MILITARY SPECIFICATION

STUD, KEYRING LOCKED, 125 and 160 KSI, FTU:
GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers locked in studs which have an integral locking keyring to prevent rotation of the stud when installed in the parent material.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Federal

QQ-A-225/6 - Aluminum Alloy Bar, Rod and Wire, Rolled or Cold Finished, 2024.
QQ-A-225/9 - Aluminum Alloy Bar, Rod, Wire and Special Shapes; Rolled, Drawn, or Cold Finished, 7075.
QQ-A-250/6 - Aluminum Alloy, 5083, Plate and Sheet.
QQ-P-35 - Passivation Treatment for Austenitic, Ferritic, and Martensitic Corrosion-Resisting Steel (Fastening Devices).
QQ-P-416 - Plating, Cadmium (Electrodeposited).
PPP-H-1581 - Hardware (Fasteners and Related Items), Packaging and Packing for Shipment and Storage of.

Military

MIL-S-5626 - Steel: Chrome-Molybdenum (4140) Bars, Rods, and Forging Stock (For Aircraft Applications).
MIL-S-6758 - Steel, Chrome-Nickel-Molybdenum (4130) Bars and Reforging Stock (Aircraft Quality).
MIL-I-6866 - Inspection, Penetrant Method of.
MIL-I-6868 - Inspection Process, Magnetic Particle.
MIL-H-6875 - Heat Treatment of Steels (Aircraft Practice, Process for).
MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-A-8879 - Screw Threads, Controlled Radius Root and Increased Minor Diameter; General Specification for.

STANDARDS

Federal

Fed. Test Method Std. No. 151 - Metals; Test Methods.

Military

MIL-HDBK-5 - Metallic Materials and Elements for Aerospace Vehicle Structures.
MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-109 - Quality Assurance Terms and Definitions.
MIL-STD-1312 - Fasteners, Test Methods

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

See Supplement 1 for list of associated specification sheets or detail specifications.

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.

Handbook H28-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.)

American National Standards Institute (ANSI) Standard

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

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

Aerospace Material Specifications

AMS2411 - Silver Plating (For High Temperature Applications.).
AMS5504 - Steel Sheet, Strip, and Plate, Corrosion and Moderate Heat Resistant.
AMS5610 - Steel, Corrosion and Moderate Heat Resistant.
AMS5737 - Steel Bars, Forgings, and Tubing, Corrosion and Heat Resistant

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.)

American Society for Testing and Materials (ASTM) Publications

E10 - Brinell Hardness of Metallic Materials, Test for.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 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 Specification Sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets.

3.2 Material.

3.2.1 Studs. Unless otherwise specified (see 6.2), studs shall be fabricated from materials specified herein.

3.2.1.1 Alloy steel. Unless otherwise specified (see 6.2), studs shall be made of alloy steel conforming to the requirements of MIL-S-6758, composition 4130; MIL-S-5626, composition 4140; and meet the mechanical properties of paragraph 3.9.

3.2.1.2 Corrosion-resistant steel. When specified in the contract or order, studs shall be made of steel, corrosion-resistant, conforming to the requirements of AMS 5737, composition A286, and meet the mechanical properties of paragraph 3.9.

3.2.2 Locking keyrings. Locking keyrings shall be made from steel, corrosion-resistant, composition 410 per AMS 5504 or 416 per AMS 5610.

3.3 Heat treatment. Studs shall be heat treated in accordance with MIL-H-6875 to develop the mechanical properties specified herein.

3.4 Protective plating or surface treatment. Studs and locking keyrings shall be furnished with a protective plating or surface treatment as specified herein.

3.4.1 Cadmium plating. Unless otherwise specified, studs of alloy steel (non-corrosion-resistant) shall be cadmium plated in accordance with QQ-P-416, Type II, Class 2. The entire stud and locking keyring shall be plated.

3.4.2 Silver plating. When specified, studs and locking keyrings shall be silver plated in accordance with AMS 2411.

3.4.3 Passivation. Unless otherwise specified, corrosion-resistant steel studs and locking keyrings shall be passivated in accordance with QQ-P-35.

