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SUPERSEDING
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FEDERAL SPECIFICATION

SCREW, CAP, SLOTTED AND HEXAGON HEAD

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of 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 Specifications and standards. The following specifications and standards, 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.

Federal Specifications:

QQ-A-225/6 - Aluminum Alloy Bar, Rod, and Wire; Rolled, Drawn, or Cold Finished, 2024.
QQ-A-225/8 - Aluminum Alloy Bar, Rod, Wire, and Special Shapes; Rolled, Drawn, or Cold Finished, 6061.
QQ-B-637 - Brass, Naval: Rod, Wire, Shapes, Forgings, and Flat Products with Finished Edges (Bar, Flat Wire, and Strip).
QQ-B-728 - Bronze Manganese; Rod, Shapes, Forgings, and Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate).
QQ-B-750 - Bronze, Phosphor; Bar, Plate, Rod, Sheet, Strip, Flat Wire, and Structural and Special Shaped Sections.
QQ-C-591 - Copper-Silicon, Copper-Zinc-Silicon, and Copper-Nickel-Silicon Alloys: Rod, Wire, Shapes, Forgings, and Flat Products, (Flat Wire, Strip, Sheet, Bar, and Plate).
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.
QQ-P-35 - Passivation Treatments for Austenitic, Ferritic, and Martensitic Corrosion-Resisting Steel (Fastening Devices).
QQ-P-416 - Plating, Cadmium (Electrodeposited).
QQ-Z-325 - Zinc Coating, Electrodeposited, Requirements for.

Federal Standards:

Fed. Std. No. 66 - Steel: Chemical Composition and Hardenability.
Fed. Std. No. 123 - Marking for Domestic Shipment (Civilian Agencies).
Fed. Test Method Std. No. 151 - Metals; Test Methods.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the

Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.)

(Single copies of this specification and other Federal Specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Washington, D.C., Atlanta, Chicago, Kansas City, Mo., Fort Worth, Denver, San Francisco, Los Angeles, and Seattle, Wash.)

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Specifications:

MIL-F-495 - Finish, Chemical, Black, for Copper Alloys.
MIL-H-3982 - Hardware (Fasteners and Related Items), Packaging and Packing for Shipment and Storage of.
MIL-I-6866 - Inspection, Penetrant Method of.
MIL-I-6868 - Inspection Process, Magnetic Particle.
MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-P-16232 - Phosphate Coatings, Heavy, Manganese or Zinc Base (for Ferrous Metals).
MIL-I-17214 - Indicator, Permeability, Low-Mu (Go-No Go).
MIL-B-24059 - Bronze, Nickel Aluminum; Rod, Flat Products with Finished Edges, Shapes and Forgings.

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-109 - Quality Assurance Terms and Definitions.
MIL-STD-129 - Marking for Shipment and Storage.
MS18153 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Head Drilled for Locking Wire, Alloy Steel, Grade 8, Cadmium Plated, UNF-2A
MS18154 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Head Drilled for Locking Wire, Alloy Steel, Grade 8, Cadmium Plated, UNC-2A
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
MS35307 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Corrosion Resisting Steel, Passivated, UNC-2A

MS35308 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Corrosion Resisting Steel, Passivated, 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
MS51095 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Head Drilled for Locking Wire, Steel, Grade 5, Cadmium Plated, UNC-2A
MS51096 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Head Drilled for Locking Wire, Steel, Grade 5, Cadmium Plated, 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
MS51105 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Shank Drilled for Cotter Pin, Steel, Grade 5, Cadmium Plated, UNC-2A
MS51106 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Shank Drilled for Cotter Pin, Steel, Grade 5, Cadmium Plated, 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
MS51109 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Shank Drilled for Cotter Pin, Steel, Corrosion Resisting, Passivated, UNC-2A
MS51110 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Shank Drilled for Cotter Pin, Steel, Corrosion Resisting Passivated, UNF-2A
MS90725 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Medium Carbon Steel, Cadmium Plated, UNC-2A
MS90726 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Medium Carbon Steel, Cadmium Plated, UNF-2A
MS90727 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Alloy Steel, Cadmium Plated, UNF-2A
MS90728 - Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Alloy Steel, Cadmium Plated, UNC-2A

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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

National Bureau of Standards (NBS) Standard:

H28, Part I - Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.)

