AEROSPACE STANDARD

AS45909™	REV. A

Issued 2007-07
Cancelled 2015-12

Superseded by NASM45909

Stud, Locked In, Ring Locked, Serrated,
General Specification For

RATIONALE

This document is cancelled and is superseded by NASM45909 available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

CANCELLATION NOTICE

This Technical Report has been declared “CANCELLED” as of December 2015 and has been superseded by NASM45909. By this action, this document will remain listed in the respective index, if applicable. Cancelled Technical Reports are available from SAE.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AS45909A

1. SCOPE

1.1 Scope

The 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).

SPECIFICATIONS

MILITARY

MS51497	Stud, Locked in - Ring Locked, Serrated, High Strength, Oversize Replacer
MS51551	Stud, Locked in - Ring Locked, Serrated, UNJF Thread Nut Eng, Increased Stud End Length
MS51994	Hole Preparation - Ring Locked Inserts and Studs, Standard Dimensions for
MS51995	Fasteners, Ring Locked - Inserts and Studs, Installation of
MS51996	Hole Preparation - Ring Locked Inserts and Studs, High Strength, Standard Dimensions for
MIL-STD-2073-1	Standard Practice for Military Packaging

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

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

(Application for copies should be addressed to ANSI, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.)

2.2.1 The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

SAE Publications: Available from SAE International, 400 Commonwealth Drive, Warrendale, PA. 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AEROSPACE MATERIAL SPECIFICATION (AMS)

AMS-H-81200 Heat Treatment of Titanium and Titanium Alloys

AMS-QQ-P-416 Plating, Cadmium (Electrodeposited)

AMS 2401 Cadmium Plating, Low Hydrogen Content Deposit

AMS 2488 Anodic Treatment of Titanium and Titanium Alloys

AMS 2700 Passivation Treatments for Corrosion Resistant Steel

AMS 4965 Titanium Alloy Bars, Wire, Forgings, and Rings

AMS 4967 Titanium Alloy Bars, Forgings, and Rings

AMS 5662 Ni Alloy Bars, Forgings, and Rings, Corrosion and Heat Resistant

AMS 5663 Ni Alloy Bars, Forgings, and Rings, Corrosion and Heat Resistant

AMS 5731 Steel Bars, Forgings, Tubing, and Rings, Corrosion and Heat Resistant

AMS 5732	Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing and Rings
AMS 5734	Steel Bars, Forgings, and Tubing, Corrosion and Heat Resistant
AMS 5737	Steel, Corrosion-Resistant, Bars, Wire, Forgings and Tubing
AMS 6322	Steel Bars, Forgings, and Rings
AMS 6370	Steel, Chrome-Nickel-Molybdenum (8740) Bars, Rods, and Forging Stock (For Aircraft Applications)
AMS 9047	Titanium and Titanium Alloy Bars (Rolled or Forged) and Reforging Stock, Aircraft Quality

AS Standards

AS8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General specification For
AS51989	Stud, Locked in - Ring Locked, Serrated
AS51990	Ring, Lock, Serrated
AS51992	Stud, Locked in - Ring Locked, Serrated, High Strength
AS51997	Ring, Lock, Serrated - High Strength

ASTM

ASTME 1444	Inspection, Magnetic Particle
ASTME 1417	Inspection, Liquid Penetrant

(Application for copies should be addressed to ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org)

NAS

NASM1312-6	Fastener Test Methods - Method 6 Hardness
NASM1312-8	Fastener Test Methods - Method 8 Tensile Strength

(Application for copies should be addressed to Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org

ASME

ASME B46.1	Surface Texture

Publications: Available on-line at www.asme.org or from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170

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, part 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 AS and MS Standard

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

3.2 Material

The stud shall be a one piece, all metal unit, made from the following materials as specified in the applicable part standard (see 3.1) when inspected in conformance with 4.10.