3.5 Design, dimensions and tolerances. Design, dimensions and tolerances shall be in accordance with MIL-S-45933/1 and MIL-S-45933/2. Studs shall conform to dimensions and tolerances after application of plating.

3.6 Threads. All threads shall be the size required for the specified part number (see 6.2) on the applicable specification sheet and conform to MIL-S-8879 and H28 Handbook. Unless otherwise specified (see 6.2), all threads shall be right hand.

3.6.1 Thread forming. Threads for nut end thread shall be fully formed by a single rolling process subsequent to heat treatment and prior to plating or surface treatment. Stud end threads may be formed by machining, grinding, or rolling.

3.6.2 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 threads may deviate from true form but shall be smooth and free of tool marks.

3.6.3 Grain flow. The grain flow in rolled threads shall be continuous and shall follow the general thread contour with a maximum density at the bottom of the root radius as shown in Figure 1.

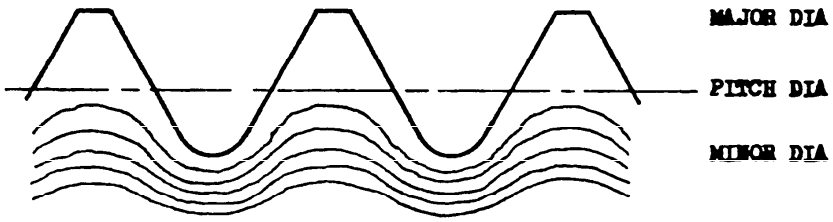


FIGURE 1. Thread Grain Flow

3.7 Surface roughness. The surface roughness of the stud, prior to plating, shall not exceed the values stated on MIL-S-45933/1 and MIL-S-45933/2 in accordance with ANSI B46.1.

3.8 Straightness. The straightness of the stud shall be within the values specified in Table I when tested in accordance with 4.5.3.

TABLE I. Straightness

Stud Size - Nut End	Deviation of Stud from Plate - Maximum (Inches per Inch of Nut End Length)
.190 and smaller	0.0040
.250 - .3125	.0030
.375 - .4375	.0025
.500 and larger	.0020

3.9 Mechanical properties. Studs conforming to the design and dimensions of MIL-S-45933/1 and MIL-S-45933/2 shall be capable of developing for a load rating, ultimate tensile strength and a minimum proof strength the values stated herein:

MIL-S-45933/1 - 125 KSI
MIL-S-45933/2 - 160 KSI

3.9.1 Tensile strength. Studs made of material conforming to 3.2 shall develop not less than the minimum tensile load requirements, as applicable, specified in Table II when tested as specified in 4.6.1.

TABLE II. Minimum Tensile Strength

Nut End Thread	Tensile (1) Stress Area (At), $in.^2$	Tensile Load (Pounds) (2)	
		MIL-S-45933/1 Studs (125 KSI)	MIL-S-45933/2 Studs (160 KSI)
.1120-40 UNJC	.00604		970
.1380-32 UNJC	.00909		1450
.1640-32 UNJC	.0140		2240
.1900-32 UNJF	.0200	2500	3200
.2500-28 UNJF	.0364	4550	5280
.3125-24 UNJF	.0580	7250	9280
.3750-24 UNJF	.0878	11,000	14,000
.4375-20 UNJF	.1187		19,000
.5000-20 UNJF	.1599		25,600
.5625-18 UNJF	.203		32,500
.6250-18 UNJF	.256		41,000
.7500-16 UNJF	.373		59,700
.8750-14 UNJF	.509		81,400
1.0000-12 UNJF	.663		106,000

(1) Tensile stress area (A_t) per Handbook H28, Part I

(2) Tensile load (A_t)x(125 or 160 KSI, as applicable).

