INCH-POUND
MIL-S-45909C
27 March 1989
SUPERSEDING
MIL-S-45909B
11 March 1985

MILITARY SPECIFICATION

STUD, LOCKED IN, RING LOCKED, SERRATED, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for locked-in studs. The method of locking in the stud is by means of a serrated collar and an accessory lockring with matching serrations installed within the parent material to prevent rotation.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander U.S. Army ARDEC, ATTN: SMCAR-BAC-S, Picatinny Arsenal, New Jersey 07806-5000 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5307

SPECIFICATIONS

FEDERAL

QQ-A-225/6 - Aluminum Alloy Bar, Rod, and Wire, Rolled, Drawn, or Cold Finished, 2024

QQ-A-250/6 - Aluminum Alloy 5083, Plate and Sheet
QQ-P-35 - Passivation Treatments for Corrosion-Resistant Steel
QQ-P-416 - Plating, Cadmium (Electrodeposited)
PPP-H-1581 - Hardware (Fasteners and Related Items), Packaging of

MILITARY

MIL-S-6049 - Steel, Chrome-Nickel-Molybdenum (8740) Bars, Rods, and Forging Stock (For Aircraft Applications)
MIL-S-6758 - Steel, Chrome-Molybdenum (4130) Bars and Reforging stock (Aircraft Quality)
MIL-H-6875 - Heat Treatment of Steels, Process for
MIL-S-7742 - Screw Threads, Standard, Optimum Selected Series: General Specification for
MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-S-8879 - Screw Threads, Controlled Radius Root with Increased Minor Diameter; General Specification for
MIL-T-9047 - Titanium and Titanium Alloy Bars (Rolled or Forged) and Reforging Stock, Aircraft Quality
MIL-H-81200 - Heat treatment of Titanium and Titanium Alloys

STANDARDS

FEDERAL

FED-STD-H28/2 - Screw-Thread Standards for Federal Services, Section 2, Unified Inch Screw Threads-UN and UNR Thread Forms
FED-STD-H28/20 - Screw-Thread Standards for Federal Services, Section 20, Inspection Methods for Acceptability of UN, UNR, UNJ, M and MJ Screw-Threads

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-453 - Inspection, Radiographic
MIL-STD-1312 - Fastener Test Methods
MIL-STD-1949 - Inspection, Magnetic Particle
MIL-STD-6866 - Inspection, Liquid Penetrant

(See supplement 1 for list of MS standards.)

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ASME B46.1 - Surface Texture

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018-3363.)

AEROSPACE MATERIAL SPECIFICATION (AMS)

AMS2401 - Cadmium Plating, Low Hydrogen Content Deposit
AMS2488 - Anodic Treatment of Titanium and Titanium Alloys
AMS4967 - Titanium Alloy Bars, Forgings, and Rings
AMS5662 - Alloy Bars, Forgings, and Rings, Corrosion and Heat Resistant
AMS5731 - Steel Bars, Forgings, Tubing, and Rings , Corrosion and Heat Resistant
AMS5734 - Steel Bars, Forgings, and Tubing, Corrosion and Heat Resistant
AMS6322 - Steel Bars, Forgings, and Rings

(Application for copies should be addressed to the Society of Automotive Engineers Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

ASTM

ASTM E8 - Tension Testing of Metallic Materials

(Application for copies should be addressed to ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other information services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained in which case the exception will be identified in the text and cited in the solicitation.

3. REQUIREMENTS

3.1 MS sheets. The individual item requirements shall be as specified herein and in accordance with the applicable MS sheet. In the event of any conflict between the requirements of this specification and the MS sheet, the latter shall govern.

3.2 Material. Recycled and reclaimed materials (see 3.1) shall be used to the maximum extent practicable. The stud shall be a one piece, all metal unit, made from the following materials as specified in the applicable MS sheet (see 3.1) when inspected in conformance with 4.6.2.

3.2.1 Alloy steel. Alloy steel shall be grade 4130 (UNS G41300) in accordance with MIL-S-6758 or grade 8740 (UNS G87400) in accordance with MIL-S-6049 or AMS6322.

3.2.2 Corrosion-resistant steel. Corrosion and heat resistant steel shall be type A286 (UNS S66286) in accordance with AMS5731 or AMS5734.

3.2.2.1 Nickel base alloy. Nickel base alloy shall be corrosion and heat resistant type 718 (UNS N07718) in accordance with AMS5662.

3.2.3 Titanium alloy. Titanium alloy shall be type Ti-6Al-4V (UNS R56400) in accordance with MIL-T-9047 or AMS4967.

3.3 Heat treatment. The stud shall be heat treated in accordance with MIL-H-6875 or MIL-H-81200 as applicable and shall develop the mechanical properties specified herein when inspected in conformance with 4.10.

3.4 Protective finish or surface treatment. The stud shall be furnished with a protective plating or surface treatment as specified in the applicable MS sheet (see 3.1) when inspected in conformance with 4.6.3.

3.4.1 Alloy steel. Alloy steel studs heat treated below 180 KSI UTS shall be cadmium plated in accordance with QQ-P-416, Type II, Class 3. Alloy steel studs heat treated 180 KSI UTS or greater shall be cadmium plated in accordance with AMS2401.

3.4.2 Corrosion-resistant steel. Corrosion-resistant steel studs shall be passivated in accordance with QQ-P-35.

3.4.3 Titanium alloy. None required. Anodic Treatment per AMS2488, type 2 when specified on applicable MS sheet (see 3.1).

3.5 Design, dimensions and tolerances. Design, dimensions and tolerances shall conform to the requirements of the applicable MS sheet (see 3.1) and shall apply after application of the protective finish and surface treatment specified in 3.4.

3.5.1 Threads. Threads shall be right hand in accordance with the applicable MS sheet (see 3.1).

3.5.1.1 Nut end threads. Nut end threads shall conform to MIL-S-7742 or MIL-S-8879 as specified in the applicable MS sheet (see 3.1). Acceptability of threads shall be in accordance with FED-STD-H28/20, system 21.

3.5.1.2 Stud end threads. Stud end threads shall conform to FED-STD-H28/2. Pitch diameter and minor diameter shall be as specified in the applicable MS sheet (see 3.1). Acceptability of threads shall be in accordance with FED-STD-H28/20, system 21.

3.5.1.3 Thread forming. Threads for nut end shall be fully formed by a single rolling process. Threads for stud end may be produced either by machining, grinding, or fully formed by a single rolling process.

3.5.1.4 Incomplete threads. The runout threads shall be faired into the shank within a minimum of one and a maximum of two pitches without an abrupt change in cross sectional area. Lead thread shall not exceed two pitches. The root and flanks of the runout thread may deviate from true thread form but shall be smooth and free of tool marks.