3.2.1 Alloy Steel

Alloy steel shall be grade 4130 (UNS G41300) in accordance with AMS 6370 or grade 8740 (UNS G87400) in accordance with AMS 6322.

3.2.2 Corrosion-resistant Steel

Corrosion and heat resistant steel shall be type A286 (UNS S66286) in accordance with AMS 5731, AMS 5732, AMS 5734 or AMS 5737.

3.2.2.1 Nickel Base Alloy

Nickel base alloy shall be corrosion and heat resistant type 718 (UNS N07718) in accordance with AMS 5662 or AMS 5663.

3.2.3 Titanium Alloy

Titanium alloy shall be type Ti-6Al-4V (UNS R56400) in accordance with AMS-T-9047, AMS 4967 or AMS 4965.

3.3 Heat Treatment

The stud or raw material shall be heat treated to develop the mechanical properties herein when inspected in conformance with 4.10.

3.4 Protective Finish or Surface Treatment

NOTICE

This document references a part which contains cadmium as a plating material. Consult local officials if you have questions concerning cadmium's use.

The stud shall be furnished with a protective plating or surface treatment as specified in the applicable part standard (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 AMS-QQ-P-416, Type II, Class 3. Alloy steel studs heat treated 180 ksi UTS or greater shall be cadmium plated in accordance with AMS 2401.

3.4.2 Corrosion-resistant Steel

Corrosion-resistant steel studs shall be passivated in accordance with AMS 2700 Type 2 or 8.

3.4.3 Titanium Alloy

None required. Anodic treatment per AMS 2488, type 2 when specified on applicable part standard (see 3.1).

3.5 Design, Dimensions, and Tolerances

Design, dimensions, and tolerances shall conform to the requirements of the applicable part standard (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 part standard (see 3.1).

3.5.1.1 Nut End Threads

Nut end threads shall conform to AS8879 as specified in the applicable AS standard (see 3.1).

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 part standard (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.

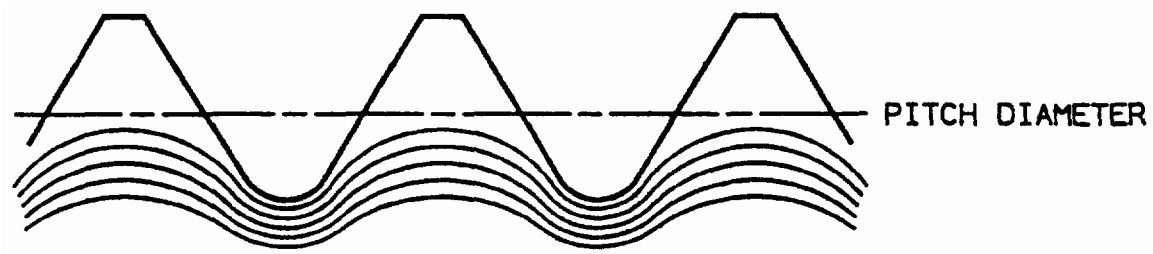


FIGURE 1 - THREAD GRAIN FLOW

3.5.2 Locking Serrations

Locking serration dimensions shall conform in size to the applicable part standard (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 part standard (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 nut end of the stud shall be within the values specified in Table 1 when tested in accordance with 4.6.5.

TABLE 1 - STRAIGHTNESS

Stud Size Nut End	Deviation of Stud from Plate, Maximum (inches per inch of stud nut end length)
0.1900 and smaller	0.0040
0.2500 - 0.3125	0.0030
0.3750 - 0.4375	0.0025
0.5000 and larger	0.0020

3.6 Mechanical Properties

Studs conforming to the design and dimensions specified in the applicable standard (see 3.1) and having load ratings as specified in Table 2 shall be capable of developing a minimum tensile strength, a minimum proof strength, and have minimum shear engagement areas in accordance with Table 2.