United States of America Standards Institute Standards:

USAS B18.2.1 - Square and Hex Bolts and Screws (including Hex Cap Screws and Lag Screws)

USAS B18.6.2 - Hexagon Head Cap Screws, Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws

(Application for copies should be addressed to the United States of America Standards Institute, 10 East 40th Street, New York, New York 10016.)

Society of Automotive Engineers (SAE) Standard:

J429 - Mechanical and Quality Requirements for Externally Threaded Fasteners

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 485 Lexington Avenue, New York, New York 10017.)

American Society for Testing and Materials (ASTM) Publication:

E8 - Tension Testing of Metallic Materials
E10 - Brinell Hardness of Metallic Materials, Test for
E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials, Test for
E112 - Estimating the Average Grain Size of Metals

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

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 Fed. Std. No. 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	MS51106
MS51095	MS90725
MS51096	MS90726
MS51105	

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 Fed. Std. No. 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 hardened sufficiently to a minimum oil-quench Rockwell hardness of C45 at the center of the threaded section, one diameter from the end of the cap screw. Cap screws of the following standards shall be made in accordance with the specification:

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	C32	C38
	Over 1-1/2 thru 3	85,000	120,000	302	352	C32	C38
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".

MS18153	MS51108
MS18154	MS90727
MS35302	MS90728
MS51107	

3.1.3.2 Optional alloy steel. The optional alloy steel shown in Table I shall have the same chemical composition as grade 8 conforming to the requirements of Fed. Std. No. 66 except that it shall be hardened sufficiently to a minimum oil quench Rockwell hardness of C50 at the center of the threaded section, one diameter from the end of the cap screw.

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 Federal Standard 66 or any other Austenitic Cres steel developed for cold heading or free machining, i.e., steel which meets the mechanical properties specified herein. Cap screws of MS35307 and MS35308 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 Fed. Std. No. 66, i.e., steel which meets the mechanical properties specified in 3.2.2.2. Cap screws of MS51099, MS51100, MS51109, and MS51110 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.

3.2 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	Composition or class	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	QQ-B-728	Class A	Soft	55,000	22,000	0.5 percent	20
Nickel-aluminum bronze	MIL-B-24059	----	Extruded and annealed	90,000	37,000	0.5 percent	18
Phosphor bronze	QQ-B-750	Composition A	Hard	60,000	33,000	----	15
Silicon bronze	QQ-C-591	Copper Alloy No. 651	Hard	60,000	40,000	0.5 percent	10
Naval brass	QQ-B-637	Composition I (Alloy 464)	Half hard	60,000	27,000	0.5 percent	25 2/
Aluminum alloy	QQ-A-225/6	Table I	Solution heat-treated temper T4	62,000	40,000	0.0058 inch per inch	10 3/
Aluminum alloy	QQ-A-225/8	Table I	Age hardened temper T6	42,000	35,000	0.0055 inch per inch	10 3/
Nickel-copper alloy	QQ-N-281	Class A	Hot finished	80,000	40,000	0.0071 inch in 2 inches	30 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 USAS 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 5/8 inch incl - 1/16 inch increments.
over 5/8 to 1-1/2 inches incl - 1/8 inch increments.
over 1-1/2 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 National Bureau of Standards Handbook H28, Part I.

3.3.3 Threads protectively coated. Unless otherwise specified (see 6.2), threads protectively coated shall meet the dimensions of National Bureau of Standards Handbook H28 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 per cent (6 per cent 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 QQ-P-35.