3.5.1.5 Grain flow. The grain flow in rolled threads shall follow the general thread contour with the maximum density at the bottom of the root radius as shown in figure 1.

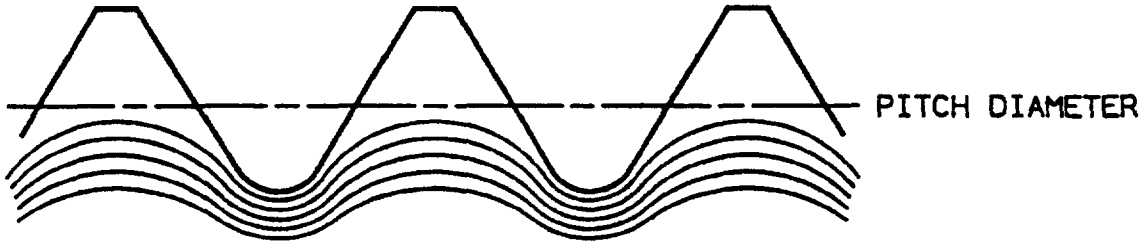


FIGURE 1. Thread grain flow.

3.5.2 Locking serrations. Locking serration dimensions shall conform in size to the applicable MS sheet part number (see 3.1) and shall be of full form.

3.5.3. Surface texture. The surface texture of the stud prior to plating shall not exceed the values specified in the applicable MS sheet (see 3.1) and shall be in accordance with ANSI/ASME B46.1 when tested in accordance with 4.6.6.

3.5.4 Straightness. The straightness of the stud shall be within the values specified in table I when tested in accordance with 4.6.5.

TABLE I. Straightness.

STUD SIZE NUT END	DEVIATION OF STUD FROM PLATE, MAXIMUM (INCHES PER INCH OF STUD NUT END LENGTH)
.190 and smaller	0.0040
.250 - .3125	0.0030
.375 - .4375	0.0025
.500 and larger	0.0020

3.6 Mechanical properties. Studs conforming to the design and dimensions specified in the applicable MS sheet (see 3.1) and having load ratings as specified in table II shall be capable of developing a minimum tensile strength, a minimum proof strength, and have minimum shear engagement areas in accordance with table II.

TABLE II. Mechanical properties.

LOAD RATING KSI	MINIMUM TENSILE STRENGTH KSI	MINIMUM PROOF STRENGTH KSI	MINIMUM SHEAR ENGAGEMENT AREA (STUD END)		
			MS51497		
			500 NUMBERS	640 NUMBERS	800 NUMBERS
140 160 180	140 160 180	95 130 145	TABLE V COL 1	TABLE V COL 2	TABLE V COL 3

LOAD RATING KSI	MINIMUM TENSILE STRENGTH KSI	MINIMUM PROOF STRENGTH KSI	MINIMUM SHEAR ENGAGEMENT AREA (STUD END)					
			MS51551					
			100 NUMBERS	100A NUMBERS	100B NUMBERS	200 NUMBERS	200A NUMBERS	200B NUMBERS
125 140 160	125 140 160	75 95 130	TABLE V COL 4	TABLE V COL 5	TABLE V COL 6	TABLE V COL 7	TABLE V COL 8	TABLE V COL 9

LOAD RATING KSI	MINIMUM TENSILE STRENGTH KSI	MINIMUM PROOF STRENGTH KSI	MINIMUM SHEAR ENGAGEMENT AREA (STUD END)	
			MS51989	
			100 & 300 NUMBERS	200 & 400 NUMBERS
125	125	75	TABLE V COL 10	TABLE V COL 11

LOAD RATING KSI	MINIMUM TENSILE STRENGTH KSI	MINIMUM PROOF STRENGTH KSI	MINIMUM SHEAR ENGAGEMENT AREA (STUD END)		
			MS51992		
			500 NUMBERS	640 NUMBERS	800 NUMBERS
140 160 180	140 160 180	95 130 145	TABLE V COL 12	TABLE V COL 13	TABLE V COL 14

3.6.1 Tensile strength. The stud shall develop the minimum axial load listed in table III when tested as specified in 4.7.1.

TABLE III. Minimum tensile strength of studs (nut end).

NOMINAL SIZE (NUT END)	TENSILE STRESS AREA (IN^2) 1/		MINIMUM AXIAL LOAD (POUNDS) 2/							
			MS51551			MS51989		MS51497 & MS51992		
	COARSE THREAD	FINE THREAD	125 KSI UNJF	140 KSI UNJF	160 KSI UNJF	125 KSI UNC	125 KSI UNF	140 KSI UNJF	160 KSI UNJF	180 KSI UNJF
.138	.0091	.0101	----	----	----	1,140	1,260	----	----	----
.164	.0140	.0147	1,840	2,060	2,350	1,750	1,840	----	----	----
.190	.0175	.0200	2,500	2,800	3,200	2,190	2,500	2,800	3,200	3,600
.250	.0318	.0364	4,550	5,100	5,800	4,000	4,550	5,100	5,800	6,550
.3125	.0524	.0580	7,300	8,100	9,200	6,600	7,300	8,100	9,200	10,400
.375	.0775	.0878	11,000	12,300	14,000	9,700	11,000	12,300	14,000	15,800
.4375	.1063	.1187	14,800	16,600	19,000	13,300	14,800	16,600	19,000	21,400
.500	.1419	.1599	20,000	22,400	25,600	17,700	20,000	22,400	25,600	28,800
.5625	.182	.203	----	----	----	22,700	25,400	----	----	----
.625	.226	.256	----	----	----	28,200	32,000	35,800	41,000	46,100
.750	.334	.373	----	----	----	41,700	46,600	----	----	----

1/ The tensile stress areas used for the calculation of the axial load values are based on the stress area per formula specified in FED-STD-H28/2.

2/ The minimum axial loads shown are the applicable tensile stress areas multiplied by the appropriate load rating.

3.6.2 Proof load. The stud shall be capable of withstanding proof loads as specified in table IV when tested in accordance with 4.7.1.

TABLE IV. Proof load for studs (nut end).