TABLE 2 - 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 5 Col. 1	Table 5 Col. 2	Table 5 Col. 3			
			MS51551					
			100 Numbers	100A Numbers	100B Numbers	200 Numbers	200A Numbers	200B Numbers
125 140 160	125 140 160	75 95 130	Table 5 Col. 4	Table 5 Col. 5	Table 5 Col. 6	Table 5 Col. 7	Table 5 Col. 8	Table 5 Col. 9
			AS51989					
			100 & 300 Numbers	200 & 400 Numbers				
125	125	75	Table 5 Col. 10	Table 5 Col. 11				
			AS51992					
			500 Numbers	640 Numbers	800 Numbers			
140 160 180	140 160 180	95 130 145	Table 5 Col. 12	Table 5 Col. 13	Table 5 Col. 14			

3.6.1 Tensile Strength

The stud shall develop the minimum axial load listed in Table 3 when tested as specified in 4.7.1.

TABLE 3 - MINIMUM TENSILE STRENGTH OF STUDS (NUT END)

Nominal Size (Nut End)	Tensile Stress Area (in^2) 1/		Minimum Axial Load (lbf) 2/							
			MS51551			AS51989		MS51497 & AS51992		
						125 ksi				
	Coarse Thread	Fine Thread	125 ksi UNJF	140 ksi UNJF	160 ksi UNJF	UNJC	UNJF	140 ksi UNJF	160 ksi UNJF	180 ksi UNJF
0.1380	0.0091	.0101	--	--	--	1,140	1,260	--	--	--
0.1640	0.0140	.0147	1,840	2,060	2,350	1,750	1,840	--	--	--
0.1900	0.0175	.0200	2,500	2,800	3,200	2,190	2,500	2,800	3,200	3,600
0.2500	0.0318	.0364	4,550	5,100	5,800	4,000	4,550	5,100	5,800	6,550
0.3125	0.0524	.0580	7,300	8,100	9,200	6,600	7,300	8,100	9,200	10,400
0.3750	0.0775	.0878	11,000	12,300	14,000	9,700	11,000	12,300	14,000	15,800
0.4375	0.1063	.1187	14,800	16,600	19,000	13,300	14,800	16,600	19,000	21,400
0.5000	0.1419	.1599	20,000	22,400	25,600	17,700	20,000	22,400	25,600	28,800
0.5625	0.1820	.2030	--	--	--	22,700	25,400	--	--	--
0.6250	0.2260	.2560	--	--	--	28,200	32,000	35,800	41,000	46,100
0.7500	0.3340	.3730	--	--	--	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 4 when tested in accordance with 4.7.1.

TABLE 4 - PROOF LOAD FOR STUDS (NUT END)

Nominal Size (Nut End)	Tensile Stress Area (in^2) 1/		Minimum Proof Load (lbf) 2/							
			MS51551			AS51989		MS51497 & AS51992		
						75 ksi				
	Coarse Thread	Fine Thread	75 ksi UNJF	95 ksi UNJF	130 ksi UNJF	UNJC	UNJF	95 ksi UNJF	130 ksi UNJF	145 ksi UNJF
0.1380	0.0091	0.0101	--	--	--	680	760	--	--	--
0.1640	0.0140	0.0147	1,100	1,400	1,911	1,050	1,100	--	--	--
0.1900	0.0175	0.0200	1,500	1,900	2,600	1,310	1,500	1,900	2,600	2,900
0.2500	0.0318	0.0364	2,750	3,450	4,700	2,400	2,750	3,450	4,700	5,250
0.3125	0.0524	0.0580	4,400	5,500	7,500	3,900	4,400	5,500	7,500	8,400
0.3750	0.0775	0.0878	6,600	8,300	11,400	5,800	6,600	8,300	11,400	12,700
0.4375	0.1063	0.1187	8,900	11,300	15,400	8,000	8,900	11,300	15,400	17,200
0.5000	0.1419	0.1599	12,000	15,200	20,800	10,600	12,000	15,200	20,800	23,200
0.5625	0.1820	0.2030	--	--	--	13,600	15,200	--	--	--
0.6250	0.2260	0.2560	--	--	--	16,900	19,200	24,300	33,300	37,100
0.7500	0.3340	0.3730	--	--	--	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 5. The installed stud with lockring (lockring optional) in place as specified in 4.1.3 shall have a minimum resistance to pullout in accordance with Table 6. Values specified in Table 6 are based on the minimum shear engagement areas of the stud (Table 5) when installed in a test block of 25 ksi shear strength and tested in accordance with 4.7.2.