TABLE III. Minimum Resistance to Pullout

Nut End Thread	MIL-S-45933/1 Studs (125 KSI)			MIL-S-45933/2 Studs (160 KSI)		
	Stud End Thread	Min. Shear Engagement Area-in² (1)	Ultimate Pullout (2) Load-lb.	Stud End Thread	Min. Shear Engagement Area-in² (1)	Ultimate Pullout (2) Load-lb.
.1120-40 UNJC				.1640-32 UNJC	.0420	1050
.1380-32 UNJC				.1900-32 UNJF	.0652	1630
.1640-32 UNJC				.2500-28 UNJF	.0917	2290
.1900-32 UNJF	.2500-28 UNJF	.1144	2860	.3125-24 UNJF	.1474	3680
.2500-28 UNJF	.3125-24 UNJF	.2065	5160	.3750-24 UNJF	.2545	6360
.3125-24 UNJF	.3750-24 UNJF	.2912	7280	.4375-20 UNJF	.3896	9740
.3750-24 UNJF	.4375-20 UNJF	.4763	11,900	.5626-18 UNJF	.5751	14,400
.4375-20 UNJF				.6250-18 UNJF	.7755	19,400
.5000-20 UNJF				.7500-16 UNJF	1.099	27,500
.5625-18 UNJF				.8750-14 UNJF	1.380	34,500
.6250-18 UNJF				1.0000-12 UNJF	1.700	42,500
.7500-16 UNJF				1.1250-12 UNJF	2.429	60,700
.8750-14 UNJF				1.3750-12 UNJF	3.299	82,500
1.0000-12 UNJF				1.5000-12 UNJF	4.262	107,000

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

(2) Pullout load = (Shear engagement area) x (F_{su}=25 KSI). To compute minimum pullout load in other materials, multiply shear engagement area by applicable ultimate shear stress (Fsu) of the material. Fsu values shall be obtained from MIL-HDBK -5 if available in that document.

3.9.2 Resistance to pullout. The installed stud (with or without locking keyring installed) shall have a minimum resistance to pullout from the parent material as specified in Table III, when tested as specified in 4.6.2

3.9.3 Torque out. The installed stud, when tested in accordance with paragraph 4.6.3, shall have a minimum resistance to torque out as specified in Table IV.

TABLE IV. Minimum Torque-Out Requirements

Nominal Size Nut End	Torque (inch-pounds)	
	MIL-S-45933/1 Studs (125 KSI)	MIL-S-45933/2 Studs (160 KSI)
.1120-40 UNJC		20
.1380-32 UNJC		35
.1640-32 UNJC		60
.1900-32 UNJF	60	80
.2500-28 UNJF	120	160
.3125-24 UNJF	170	270
.3750-24 UNJF	270	450
.4375-20 UNJF		720
.5000-20 UNJF		1000
.5625-18 UNJF		1500
.6250-18 UNJF		1800
.7500-16 UNJF		3000
.8750-14 UNJF		4500
1.0000-12 UNJF		6000

3.9.4 Hardness. Studs shall have a hardness range as specified in MIL-S-45933/1 and MIL-S-45933/2 when tested as stated in 4.6.4.

3.10 Metallurgical properties.

3.10.1 Discontinuities. Studs shall not contain discontinuities which exceed the following limitations.

3.10.1.1 Cracks. Studs shall be free from cracks in any direction or location.

3.10.1.2 Laps and seams. Studs may possess laps and seams, except in locations as shown in Figure 2. Permissible laps and seams as shown in Figure 2 shall not exceed the depths specified in Table V.

TABLE V. Maximum Discontinuity Depth 1/

Stud Size - Nut End	.164 thru .3125	.375	.4375	.500 thru 1.750
Maximum Depth in Inches	0.005	0.008	0.007	0.008

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

3.10.1.3 Inclusions. Studs shall show no evidence of surface or subsurface inclusions at the thread root as shown in Figure 2 when examined as specified in 4.8.