NOMINAL SIZE (NUT END)	TENSILE STRESS AREA (IN^2) 1/		MINIMUM PROOF LOAD (POUNDS) 2/							
			MS51551			MS51989		MS51497 & MS51992		
	COARSE THREAD	FINE THREAD	75 KSI UNJF	95 KSI UNJF	130 KSI UNJF	75 KSI UNC	75 KSI UNF	95 KSI UNJF	130 KSI UNJF	145 KSI UNJF
.138	.0091	.0101	----	----	----	680	760	----	----	----
.164	.0140	.0147	1,100	1,400	1,911	1,050	1,100	----	----	----
.190	.0175	.0200	1,500	1,900	2,600	1,310	1,500	1,900	2,600	2,900
.250	.0318	.0364	2,750	3,450	4,700	2,400	2,750	3,450	4,700	5,250
.3125	.0524	.0580	4,400	5,500	7,500	3,900	4,400	5,500	7,500	8,400
.375	.0775	.0878	6,600	8,300	11,400	5,800	6,600	8,300	11,400	12,700
.4375	.1063	.1187	8,900	11,300	15,400	8,000	8,900	11,300	15,400	17,200
.500	.1419	.1599	12,000	15,200	20,800	10,600	12,000	15,200	20,800	23,200
.5625	.182	.203	----	----	----	13,600	15,200	----	----	----
.625	.226	.256	----	----	----	16,900	19,200	24,300	33,300	37,100
.750	.334	.373	----	----	----	25,000	28,000	----	----	----

1/ The tensile stress areas used for the calculation of the axial load values are based on the stress area per formula specified in FED-STD-H28/2.

2/ The minimum proof loads shown are the applicable tensile stress areas multiplied by the appropriate load rating.

3.6.3 Resistance to pullout. The stud shall demonstrate minimum shear engagement areas as specified in table V. The installed stud with lockring in place as specified in 4.1.3 shall have a minimum resistance to pullout in accordance with table VI. Values specified in table VI are based on the minimum shear engagement areas of the stud (table V) when installed in a test block of 25 KSI shear strength and tested in accordance with 4.7.2.

TABLE V. Minimum shear engagement area of studs.

NOMINAL SIZE (NUT END)	MINIMUM SHEAR ENGAGEMENT AREA (IN^2) 1/								
	MS51497			MS51551					
	500 NUMBERS	640 NUMBERS	800 NUMBERS	100 NUMBERS	100A NUMBERS	100B NUMBERS	200 NUMBERS	200A NUMBERS	200B NUMBERS
	COL 1 FINE THREAD (NS)	COL 2 FINE THREAD (NS)	COL 3 FINE THREAD (NS)	COL 4 COARSE THREAD (NS)	COL 5 COARSE THREAD (NS)	COL 6 COARSE THREAD (NS)	COL 7 FINE THREAD (NS)	COL 8 FINE THREAD (NS)	COL 9 FINE THREAD (NS)
.138	----	----	----	----	----	----	----	----	----
.164	----	----	----	.0667	.1146	.1665	.0701	.1174	.1689
.190	.1396	.1804	.2486	.1131	.1789	.2544	.1290	.1906	.2642
.250	.2450	.3192	.4377	.2088	.3048	.3918	.2335	.3172	.4038
.3125	.3931	.5088	.6775	.3489	.5181	.6758	.3768	.5318	.6882
.375	.6796	.8722	1.1412	.4089	.6066	.7920	.4744	.6608	.8462
.4375	.8873	1.1358	1.5032	.5249	.7467	.9715	.6140	.8206	1.0448
.500	1.0625	1.3855	1.8627	.6489	.8936	1.2269	.6908	.9157	1.2460
.5625	----	----	----	----	----	----	----	----	----
.625	1.8267	2.3311	3.0291	----	----	----	----	----	----
.750	----	----	----	----	----	----	----	----	----

NOMINAL SIZE (NUT END)	MINIMUM SHEAR ENGAGEMENT AREA (IN^2) 1/				
	MS51989		MS51992		
	100 & 300 NUMBERS	200 & 400 NUMBERS	500 NUMBERS	640 NUMBERS	800 NUMBERS
	COL 10 COARSE THREAD (NS)	COL 11 FINE THREAD (NS)	COL 12 FINE THREAD (NS)	COL 13 FINE THREAD (NS)	COL 14 COARSE THREAD (NS)
.138	.0206	.0216	----	----	----
.164	.0667	.0701	----	----	----
.190	.1131	.1290	.1265	.1594	.2050
.250	.2088	.2335	.2264	.2890	.3708
.3125	.3489	.3768	.3684	.4694	.5905
.375	.4089	.4744	.5524	.7070	.8881
.4375	.5249	.6140	.7472	.9530	1.2105
.500	.6489	.6908	1.0204	1.2955	1.6410
.5625	.8526	.9989	----	----	----
.625	1.1772	1.3612	1.6251	2.0649	2.5955
.750	1.7034	1.9309	----	----	----

1/ Shear engagement area is the assembled dimensional value for the overall engaged area of mating thread members. It does not represent a dimension of either of the members in an unassembled condition.

TABLE VI. Resistance to pullout, stud end threads.

NOMINAL SIZE (NUT END)	MINIMUM RESISTANCE TO PULLOUT (POUNDS) 1/								
	MS51497			MS51551					
	500 NUMBERS	640 NUMBERS	800 NUMBERS	100 NUMBERS	100A NUMBERS	100B NUMBERS	200 NUMBERS	200A NUMBERS	200B NUMBERS
	COL 1 FINE THREAD (NS)	COL 2 FINE THREAD (NS)	COL 3 FINE THREAD (NS)	COL 4 COARSE THREAD (NS)	COL 5 COARSE THREAD (NS)	COL 6 COARSE THREAD (NS)	COL 7 FINE THREAD (NS)	COL 8 FINE THREAD (NS)	COL 9 FINE THREAD (NS)
.138	----	----	----	----	----	----	----	----	----
.164	----	----	----	1,670	2,860	4,160	1,750	2,930	4,220
.190	3,490	4,510	6,220	2,830	4,470	6,360	3,220	4,760	6,600
.250	6,120	7,980	10,940	5,220	7,620	9,790	5,840	7,930	10,090
.3125	9,830	12,720	16,940	8,720	12,950	16,890	9,420	13,290	17,200
.375	17,000	21,800	28,530	10,220	15,160	19,800	11,860	16,520	21,150
.4375	22,180	28,400	37,580	13,120	18,670	24,290	15,350	20,510	26,120
.500	26,560	34,640	46,570	16,220	22,340	30,670	17,270	22,890	31,150
.5625	----	----	----	----	----	----	----	----	----
.625	45,660	58,280	76,730	----	----	----	----	----	----
.750	----	----	----	----	----	----	----	----	----

NOMINAL SIZE (NUT END)	MINIMUM RESISTANCE TO PULLOUT (POUNDS) 1/				
	MS51989		MS51992		
	100 & 300 NUMBERS	200 & 400 NUMBERS	500 NUMBERS	640 NUMBERS	800 NUMBERS
	COL 10 COARSE THREAD (NS)	COL 11 FINE THREAD (NS)	COL 12 FINE THREAD (NS)	COL 13 FINE THREAD (NS)	COL 14 COARSE THREAD (NS)
.138	510	540	----	----	----
.164	1,670	1,750	----	----	----
.190	2,830	3,220	3,140	3,980	5,120
.250	5,220	5,840	5,660	7,220	9,270
.3125	8,720	9,420	9,210	11,730	14,760
.375	10,220	11,860	13,810	17,670	22,200
.4375	13,120	15,350	18,680	23,820	30,260
.500	16,220	17,270	25,510	32,390	41,020
.5625	21,320	24,970	----	----	----
.625	29,430	34,030	40,630	51,620	64,890
.750	42,580	48,270	----	----	----

1/ Installed in a test block with a shear strength as specified in 3.6.3.