TABLE 5 - MINIMUM SHEAR ENGAGEMENT AREA OF STUDS

	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
Nominal Size (Nut End)	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)
0.1380	--	--	--	--	--	--	--	--	--
0.1640	--	--	--	0.0667	0.1146	0.1665	0.0701	0.1174	0.1689
0.1900	0.1396	0.1804	0.2486	0.1131	0.1789	0.2544	0.1290	0.1906	0.2642
0.2500	0.2450	0.3192	0.4377	0.2088	0.3048	0.3918	0.2335	0.3172	0.4038
0.3125	0.3931	0.5088	0.6775	0.3489	0.5181	0.6758	0.3768	0.5318	0.6882
0.3750	0.6796	0.8722	1.1412	0.4089	0.6066	0.7920	0.4744	0.6608	0.8462
0.4375	0.8873	1.1358	1.5032	0.5249	0.7467	0.9715	0.6140	0.8206	1.0448
0.5000	1.0625	1.3855	1.8627	0.6489	0.8936	1.2269	0.6908	0.9157	1.2460
0.5625	--	--	--	--	--	--	--	--	--
0.6250	1.8267	2.3311	3.0291	--	--	--	--	--	--
0.7500	--	--	--	--	--	--	--	--	--

	AS51989		AS51992		
	100 & 300 Numbers	200 & 400 Numbers	500 Numbers	640 Numbers	800 Numbers
Nominal Size (Nut End)	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)
0.1380	0.0206	0.0216	--	--	--
0.1640	0.0667	0.0701	--	--	--
0.1900	0.1131	0.1290	0.1255	0.1594	0.2050
0.2500	0.2088	0.2335	0.2264	0.2890	0.3708
0.3125	0.3489	0.3768	0.3684	0.4694	0.5905
0.3750	0.4089	0.4744	0.5524	0.7070	0.8881
0.4375	0.5249	0.6140	0.7472	0.9530	1.2105
0.5000	0.6489	0.6908	1.0204	1.2955	1.6410
0.5625	0.8526	0.9989	--	--	--
0.6250	1.1772	1.3612	1.6251	2.0649	2.5955
0.7500	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 6 - RESISTANCE TO PULLOUT, STUD END THREADS

Nominal Size (Nut End)	Minimum Resistance to Pullout (lbf) 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)
0.1380	--	--	--	--	--	--	--	--	--
0.1640	--	--	--	1,670	2,860	4,160	1,750	2,930	4,220
0.1900	3,490	4,510	6,220	2,830	4,470	6,360	3,220	4,760	6,600
0.2500	6,120	7,980	10,940	5,220	7,620	9,790	5,840	7,930	10,090
0.3125	9,830	12,720	16,940	8,720	12,950	16,890	9,420	13,290	17,200
0.3750	17,000	21,800	28,530	10,220	15,160	19,800	11,860	16,520	21,150
0.4375	22,180	28,400	37,580	13,120	18,670	24,290	15,350	20,510	26,120
0.5000	26,560	34,640	46,570	16,220	22,340	30,670	17,270	22,890	31,150
0.5625	--	--	--	--	--	--	--	--	--
0.6250	45,660	58,280	75,730	--	--	--	--	--	--
0.7500	--	--	--	--	--	--	--	--	--

