112.

4.4.5 Protective coating test. Protective coating and plating tests shall be conducted in accordance with the applicable specifications shown in 3.4.3 through 3.4.7.

4.6 Passivation test. Passivation test shall be conducted in accordance with SAE-AMS2700, Method 1 .

4.4.7 Hydrogen embrittlement. The contractor shall furnish the Government certification that electroplated or phosphate coated alloy steel screws have been subjected to the hydrogen embrittlement relief treatment specified in 3.4.8. When specified (see 6.2), electroplated or phosphate coated screws shall be subjected to the embrittlement relief test specified in the applicable plating or coating specification.

4.4.8 Magnetic permeability. Austenitic corrosion resisting steel cap screws, subjected to visual and dimensional examination, shall also be tested to determine

magnetic permeability (see 3.1.4.1) in accordance with ASTM A342/A342M.

4.4.9 Discontinuities. Magnetic particle inspection performed in accordance with ASTM E1444 or liquid penetrant inspection performed in accordance with ASTM E1417 shall be used to determine the presence of cracks and discontinuities such as laps, seams, and inclusions. Magnetic particle or penetrant indications alone shall not be cause for rejection, and such screws may be sectioned and discontinuities measured microscopically under 10X magnification to determine conformance to the requirements of 3.9. The inspection shall be performed on unfinished cap screws, free of lubrication and subsequent to any processing operation which could adversely affect the cap screws.

4.4.9.1 Tool marks. Tool marks on the bearing surface are permissible discontinuities providing that the surface roughness does not exceed 125 microinches, determined as the arithmetic average deviation from the mean surface. Tool marks on other surfaces are permissible discontinuities and shall not be cause for rejection of otherwise acceptable screws.

4.4.9.2 Voids. Voids on the bearing surface of the screws are permissible discontinuities providing that no void has a depth greater than 0.010 inch and that the combined area of all voids does not exceed 5 percent of the specified minimum area of the bearing surface.

4.4.9.3 Folds. Folds located in internal corners at or below the bearing surface, e.g. in the fillet at the junction of head and shank, are not permitted.

4.4.9.4 Bursts. Bursts in the flats of hexagon head screws are permissible discontinuities providing that no burst has a width or an open depth greater than 0.010 inch plus 0.025D, where D is the nominal screw size in inches. No burst shall extend into the bearing surface.

4.4.10 Self-locking. Self-locking screws having non-metallic elements shall be tested in accordance with MIL-DTL-18240.

4.4.11 Mercurous nitrate (stress relief) test. The contractor shall furnish the government certification that cold worked naval brass screws have been subjected to the stress relief treatment specified in 3.1.5.1. When specified (see 6.2), samples taken as specified in 4.2.6 shall be subjected to a mercurous nitrate test conducted in accordance with ASTM B154/B154M. There shall be no evidence of cracks.

4.4.12 Proof load. Proof load test for cap screws shall be conducted in accordance with ASTM F606/F606M.

4.4.13 Yield strength. Yield strength test for cap screws shall be conducted in accordance with ASTM F606/F606M.

4.4.14 Wedge tensile tests. Wedge tensile tests are only required by manufacturers when required by contract.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

6.1 Intended use. Hexagon head and slotted head cap screws are designed primarily for use in precision machine tools and similar applications. They are commonly used in tapped holes, but may be used with nuts.

6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

(a) Title, number, and date of this specification.
(b) Type and style, grade (for carbon and alloy steel), and size or standard part number (1.2).
(c) Material and condition (3.1).
(d) Mechanical properties, if other than those specified in Tables I and IA (3.2).
(e) Length, thread series, class, and hand (3.3).
(f) Coating, if required, and whether thread shall conform to different size requirements (3.3.3 and 3.4).
(g) Decarburization test, if required (3.5.1).
(h) Copper alloy grain size, if required (3.5.2).
(i) Surface roughness, if different (3.6).
(j) Method of manufacture, if necessary (3.7)
(k) Material certification, if applicable (4.2.4).
(l) Hardness and tensile tests (4.4.2 and 4.4.3).
(m) Metallographic tests, if required (4.4.4).
(n) Selection of applicable level of packaging and packing required (5.1).
(o) Embrittlement relief test, if required (4.4.7).
(p) Mercurous nitrate test, if required (4.4.11).
(q) Proof load test, if required (4.4.12).
(r) Yield strength test, if required (4.4.13).

6.3 Military procurement. Items procured under this specification for Military use shall be limited to the variety and materials specified on the applicable MS. Cap screws of low carbon steel are non-preferred for military use. Personnel of the Military departments are requested to refer to these documents for guidance.