3.6.4 Rotational resistance. The stud shall produce a minimum torque resistance value not less than that specified in table VII when installed in conformance with MS51995 and the applicable MS sheet (see 3.1) and tested in accordance with 4.7.3.

3.6.4.1 Removal and replacement. The stud and lockring shall meet the requirements of 3.6.4 when replacing an identical stud and lockring (see 3.1) in an existing hole conforming to MS51994 or MS51996 and installed as specified in MS51995 provided the hole is undamaged by the stud removal operation.

TABLE VII. Rotational resistance strength.

NOMINAL THREAD (NUT END)	MINIMUM ROTATIONAL RESISTANCE (TORQUE-OUT IN INCH-POUNDS)			
	MS51497	MS51551	MS51989	MS51992
.138	----	----	30	----
.164	----	45	45	----
.190	200	65	65	120
.250	400	150	150	200
.3125	650	300	300	400
.375	900	550	550	650
.4375	1,300	850	850	900
.500	2,300	1,100	1,100	1,300
.5625	----	----	1,600	----
.625	3,000	----	2,300	2,300
.750	----	----	4,000	----

3.6.5 Hardness. The stud shall meet the hardness as specified in the applicable MS sheet (see 3.1) when tested in accordance with 4.7.4.

3.7 Metallurgical properties.

3.7.1 Discontinuities. The stud shall not exhibit discontinuities exceeding the following limitations when tested in accordance with 4.8.

3.7.1.1 Cracks. (see 6.3.1) The stud shall be free of cracks in any direction or location.

3.7.1.2 Laps and seams. (see 6.3.2 and 6.3.3) The stud may possess laps and seams except in locations specified in 3.7.2. Discontinuity depths shall not exceed the values specified in table VIII.

TABLE VIII. Discontinuity depth.

NOMINAL STUD SIZE (NUT END)	DISCONTINUITY DEPTH IN INCHES, MAX 1/
.138 THRU .3125	0.005
.375	0.006
.4375	0.007
.500 THRU 1.250	0.008

1/ Depth of discontinuity shall be measured normal to the surface at a point of greatest penetration.

3.7.1.3 Inclusions. (see 6.3.4) The stud shall show no evidence of surface or subsurface inclusions at the thread root when examined in accordance with 4.8. Small inclusions in other parts of the stud, not indicative of unsatisfactory quality, shall not be cause for rejection.

3.7.2 Thread discontinuities. (Laps, seams, and surface irregularities in rolled threads.) Threads shall have no laps at the root or along the flanks as shown in figure 2. Multiple laps on the sides of threads are not permissible regardless of location. A single lap is permissible along the side of the thread above the pitch diameter on either the pressure or non-pressure side (one lap per thread) provided it extends toward the crest and generally parallel to the side as shown in figure 3a. Crest craters, crest laps, or a crest lap in combination with a crest crater are permissible, provided the imperfection does not extend deeper than 20 percent of the basic thread height (see table IX) as measured from the thread crest when the thread major diameter is at a minimum size (see figure 3a). Slight deviation from the thread contour is permissible at the crest of the thread within the major diameter limits as shown in figure 3b. The incomplete thread at each end of the thread may also deviate slightly from contour.

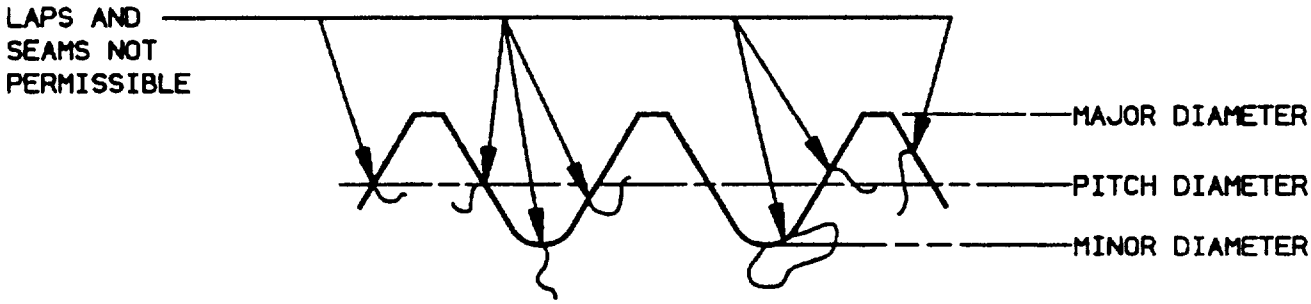


FIGURE 2. Laps, seams and surface thread.

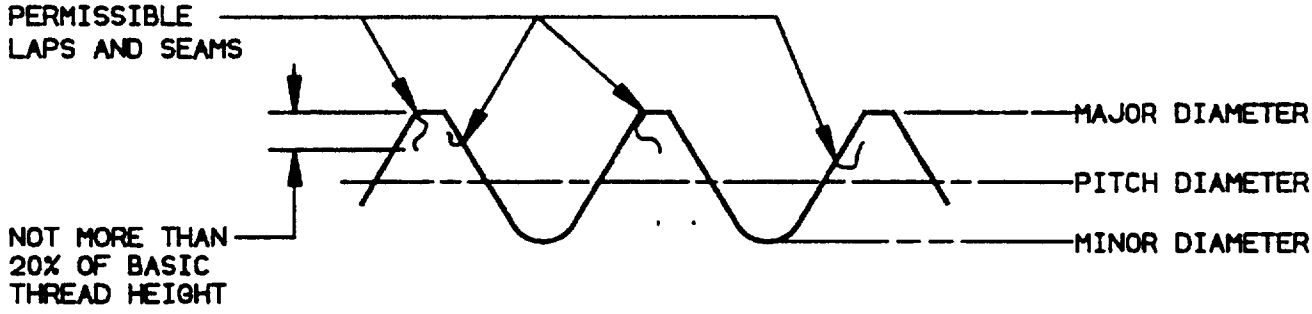


FIGURE 3a. Laps, seams and surface thread.