Nominal Size (Nut End)	AS51989		AS51992		
	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)
0.1380	510	540	--	--	--
0.1640	1,670	1,750	--	--	--
0.1900	2,830	3,220	3,140	3,980	5,120
0.2500	5,220	5,840	5,660	7,220	9,270
0.3125	8,720	9,420	9,210	11,730	14,760
0.3750	10,220	11,860	13,810	17,670	22,200
0.4375	13,120	15,350	18,680	23,820	30,260
0.5000	16,220	17,270	25,510	32,390	41,020
0.5625	21,320	24,970	--	--	--
0.6250	29,430	34,030	40,630	51,620	64,890
0.7500	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 7 when installed in conformance with MS51995 and the applicable AS standard (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 7 - ROTATIONAL RESISTANCE STRENGTH

Nominal Thread (Nut End)	Minimum Rotational Resistance (Torque-out in lbf-in)			
	MS51497	MS51551	AS51989	AS51992
0.1380	--	--	30	--
0.1640	--	45	45	--
0.1900	200	65	65	120
0.2500	400	150	150	200
0.3125	650	300	300	400
0.3750	900	550	550	650
0.4375	1,300	850	850	900
0.5000	2,300	1,100	1,100	1,300
0.5625	--	---	1,600	--
0.6250	3,000	---	2,300	2,300
0.7500	--	---	4,000	--

3.6.5 Hardness

The stud shall meet the hardness as specified in the applicable standard (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 8.

TABLE 8 - DISCONTINUITY DEPTH

Nominal Stud Size (Nut End)	Discontinuity Depth in Inches, Max 1/
0.1380 thru 0.3125	0.005
0.3750	0.006
0.4375	0.007
0.5000 thru 1.2500	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% of the basic thread height (see Table 9) 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.