3.4.3 Cadmium plating. When specified in the invitation for bid, contract, or order, cap screws shall be cadmium plated as specified in QQ-P-416, type II, class 3 (see 6.2).

3.4.4 Zinc plating. When specified in the invitation for bid, contract or order, cap screws shall be zinc plated as specified in QQ-Z-325, type II, class 2 (see 6.2).

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 on the invitation for bid, contract, or order, cap screws shall be treated in conformance to MIL-P-16232, type Z, class 2 (see 6.2).

3.4.7 Black oxide. When black oxide finish is 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 in the invitation for bids, contract or order (see 6.2), the partial decarburization of threads of steel cap screws, when tested in accordance with 4.4.4.1, shall not exceed the amount shown in figure 1.

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.

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

3.8 Head markings. Cap screws shall be marked with the grade identification symbol conforming to SAE J429 and applicable documents. In addition, 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 Cracks. Cap screws shall be free from cracks in any direction or location.

3.9.1.1.1 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 7.

3.9.1.1.2 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 7.

3.9.1.2 Laps and seams. Cap screws may possess laps and seams except in locations specified in 3.9.2. The depth shall not exceed 20 percent of the thread height (sharp V thread). They shall be examined as specified in 4.4.9. Typical lap and seam discontinuities are shown in figure 6.

3.9.1.3 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.

3.9.1.4 Tool marks. Tool marks or undercuts of depths not to exceed those shown in table II and figure 8 are acceptable, provided they flare out into the shank with no scratches, gouges, or corners.

TABLE II. Limits of tool marks or undercuts

Size (Inch)	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

3.9.1.5 Voids. Voids are permissible discontinuities if in the limits specified in 4.4.9.2. Typical voids are shown in figure 8.

3.9.1.6 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 7.

3.9.1.7 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 7.

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 6. 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 6. Magnetic inspection techniques may be used in accordance with 4.4.9.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.1.1 Inspection terms and definitions. Inspection terms and definitions shall be as defined in MIL-STD-109.

4.2 Sampling for lot acceptance.

4.2.1 Inspection lot. A lot shall consist of cap screws of the same type, size, material, coating and thread series offered for delivery at one time.

4.2.2 Sampling for examination of cap screws. A random sample of cap screws shall be selected from each lot in accordance with MIL-STD-105, Inspection Level S-4. The Acceptable Quality Level (AQL) shall be as indicated in table III.

TABLE III. Classification of defects

Categories	Defects	Inspection method
Critical	AQL = 1.0 percent	
1	Circumferential cracks (3.9.1.1)	Metallographic Microscope
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	Tool marks (3.9.1.4)	Visual
104	Discontinuities (cracks, etc.) (3.9.1)	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 test of mechanical properties. A random sample of cap screws shall be selected from each lot in accordance with MIL-STD-105, Inspection Level S-1. The AQL shall be 1.5 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 Fed. Test Method Std. No. 151, method 111.2. 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 MIL-H-3982.

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 MIL-STD-105.

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 MIL-H-3982.

4.4 Test procedure.

4.4.1 The test specified in 4.4.2 and 4.4.3 shall be required, the tests specified in 4.4.4 through 4.4.9 may be required at the option of the Government.

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 E8.

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 2.

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 E8. 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 4.

4.4.3.3 Ductility test specimens. Test for elongation and reduction in area shall be conducted on turned shank specimens (figure 3) having dimensions to the largest practical specimens (see 4.4.3).

4.4.4 Metallographic tests.

4.4.4.1 Decarburization. To test for decarburization (see 3.5.1), the threaded part shall be sectioned longitudinally through the axis and polished in such a manner that rounding of the thread edges is held to a minimum. The section shall be etched with the usual metallographic etchants (such as nital) and examined with a metallographic microscope. Measurements shall be made from the crest of the thread to the end of the decarburized zone. Such distance shall not exceed that indicated in figure 1 (see 6.4). Measurements shall be made with a fixed-scale micrometer eye-piece, or the image of the threading may be thrown on the ground glass of the camera and measurements made with a pair of dividers and a scale. This does not apply to austenitic grades of stainless steel.