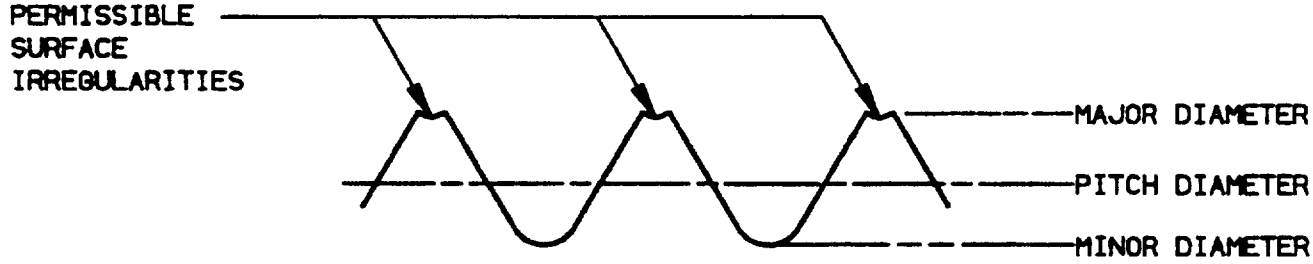


FIGURE 3b. Laps, seams and surface thread.

TABLE IX. Basic thread height, unified threads.

THREADS PER INCH	BASIC THREAD HEIGHT (REF)	20% BASIC THREAD HEIGHT
40	0.0162	0.0032
36	0.0180	0.0036
32	0.0203	0.0041
28	0.0232	0.0046
24	0.0271	0.0054
20	0.0325	0.0065
18	0.0361	0.0072
16	0.0406	0.0081
14	0.0464	0.0093
13	0.0500	0.0100
12	0.0541	0.0108
11	0.0590	0.0118
10	0.0650	0.0130

3.7.3 Grinding burns. The stud shall show no evidence of grinding burns.

3.8 Workmanship. Workmanship shall be consistent with the type of product, finish, and class of thread fit specified. the stud shall be of uniform quality free from laps, cracks, seams, inclusions, splits, or other defects or irregularities which would be detrimental to the performance of the stud in service use.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility and compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification 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 operations, is an acceptable practice to ascertain 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 Test block fabrication. Test blocks shall be fabricated in accordance with figures 4 or 5 as applicable. Test blocks may exceed dimensions specified in figures 4 or 5 to accommodate multiple testing of studs and lockrings except for tests of 4.7.1 and 4.7.2.

4.1.3 Test specimen installation. Sample studs and lockrings shall be installed in accordance with MS51995 in test blocks specified in 4.1.2.

4.1.3.1 Inspection of installed studs and lockrings. The studs and lockrings installed as specified in 4.1.3 shall be visually inspected under 10 diameters magnification. The presence of cracks in either test block, stud or lockring as a result of installation shall be cause for rejection. When visual inspection discloses a condition which shows cause for further examination, the test specimen shall be penetrant inspected in accordance with MIL-STD-6866.

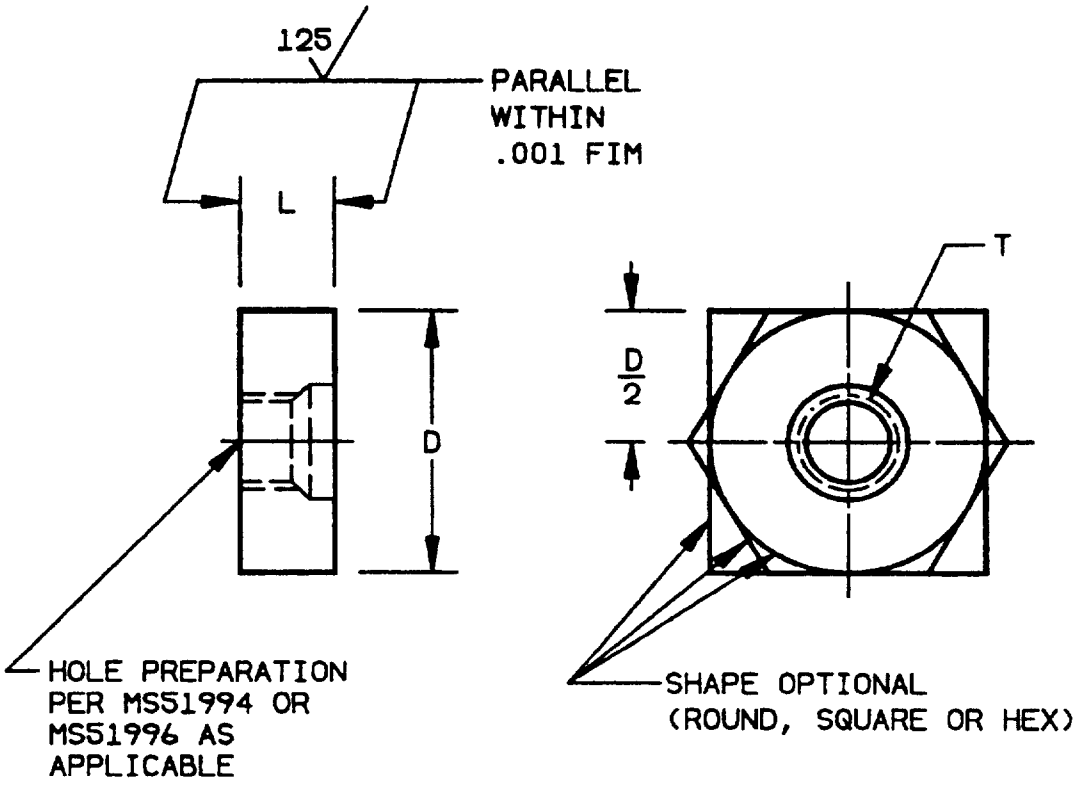
4.1.4 Test equipment and inspection facilities. The contractor shall insure that test and inspection facilities of sufficient accuracy, quality and quantity are established and maintained to permit performance of required inspections.

4.2 Quality conformance inspection. Quality conformance inspection shall be as specified in table X.

4.2.1 Inspection lot. An inspection lot shall consist of all studs under the same part identifying number (see 3.1), produced from a single mill heat of material, processed as one continuous run and submitted for inspection at one time.

4.2.2 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. A resubmitted lot shall be inspected using tightened inspection. Such lots shall be separated from new lots and clearly identified as reinspected lots.