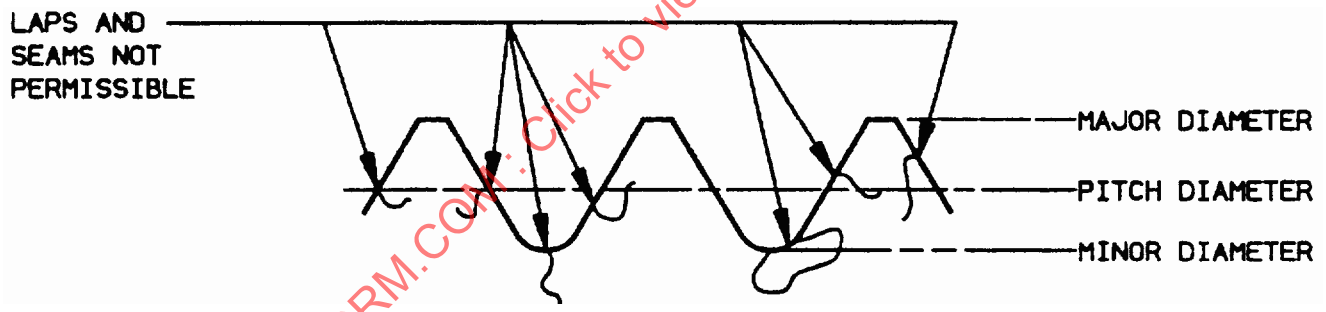


FIGURE 2 - LAPS, SEAMS, AND SURFACE THREAD

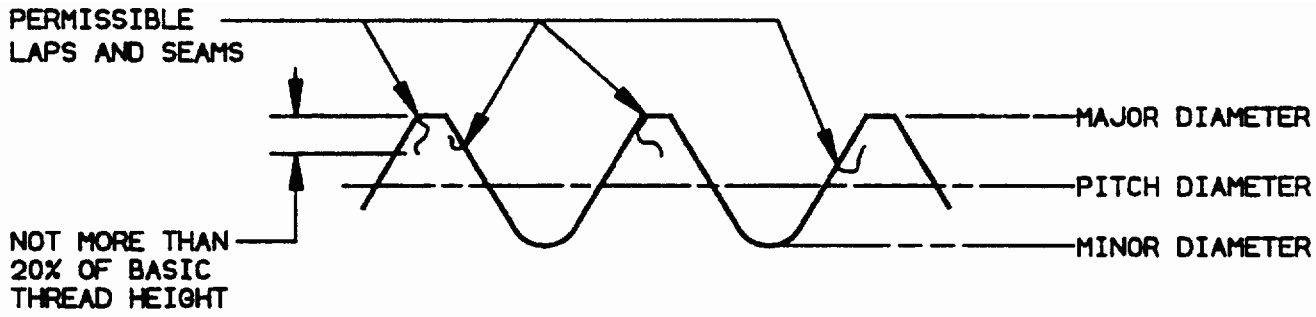


FIGURE 3A - LAPS, SEAMS, AND SURFACE THREAD

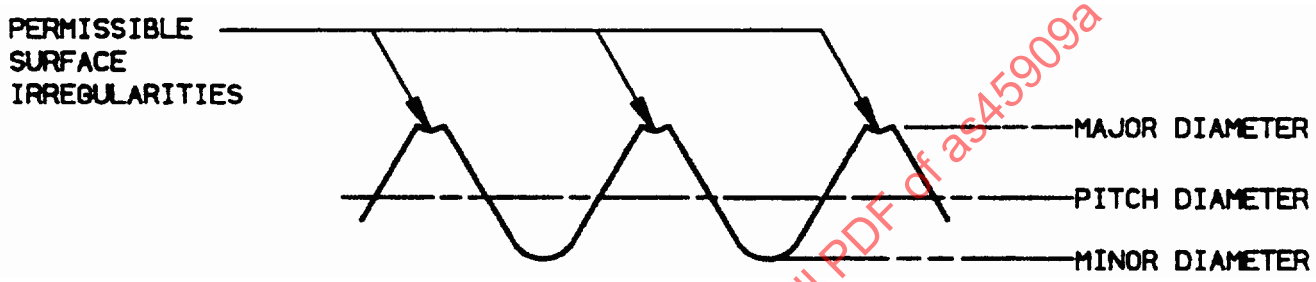


FIGURE 3B - LAPS, SEAMS, AND SURFACE THREAD

TABLE 9 - 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.

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 Customer. The Customer 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 Customer to accept defective material.

4.1.2 Test Block Fabrication

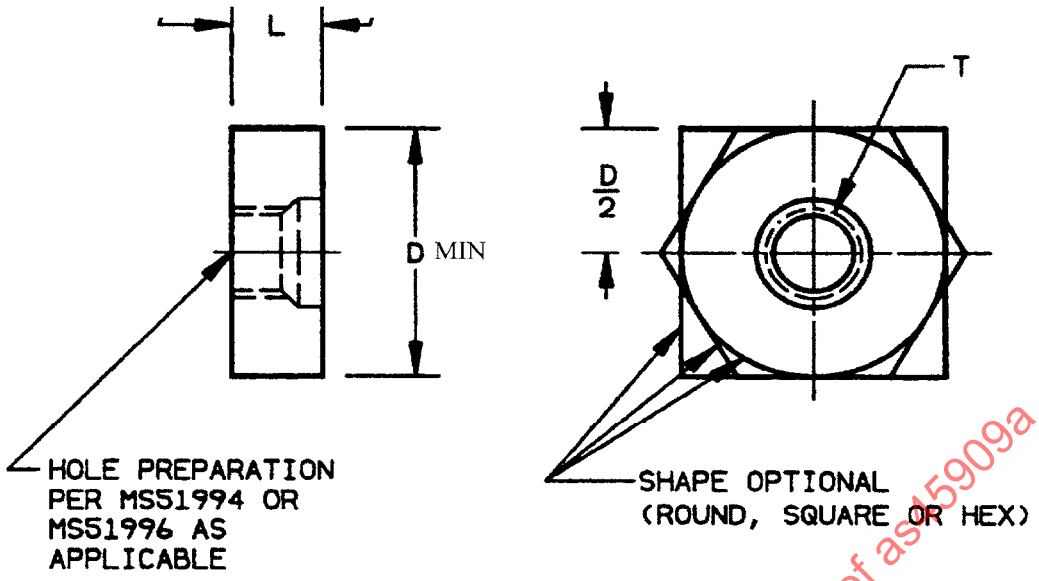
Test blocks shall be fabricated in accordance with Figures 4 or 5 as applicable. Test blocks may exceed dimensions specified in Figures 4 or 5 to accommodate multiple testing of studs and lockrings except for tests of 4.7.1 and 4.7.2.