4.4.4.2 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.

4.4.6 Passivation test. Passivation test shall be conducted in accordance with QQ-P-35.

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, except that the screws shall be held under load for 23 hours and then examined for cracks or fractures.

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 MIL-I-17214.

4.4.9 Discontinuities. Magnetic particle inspection performed in accordance with MIL-I-6868 for Grade 8 and optional alloy steel cap screws and penetrant particle inspection performed in accordance with MIL-I-6866 for corrosion-resistant steel cap screws 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 110 RHR (roughness height ratings). 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 0.025 D, where D is the nominal screw size in inches. No burst shall extend into the bearing surface.

5. PREPARATION FOR DELIVERY

5.1 Packaging and packing shall be level A, B, or C, as specified (see 6.2).

5.1.1 Level A, B, or C. Cap screws shall be packaged and packed in accordance with the requirements of MIL-H-3982. When level B packaging is specified for civil agency procurement, requirements in 3.3.1 of MIL-H-3982 shall apply.

5.2 Marking.

5.2.1 Civil agencies. In addition to markings required by the contract or order, the packages and shipping containers shall be marked in accordance with Fed. Std. No. 123.

5.2.2 Military activities. In addition to markings required by the contract or order, the packaging and shipping containers shall be marked in accordance with MIL-STD-129.

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, style, grade, and size required (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).

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 Addendum, figure 1. The addendum symbol "ha" is defined in Handbook H28, Screw Thread Standards for Federal Services as: "The distance measured perpendicularly to the axis, between the major and pitch cylinder or cones, respectively.

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

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

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

6.4.3 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.

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

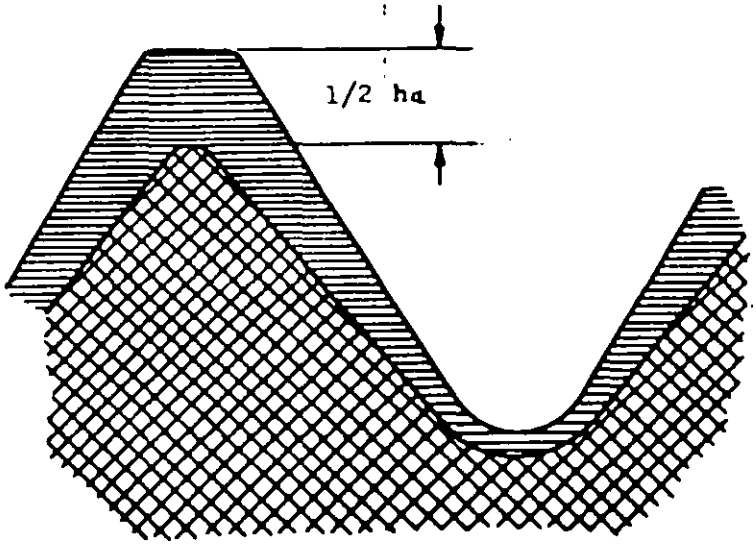
6.4.5 Inclusions. Inclusions are non-metallic material in a solid metallic matrix.

6.4.6 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.

6.4.7 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.

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

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



Full Carbon Zone

Partial Decarburized Zone

Thds per Inch	1/2 ha
80	.002
72	.002
64	.003
56	.003
48	.003
44	.004
40	.004
36	.005
32	.005
28	.006
24	.007
20	.008
18	.009
16	.010
14	.012
13	.012
12	.014
11	.015
10	.016
9	.018
8	.020
7	.023
6	.027

1/2 ha = 1/2 Addendum.

FIGURE 1. Decarburization classification of screw threads.