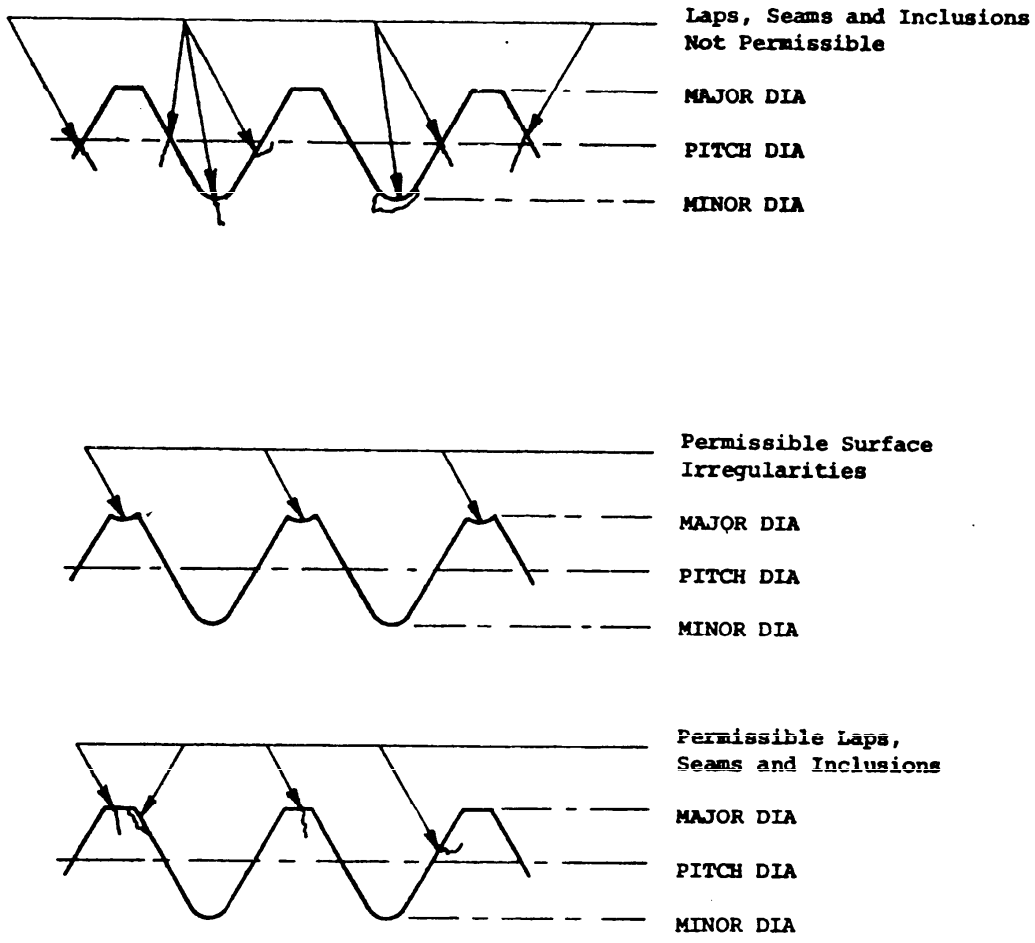


FIGURE 2. Laps, Seams and Surface Irregularities in Thread

3.10.2 Grinding burns. The studs shall show no evidence of grinding burns.

3.11 Workmanship. Workmanship shall be consistent with the type of product, finish, and class of thread fit specified. Studs shall be of uniform quality and free from defects which would be detrimental to the performance of the stud.

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 supplies and services conform to prescribed requirements.