6.4 Definitions.

6.4.1 Cracks. A crack is a clean crystalline break passing through the grain or grain boundary without the inclusion of foreign elements.

6.4.1.1 Quench cracks. Quench cracks are fractures occurring during heat treatment, due to excessive high thermal and transformation stresses.

6.4.1.2 Forging cracks. Forging cracks are cracks that may occur during the cut-off or forging operations.

6.4.2 Lap. A lap is a surface defect appearing as a seam, caused by the folding over of metal fins or sharp corners and then rolling or forging them into the surface, but not welding them.

6.4.3 Seam. A seam is an unwelded fold or lap which appears as an opening in the raw material as received from the source.

6.4.4 Inclusions. Inclusions are non-metallic material in a solid metallic matrix.

6.4.5 Tool marks. Tool marks are longitudinal or circumferential grooves of shallow depth produced by the movement of manufacturing tools over the surface of the screw.

6.4.6 Void. A void is a shallow pocket or hollow on the surface of the screw due to non-filling of metal during forging or upsetting.

6.4.7 Fold. A fold is a doubling over of metal which may occur during the forging operation.

6.4.8 Burst. A burst is an open break in the metal.

6.5 Subject term (keyword) listing.

Slotted head screw
Plain head screw
Screw thread

6.6 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensive changes.

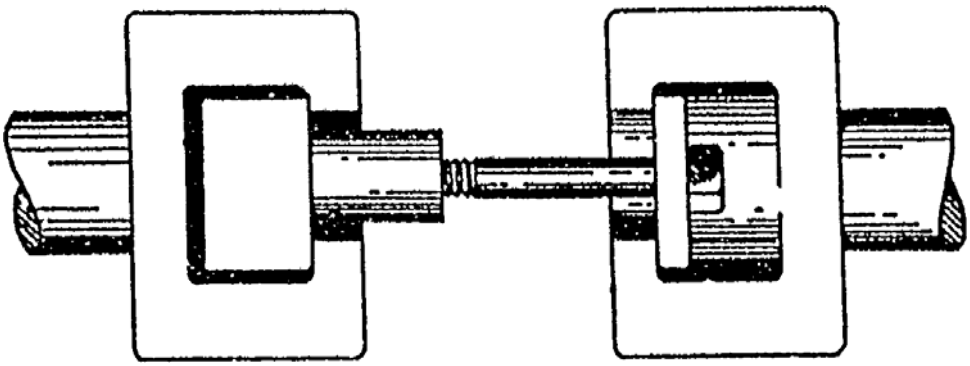


FIGURE 1. *Tension testing full-size screw.*

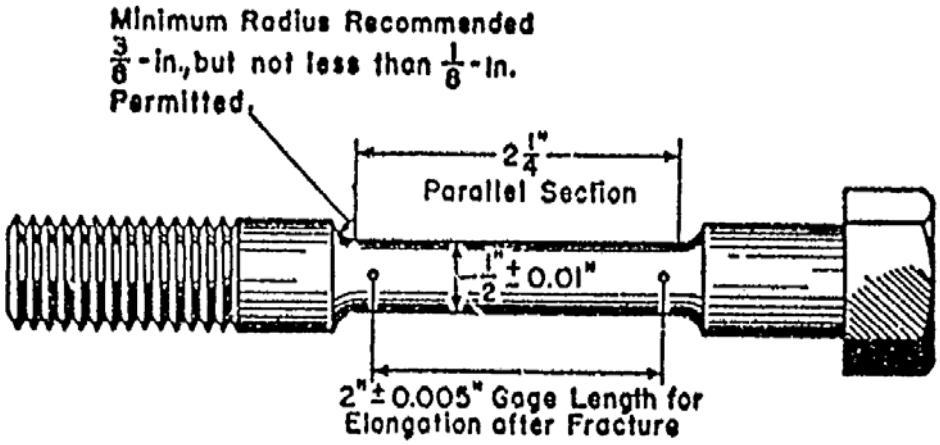


FIGURE 2. *Tension-test specimen for screw with turned-down shank.*

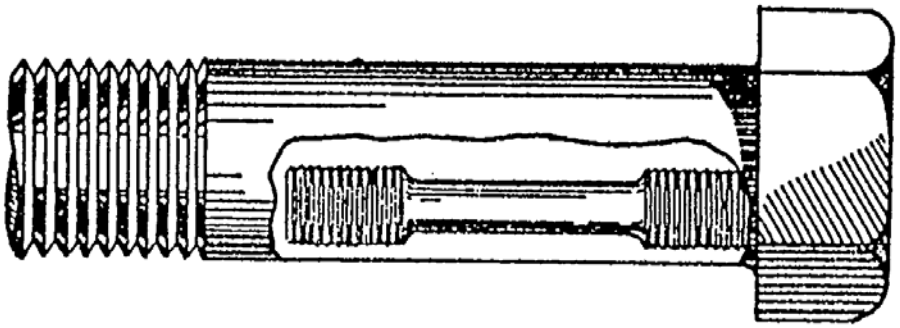


FIGURE 3. *Location of standard, round, 2-inch-gage-length, tension-test specimen when turned from large-size screw.*