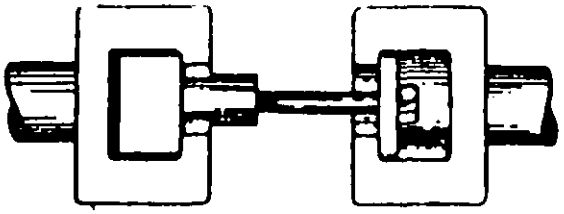


FIGURE 2. Tension testing full-size screw.

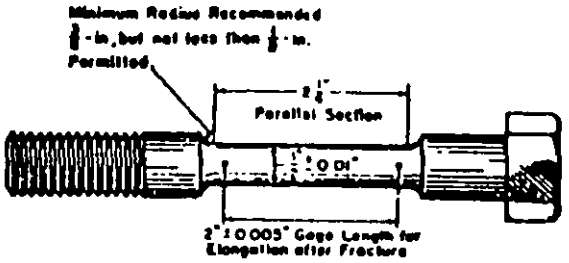


FIGURE 3. Tension-test specimen for screw with turned-down shank.

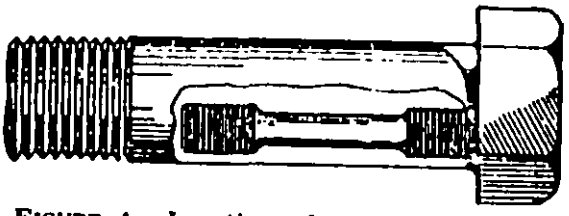


FIGURE 4. Location of standard, round, 2-inch-gage-length, tension-test specimen when turned from large-size screw.

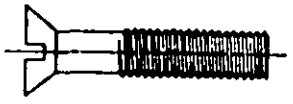
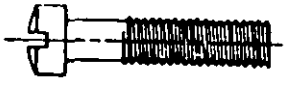
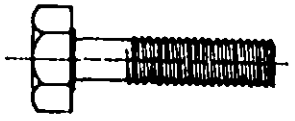
TYPE	STYLE	HEAD	DRIVE
I	1s	ROUND	
	2s	FLAT 82°	
I	4s	FILLISTER	
II	10P	HEXAGON	