4.2 Inspection terms. The definition of terms used in this section shall be in accordance with MIL-STD-109.

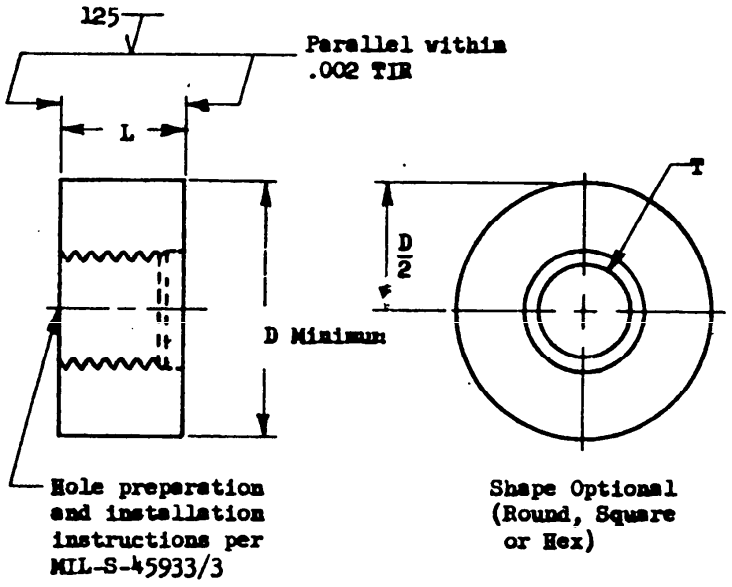
4.3 Acceptance tests. Test methods for acceptance shall consist of examination and tests.

4.4 Sampling.

4.4.1 Lot. A lot shall consist of finished studs which are of the same material, type, size, fabricated by the same process, heat treated in the same manner, and produced as one continuous run or order, or part thereof, and submitted for acceptance tests at the same time.

4.4.2 Sampling for test materials

4.4.2.1 Test blocks. Test blocks shall be fabricated as specified in Figures 3 and 4, as applicable. Larger test blocks for multiple testing of studs are permissible except for test of 4.6.2 and 4.6.3.



1. Dimensions:

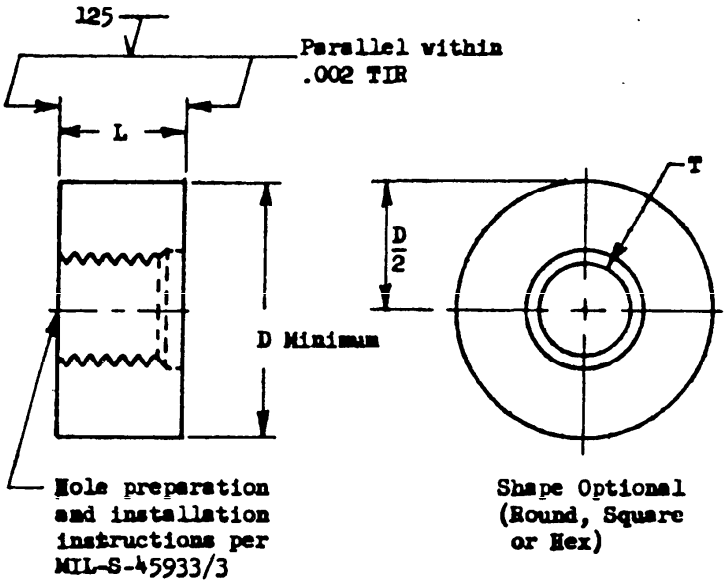
T - Nominal thread diameter of applicable stud end external thread.
D - 4 x T (For T thread sizes smaller than .500 dia.).
3 x T (For T thread sizes .500 dia. and larger).
L - Length of applicable stud thread plus .063.

2. Material:

Axial (proof) test (3.9.1) - aluminum alloy 2024 per QQ-A-225/6 or 7075 per QQ-A-225/9,
Pullout test (3.9.2) - aluminum alloy 5083 per QQ-A-250/6.

3. Anodize per MIL-A-8625, Type I, Class 1.

FIGURE 3. Axial Load Test Blocks



1. Dimensions:

T - Nominal thread diameter of applicable stud end external thread.
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 (3.9.3).

2. Material:

Aluminum Alloy, 5083 per QQ-A-250/6.

3. Anodize per MIL-A-8625, Type I, Class 1.

FIGURE 4. Torque Test Blocks

4.4.2.2 Test specimens. Test specimens of studs taken in accordance with 4.4.4 shall be installed in conformance with MIL-S-45933/3 in test blocks specified in 4.4.2.].

4.4.3 Sampling for examination. Sampling for examination of studs shall be in accordance with MIL-STD-105 at Inspection Level II.

4.4.4 Sampling for test. Samples of studs shall be taken from a single production lot for testing in accordance with Level II of MIL-STD-105. The Acceptable Quality Level (AQL) shall be 1.5 percent defective.