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 ASTM E 1417.



NOTES:

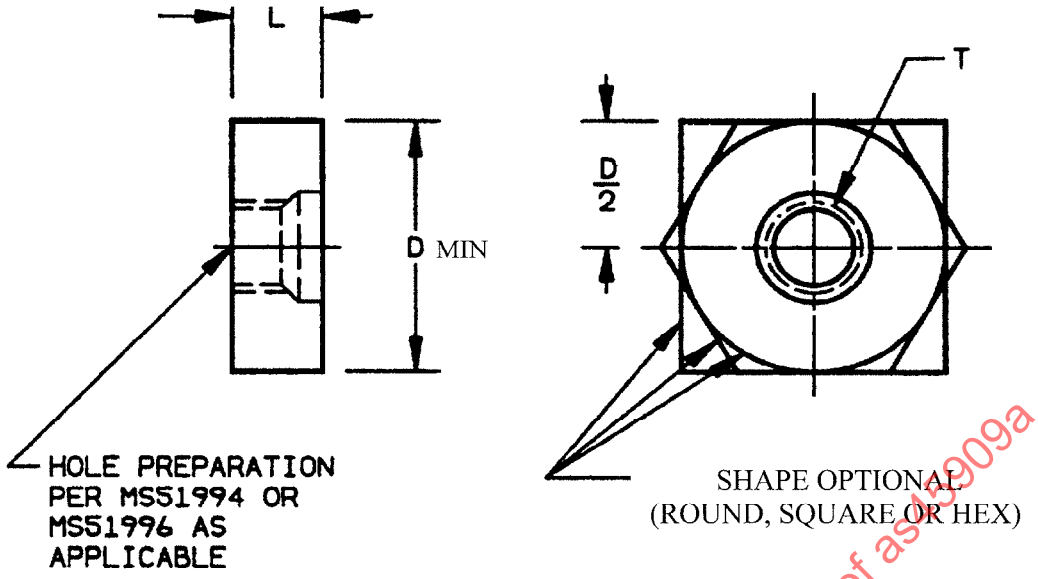
1. DIMENSIONS:

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 MINIMUM.

2. MATERIAL:

ALUMINUM ALLOY PER 2024-T4 OR 2024-T351 PER AMS-QQ-A-225/6.

FIGURE 4 - ROTATIONAL RESISTANCE (TORQUE-OUT) TEST BLOCK



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 MINIMUM.

2. MATERIAL:

   ALUMINUM ALLOY 6061-T6 OR 6061-T651 PER AMS-QQ-A-225/8.

FIGURE 5 - PULLOUT TEST BLOCK

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 10.

TABLE 10 - 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

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 Table 11.

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 ANSI/ASQS Z1.4 and the applicable inspection level and Acceptable Quality Level (AQL) specified in Table 11. A statistical method for product acceptance which provides equivalent or greater quality assurance than this sampling procedure may be used.

4.5 Inspection of Packaging

The sampling and inspection of the preservation, packing, and container marking shall be in accordance with requirements of MIL-STD-2073-1.

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.

TABLE 11 - CLASSIFICATION OF DEFECTS AND INSPECTION SAMPLING

Category	Defect	Inspection Method
Critical	None defined	
MAJOR	AQL = 1.5% 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	Thread discontinuities (3.7.2)	CIE
MINOR A	AQL = 2.5% 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% defective, Level S1	
301	Chamfer on thread ends (3.5)	VISUAL