FIGURE 5. Types, heads and styles

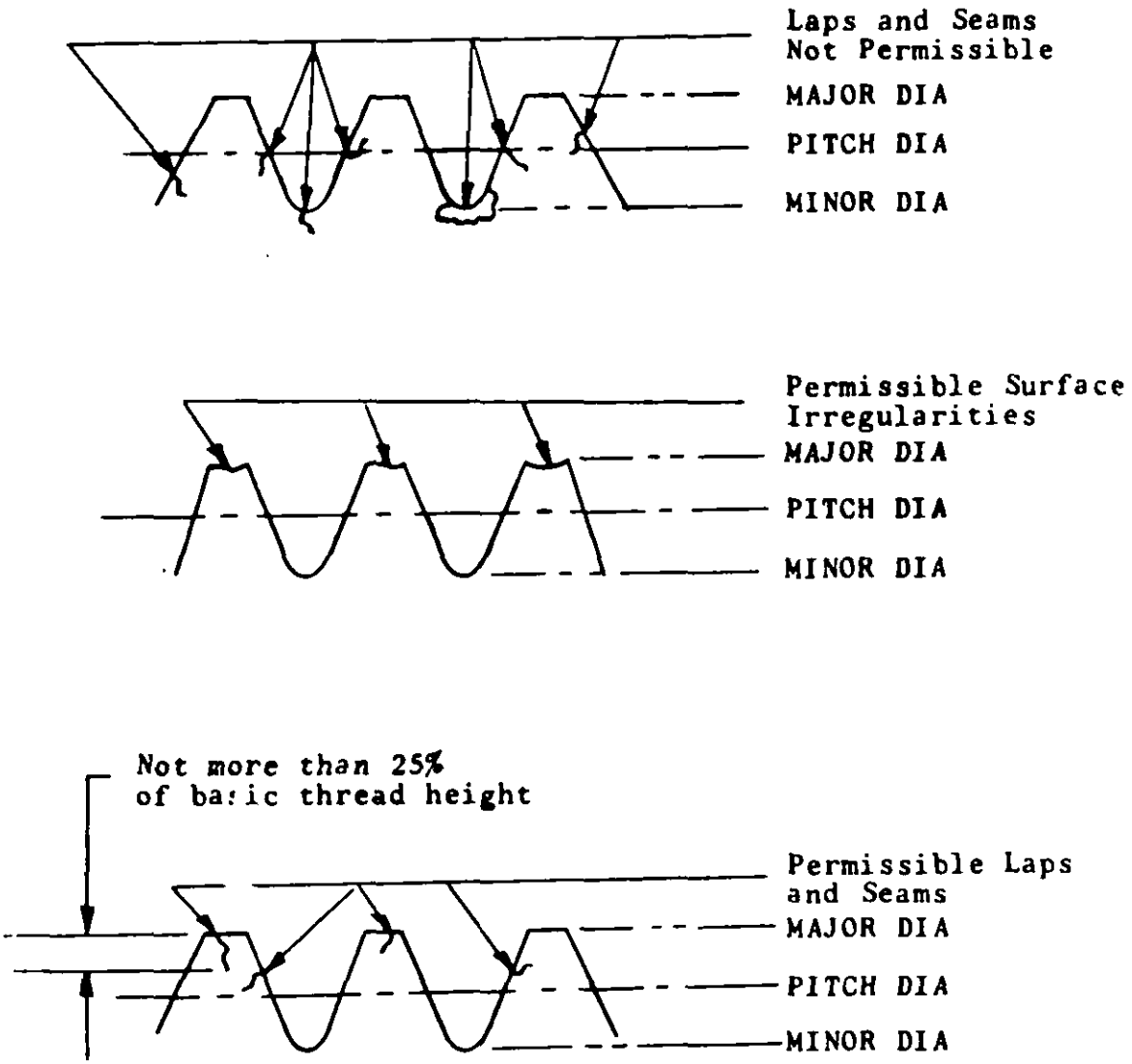


FIGURE 6. Laps, Seams, and Surface Irregularities in Thread

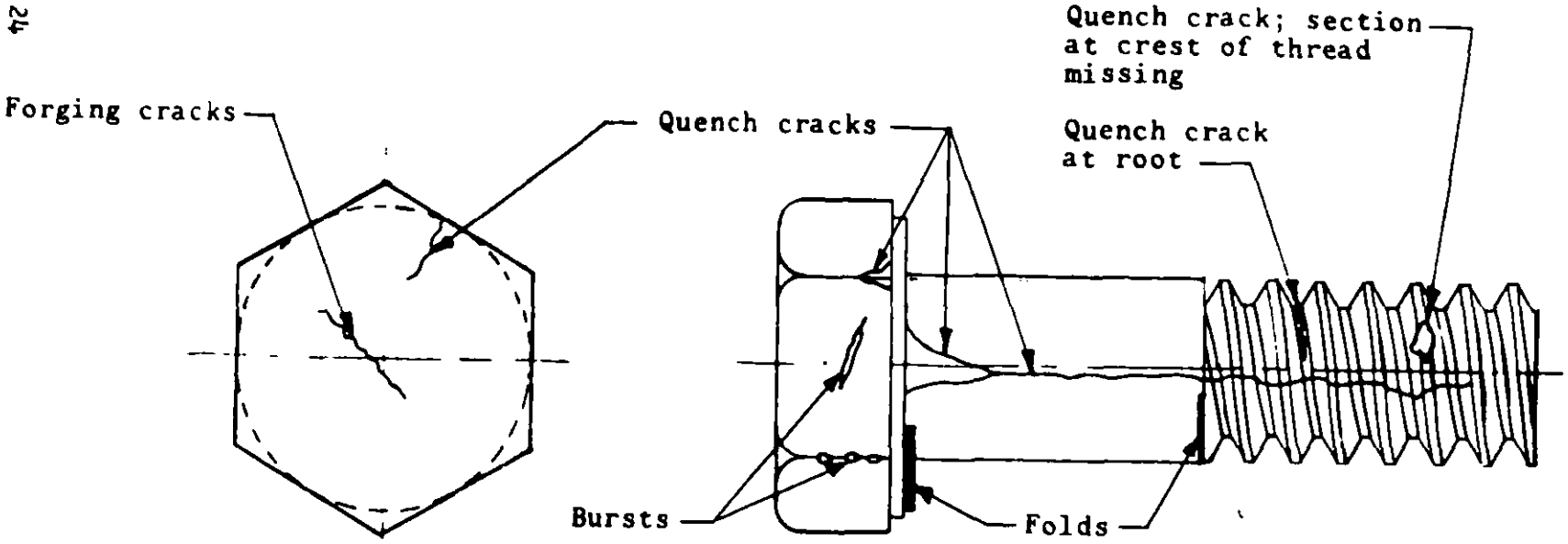


FIGURE 7. Forging and quench cracks, folds and bursts in screws

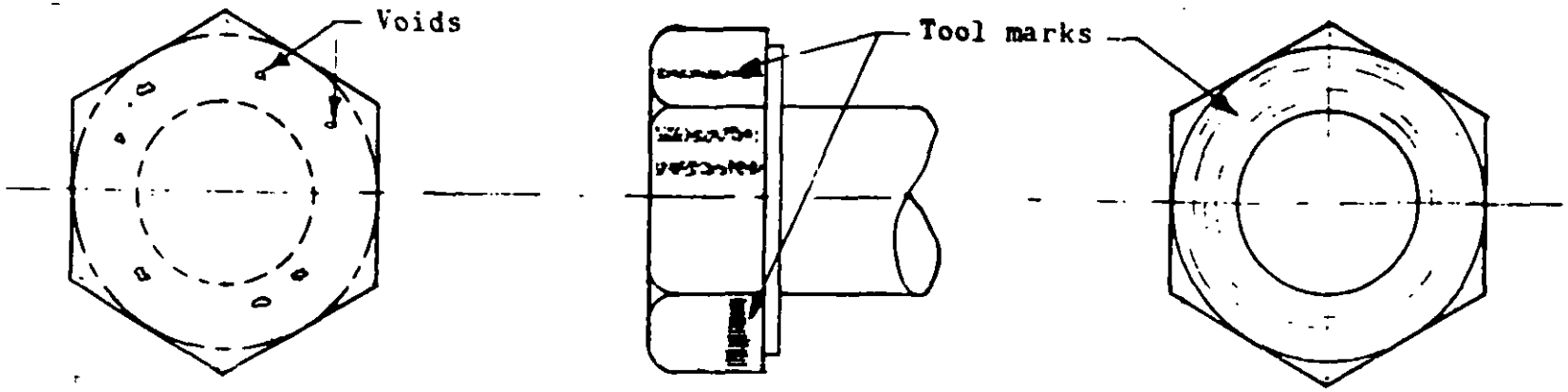


FIGURE 8. Tool marks; voids on the bearing surface of screws

MILITARY INTERESTS

Custodians:

Army - WC
Navy - SH
Air Force - 82

Review activities:

Army - AT, AV, MI, MU
Navy - None
Air Force - 85
DSA - IS
NSA

Preparing activity:

Army - WC

User activities:

Army - CE, EL, GL, ME
Navy - MC, OS, YD
Air Force - None

CIVIL AGENCIES INTEREST:

AGR
COM
DC
GSA
JUS

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(See Instructions – Reverse Side)

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5. PROBLEM AREAS

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b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
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