4.3 Classification of defects. Classification of defects shall be in accordance with MIL-STD-105 and table XI.



NOTES:

1. DIMENSIONS:

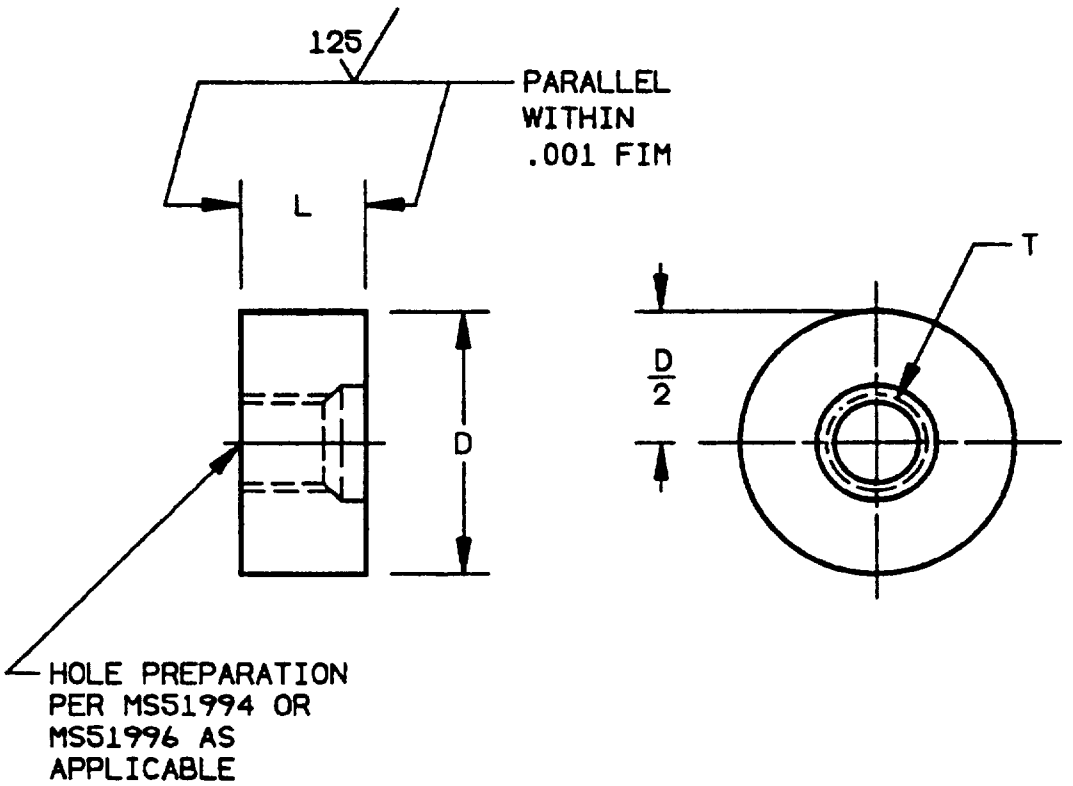
   T = NOMINAL THREAD DIAMETER OF APPLICABLE STUD (STUD END).
   D = 4 x T (FOR T THREAD SIZES SMALLER THAN .500 DIA).
   3 x T (FOR T THREAD SIZES .500 DIA AND LARGER).
   L = LENGTH OF APPLICABLE STUD END PLUS .063 FOR ROTATIONAL RESISTANCE TESTS (SEE 3.6.4).

2. MATERIAL:
   ALUMINUM ALLOY 2024-T4 PER QQ-A-225/6 (BAR).

3. ANODIZE PER MIL-A-8625, TYPE I, CLASS 1 OR CLASS 2.

4. PENETRANT INSPECT PER MIL-STD-6866: DISCONTINUITIES OR CRACKS NOT ACCEPTABLE.

FIGURE 4. Rotational resistance (torque-out) test block.



NOTES:

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   3 x T (FOR T THREAD SIZES .500 DIA AND LARGER).
   L = LENGTH OF APPLICABLE STUD END PLUS .063.

2. MATERIAL:
   ALUMINUM ALLOY 5083-H321 PER QQ-A-250/6 (PLATE)

3. ANODIZE PER MIL-A-8625, TYPE I, CLASS 1 OR CLASS 2.

4. PENETRANT INSPECT PER MIL-STD-6866: DISCONTINUITIES OR CRACKS NOT ACCEPTABLE.

FIGURE 5. Pullout test block.

TABLE X. Quality conformance inspection.

INSPECTION	REQUIREMENT PARAGRAPH	TEST METHOD PARAGRAPH
Group A		
Visual & dimensional	3.5	4.6.1
Material	3.2	4.6.2
Heat treatment	3.3	4.10
Protective finish or surface treatment	3.4 (as applicable)	4.6.3 (as applicable)
Grinding burns	3.7.3	4.6.1
Workmanship	3.8	4.6.1
Packaging	5.1	4.5
Group B		
Threads	3.5.1	4.6.4
Locking serrations	3.5.2	4.6.1
Surface texture	3.5.3	4.6.6
Straightness	3.5.4	4.6.5
Group C		
Mechanical properties	3.6	4.7
Tensile strength	3.6.1	4.7.1
Proof load	3.6.2	4.7.1
Resistance to pullout	3.6.3	4.7.2
Rotational resistance	3.6.4	4.7.3
Removal and replacement	3.6.4.1	4.7.3
Hardness	3.6.5	4.7.4
Discontinuities	3.7.1	4.8
Cracks	3.7.1.1	4.8
Laps and seams	3.7.1.2	4.8
Inclusions	3.7.1.3	4.8
Thread discontinuities	3.7.2	4.8

TABLE XI. Classification of defects and inspection sampling.

CATEGORY	DEFECT	INSPECTION METHOD
Critical	None defined	
MAJOR	AQL = 1.5 percent defective, level II	
101	Threads not as specified (3.5.1, 3.5.1.1, 3.5.1.2)	Commercial Inspection Equipment (CIE)
102	Shank diameter (3.5)	CIE
103	Incomplete threads (3.5.1.4)	CIE
104	Grip length (3.5)	CIE
105	Stud end length (3.5)	CIE
106	Drilled hole in nut end missing (when required) (3.5)	VISUAL
107	Concentricity between shank and locking serrations (3.5.2)	CIE
108	Imperfect serrations (3.5.2)	VISUAL
109	Straightness of stud (3.5.4)	CIE
110	Surface texture (3.5.3)	CIE
111	Protective finish or surface treatment (3.4 as applicable)	VISUAL
112	Thread discontinuities (3.7.2)	CIE
113	Heat treatment (3.3)	CIE
MINOR A	AQL = 2.5 percent defective, Level S1	
201	Overall length (3.5)	CIE
202	Drilled hole diameter and location (3.5)	CIE
203	Workmanship (3.8)	VISUAL
MINOR B	AQL = 4.0 percent defective, Level S1	
301	Chamfer on thread ends (3.5)	VISUAL

4.3.1 Defect noncompliance. A stud exhibiting one or more defects shall be considered defective.

4.4 Inspection sampling. Inspection sampling shall be in accordance with MIL-STD-105 and the applicable inspection level and Acceptable Quality Level (AQL) specified in table XI.

4.5 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with requirements of PPP-H-1581.

4.6 Methods of inspection.

4.6.1 Visual and dimensional. The stud shall be examined to verify that physical dimensions, grinding burns, locking serrations, surface texture and workmanship are in accordance with the applicable requirements of 3.5, 3.5.2, 3.5.3, 3.7.3 and 3.8.