4.4.5 Sampling for packaging and packing. Sampling for packaging and packing shall be in accordance with PPP-H-1581.

4.5 Examination.

4.5.1 Nut end threads. Nut end threads shall be checked in accordance with MIL-S-8879.

4.5.2 Stud end threads. Threads shall be inspected for thread form per MIL-S-8879 and Handbook H28, Screw-Thread Standards for Federal services.

4.5.3 Straightness. Straightness of the nut end shall be checked when rolled on a surface plate and the maximum clearance measured with a feeler gage shall not exceed the values of Table I.

4.5.4 Finish dimensions and surface roughness. Finish, dimensions, and surface roughness shall be checked visually and by means of applicable gages.

4.5.5 Plating. The cadmium plating shall be checked for conformance with the requirements of 3.4

4.5.6 Classification of defects. The classification of defects and the Acceptable Quality Level (AQL) for locked in studs shall be in accordance with Table VI. Any stud containing one or more defects shall be considered a defective unit. The number of defective units which will reject a lot shall be in accordance with Tables I and IV-A of MIL-STD-105.

TABLE VI. Classification of Defects

Categories	Defects	Inspection Method
Critical	None Defined	
Major	AQL = 1.5 percent	
101	Locking keyring missing (3.2.2)	Visual
102	Surface finish plating (3.4)	Visual
103	Shank diameter (3.5)	Measure
104	Thread size and form (3.6 and 3.6.1)	Measure
105	Nut end thread length (3.6)	Measure
106	Drilled hole in nut end missing (when required)	Visual
107	Stud end length (3.6.1)	Measure
108	Imperfect threads (3.6.2)	Measure
109	Nut end thread formed only by rolling process (3.6.3)	Macroexamination
110	Surface roughness (3.7)	Measure or Comparison
111	Straightness of stud (3.8)	Measure
Minor	AQL = 4.0 percent 1/	
201	Overall length (3.5)	Measure
202	Drilled hole diameter and location (3.5)	Measure
203	Chamfer on thread ends (3.6.1 and 3.6.2)	Visual
204	Burrs and tool marks (3.11)	Visual

1/ 4.0 percent AQL shall apply to the total number of defective units, including major defects, which shall reject a lot.

4.5.7 Examination and tests for preparation for delivery. The inspection and testing of the preservation, packaging, packing and marking shall be in accordance with PPP-H-1581.

4.6 Test Methods.

4.6.1 Tensile strength test. Nut end threads of the studs shall be tested in accordance with the applicable requirements by Test No. 8 of Military Standard No. 1312 in tension between the nut end and the stud end. Samples shall be of sufficient length to develop the full strength of the nut end thread of the stud without stripping the thread. Studs of insufficient length for tensile tests shall be accepted on the basis of hardness tests (4.6.4).

4.6.2 Resistance to pullout test. Test specimens of studs installed in test blocks (Figure 3) as specified in 4.4.2.2 shall be used for pullout strength tests. The bushing and test block clearance holes in the upper and lower yokes shall have a free fit not in excees of 0.06 inch greater than the bushing and test block diameters. The stud clearance hole in the upper bushing shall be 0.005 to 0.015 inch larger in diameter than the nominal shank diameter of test stud specimen. 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. 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. (See Figure 5.) Studs having a grip length of less than twice their shank diameter need not be axial tested. The minimum axial load specified in Table III, as applicable, shall then be applied to the assembly and failure of the stud shall not occur below the tensile load value specified in Table II. Rate of loading shall not exceed 100,000 PSI per minute per square inch of the minimum shank area of the stud. The 5083 aluminum alloy stock used for the test block shall be tested to determine its ultimate single shear strength and test values adjusted accordingly.