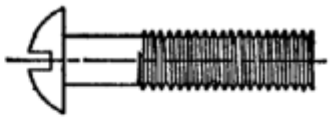
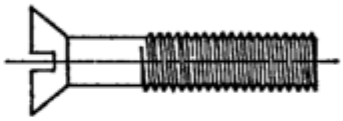
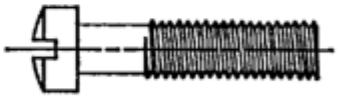
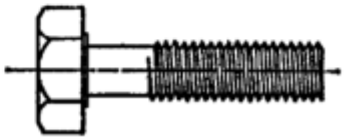
TYPE	STYLE	HEAD	DRIVE
I	1s	ROUND	
I	2s	FLAT	
I	4s	FILLISTER	
II	10P	HEXAGON	

Figure 4 - Types, heads and styles

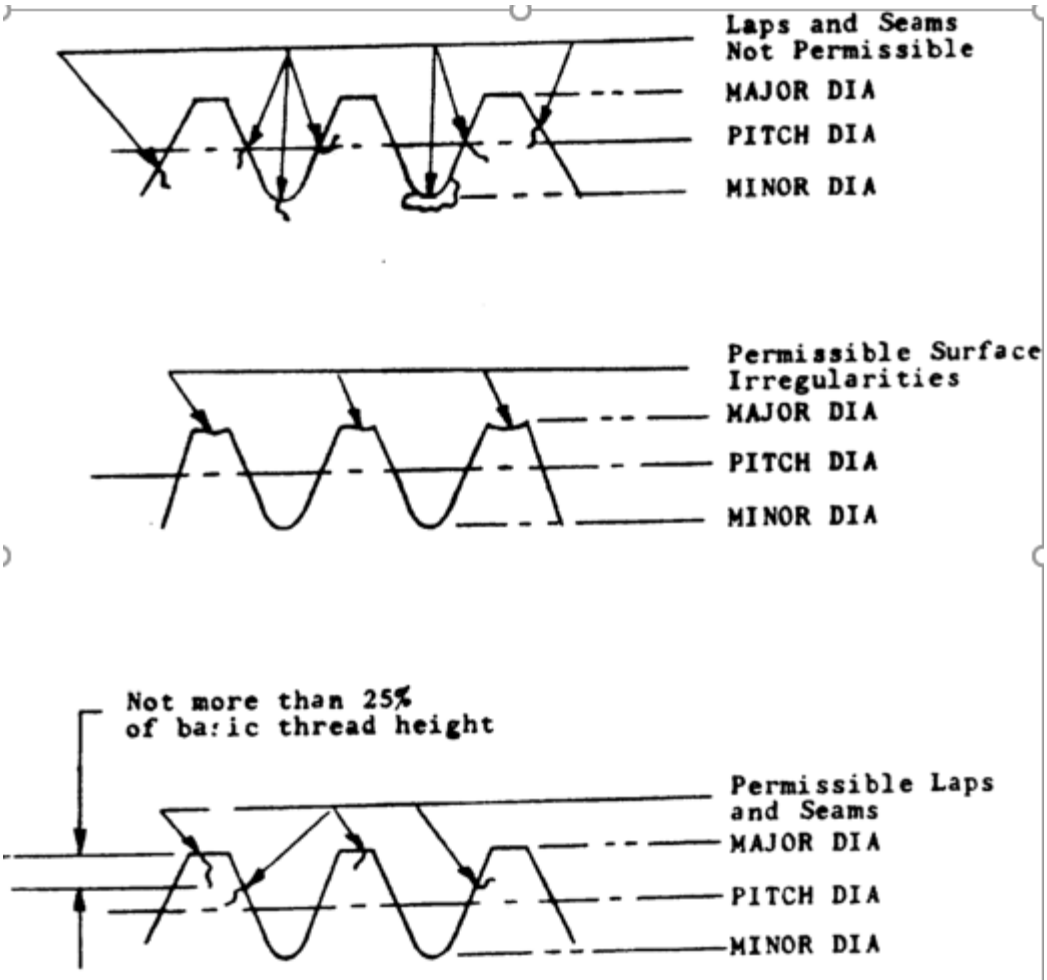


Figure 5. Laps, Seams and Surface Irregularities in Thread

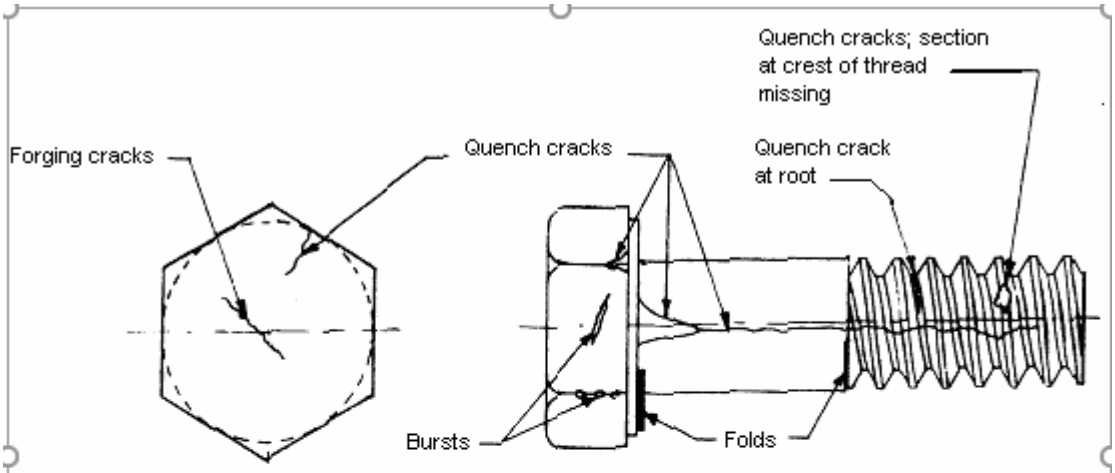


Figure 6. Forging and quench cracks, folds and bursts in screws

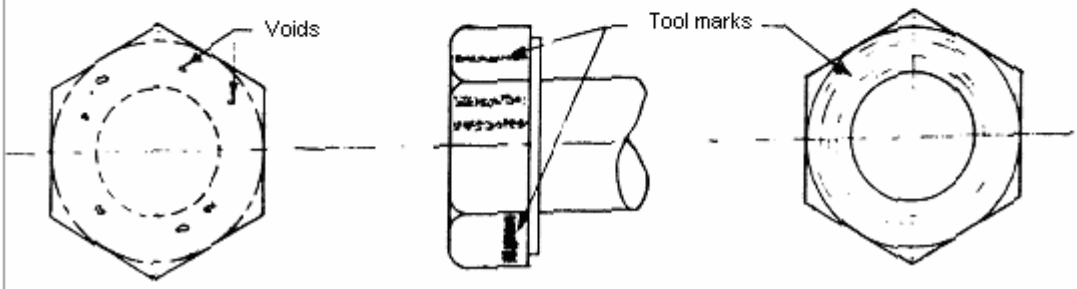


Figure 7. Tool marks; voids on the bearing surface of screws

MILITARY INTERESTS

Custodians:
Army - AR
Navy - SH
Air Force - 71

Preparing activity:
DLA-IS

(Project No. 5305-2019-003)

Review activities:
Army - AV
Navy - AS
NSA – NS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.

APPENDIX 1

Wedge tension test. Should the procuring activity determine that wedge tensile testing is required for the procurement, wedge testing shall be performed in accordance with ASTM F606/F606M, with wedge angles in accordance with Table V. Samples that have been yield tested shall not be used for wedge tensile testing. Samples that were used for proof testing may be used for wedge tensile testing, provided the fastener passed the proof test.

Wedge Angle Testing table

Material	Size	Wedge Angle /1	
		Body Lengths greater than 2D	Body Lengths 2D or less or Threaded to the Head
Alloy Steel	0.112 - 0.50 incl.	10	6
	0.625 - 0.750 incl.	8	6
	0.875 and larger	6	4
CRES and Heat and Corrosion Resistant Steel	0.112	10	6
	Over 0.750	6	4
Nonferrous (except titanium)	0.112 - 0.750 incl.	10	6
	Over 0.750	6	4
Titanium	0.112 - 0.750 incl.	6	4
	Over 0.750	4	4

1. Wedge angels listed are minimum values. Fasteners that have previously been axial tension tested or wedge tested should not be submitted for acceptance.