4.6.2 Material inspection. Material inspection shall consist of certification supporting verifying data that the materials used in fabricating the stud are in accordance with the applicable requirements of 3.2.

4.6.3 Treatment and finish inspection.

4.6.3.1 Protective finish inspection. Sample studs shall be inspected for minimum thickness and continuity of plating in accordance with QQ-P-416 or AMS2401 as applicable and 3.4.1.

4.6.3.2 Passivation inspection. Sample studs shall be inspected for passivation in accordance with QQ-P-35 and 3.4.2.

4.6.4 Thread inspection.

4.6.4.1 Nut end threads. Sample stud, nut end threads shall be inspected in accordance with FED-STD-H28/20, system 21 and 3.5.1.1.

4.6.4.2 Stud end threads. Sample stud, stud end threads shall be inspected in accordance with FED-STD-H28/20, system 21 and 3.5.1.2.

4.6.5 Straightness inspection. Sample studs shall be inspected for straightness when rolled on a surface plate. The clearance measured by a feeler gauge shall not exceed the values specified in 3.5.4.

4.6.6 Surface texture inspection. Sample studs shall be inspected for surface texture with any of the surface examination and measurement methods specified in ANSI/ASME B46.1 in accordance with 3.5.3.

4.7 Mechanical properties inspection. In lieu of the mechanical properties sampling inspection of 4.7, mechanical properties inspection may consist of certification supporting verifying data that the stud has met the requirements of 3.6.

4.7.1 Axial strength (tensile and proof) inspection. Nut end threads of the studs shall be tested in tension between the nut end and the stud end in accordance with ASTM E8. Samples shall be of sufficient length to develop the full strength of the nut end thread of the stud without stripping the thread. The axial tensile load values determined by table III and specified in table IV, as applicable, shall be applied by the test assembly. The test may be terminated when proof load is reached providing there is no evidence of failure of the nut end or stud end threads. Studs not having sufficient nut end length for tensile tests shall be accepted on the basis of hardness test results.

4.7.2 Resistance to pullout test. Sample studs shall be installed in test blocks in accordance with figure 5 and 4.1.3 to meet the requirements of 3.6.3. The minimum single shear strength of the test block material shall be determined by means of double shear tests of coupons taken from the material from which the test blocks are fabricated. The bushing and test block clearance holes in the upper and lower yokes (see figure 6) shall have a free fit not in excess of .06 inch greater than the bushing and test block diameters. The stud clearance hole in the upper bushing (see figure 6) shall be .005 to .015 inch diameter larger than the nominal shank diameter of test stud specimen. The stud clearance hole in lower yoke shall have a diameter of 1.5 x the nominal stud end thread diameter ±.015 inch. The studs shall be tested with a threaded member of sufficient size to develop the full strength of the nut end of the stud without stripping the thread (see figure 6). The bearing face of the threaded member shall be located a minimum of two and a maximum of three pitches from the stud thread termination. Studs having a grip length of less than twice their shank diameter need not be axial tested. To demonstrate average shear engagement area, an axial load of magnitude sufficient to produce failure (pullout) shall be applied to the assembly. The axial load test result shall be adjusted for test block shear strength as follows: The product of the axial load test result (pounds) and the ratio of 25 KSI to the actual minimum shear strength shall be used as the resistance to pullout (pounds). The resultant value should compare favorably with table VI. Rate of loading shall not exceed 100 KSI per minute per square inch of the minimum shank area of the stud. Whenever the pullout values exceed the tensile strength of the stud or the test loads exceed the capabilities of the test equipment, it is permissible to use lower shear strength materials (15 KSI approx.) in lieu of test block materials specified in 4.1.2. Double shear tests on coupons taken from the lower shear strength test blocks shall be performed and the resultant shear strength used to adjust the test result as specified above.

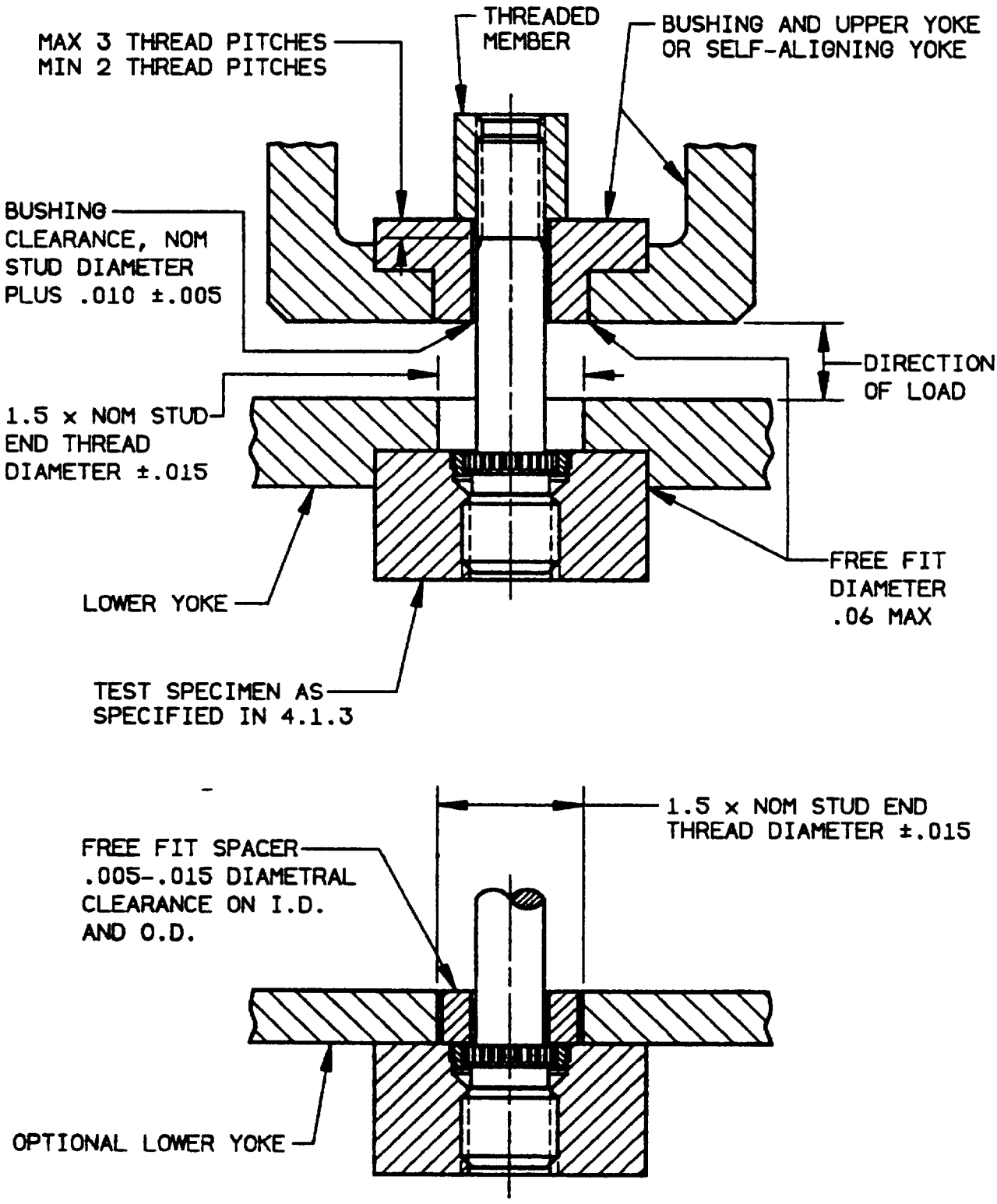

FIGURE 6. Resistance to pullout fixture.

4.7.3 Rotational resistance test. Sample studs shall be installed in test blocks in accordance with figure 4 and 4.1.3 to meet the requirements of 3.6.4 and 3.6.4.1. Torque-out values, with no axial load on the stud, shall not be less than the values specified in table VII. The test can be accomplished with a stud removal tool which shall be positioned on the stud shank or threaded portion of the nut end. The rotational force shall be applied by a torque wrench in a counter-clockwise direction.

4.7.4 Hardness test. Sample studs shall be tested for hardness to meet the requirements of 3.6.5 in accordance with MIL-STD- 1312, test 6.

4.8 Metallurgical properties inspection. Sample studs shall be inspected for discontinuities such as cracks, laps, seams and inclusions in accordance with 3.7. Any crack detected during visual examination shall be cause for rejection of the lot. When visual evidence of discontinuities show cause for further inspection, sample studs shall be subjected to magnetic particle inspection performed in accordance with MIL-STD-1949 for alloy steel, fluorescent penetrant inspection performed in accordance with MIL-STD-6866 for corrosion resistant steel and radiographic inspection performed in accordance with MIL-STD-453 for titanium alloy. Magnetic or penetrant particle indications alone shall not be cause for rejection. If indications are considered cause for rejection, representative samples shall be taken from those studs showing indication and these samples shall be further examined. Studs may be sectioned as shown in figure 7 and shall be inspected parallel to the axis. Discontinuities are measured microscopically under 10X magnification to determine conformance to the requirements of 3.7.1 and 3.7.2. The inspection shall be performed on finished studs free of lubrication and subsequent to any processing operation which could adversely affect the studs. Certification shall be required for identification marking. Particle inspection shall not be required for studs having a nut end diameter of less than .250 inch.

4.9 Grain flow inspection. Sample studs shall be microexamined to determine compliance with the requirements of 3.5.1.5 grain flow for rolled threads. Specimens shall be taken from the stud as shown in figure 7. The studs shall be etched in a suitable etchant for sufficient time to reveal the macrostructure property.

4.10 Heat treatment inspection. Heat treatment verification of the stud shall be in accordance with MIL-H-6875 or MIL-H-81200 as applicable and 3.3.

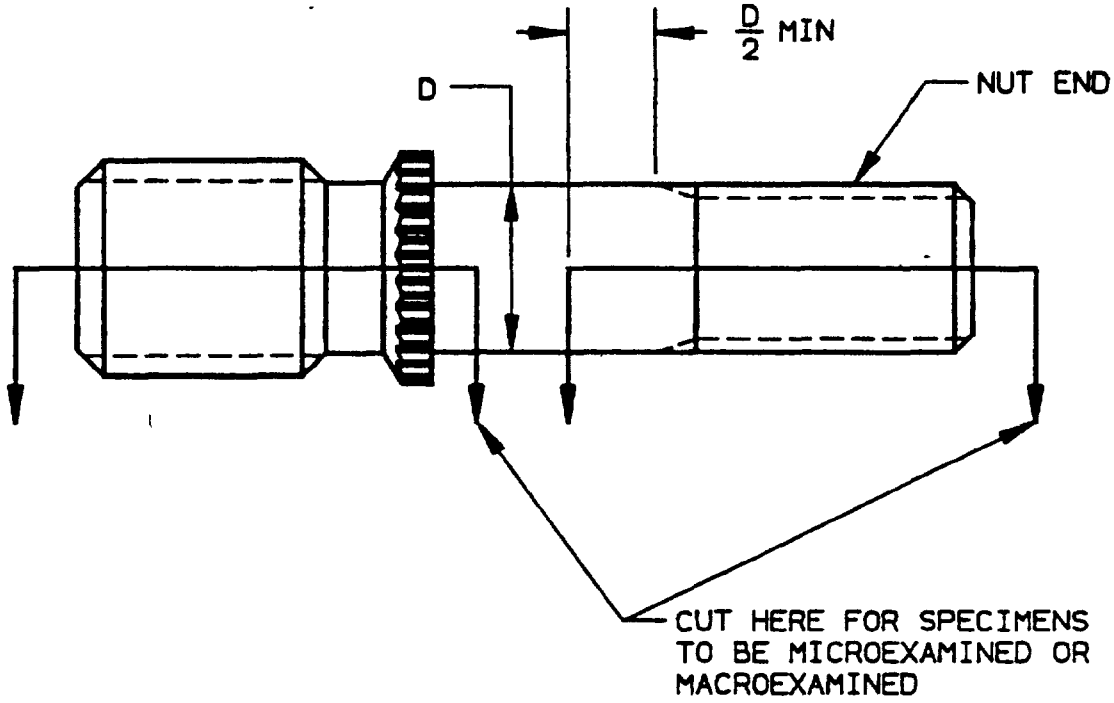

FIGURE 7. Metallurgical specimen.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with PPP-H-1581 (see 6.2).

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful but is not mandatory.)

6.1 Intended use. Studs covered by this specification are intended as a general-purpose fastener with a mechanical lock feature to resist rotation. See MS51999 for design and usage limitations.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.
b. Title, number and date of applicable Military Standard (see 3.1).
c. Applicable Military Standard part number (see 3.1).
d. Level (degree) of protection, in accordance with PPP-H-1581, ordering data (see 5.1).

6.3 Definitions.

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

6.3.2 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.

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

6.3.4 Inclusions. Inclusions are non-metallic materials in a solid metallic matrix.

6.4 Subject Term (key word) listing.
High Strength Stud
Locked-In Stud
Ring-Locked Stud
Serrated Ring Lock, Locked-In
Stepped Stud, Ring Locked
Stud

6.5 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - AR
Navy - AS
Air Force - 99

Preparing activity
Army - AR

(Project 5307-0456)

Review activities:
Army - AT, AV, ER, GL
Navy - MC
Air Force - 82
NSA - NS
DLA - IS

User activities:
Army - ME

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-S-45909C	

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
	☐ USER
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

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
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*