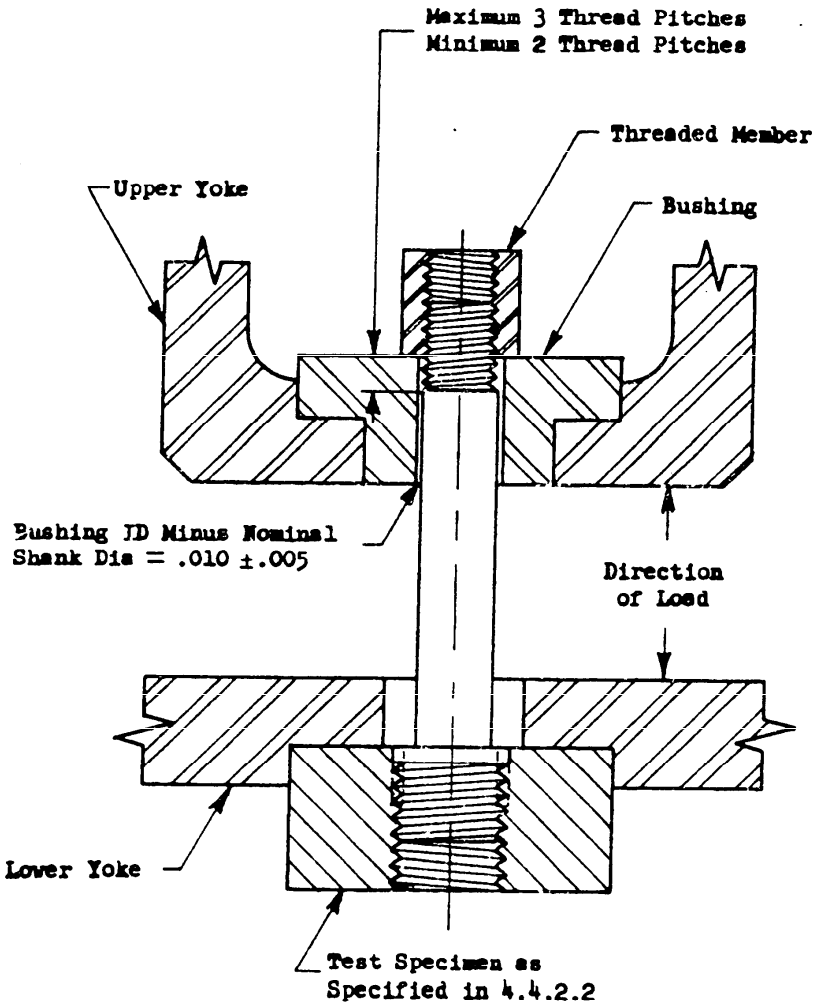


FIGURE 5. Resistance to Pullout Fixtures (4.6.2)

4.6.3 Rotational resistance test. Test specimens installed into test blocks (Figure 4) as specified in 4.4.2.2 shall be used for rotational resistance tests. Torque-out values, with no axial load on the stud, shall not be less than the values specified in Table IV. The test shall be accomplished with a commercial stud removal tool which shall be positioned on the stud shank or threaded portion of the nut end. The rotational force to be applied with a torque wrench in a counter-clockwise direction.

4.6.4 Hardness test. Samples of studs taken in accordance with 4.4.4 shall be tested for hardness requirements of 3.9.4. The test procedure shall be Test No. 6 of MIL-STD-1312 for alloy steel and ASTM E10 for corrosion-resistant steel.

4.7 Chemical Analysis. The sample stud taken in accordance with 4.4.4 shall be tested for the composition requirement of 3.2.1 and 3.2.2. The test procedure shall be by Method 111.2 or 112.2 of Federal Test Method No. 151.

4.8 Discontinuities. Magnetic particle inspection in accordance with MIL-I-6868 for alloy steel and penetrant particle inspection in accordance with MIL-I-6866 for corrosion-resistant steel shall be used to determine the presence of cracks and discontinuities such as laps, seams and inclusions.

4.9 Grain flow. Thread grain flow as shown in Figure 1 shall be determined by macroexamination. Specimens shall be taken from the finished stud nut end as shown in Figure 6. The specimens shall be etched in an aqueous solution containing 50 percent (by volume) of commercial hydrochloric acid at 71° to 82°C (160° to 180°F) for sufficient time to reveal the macrostructure properly.

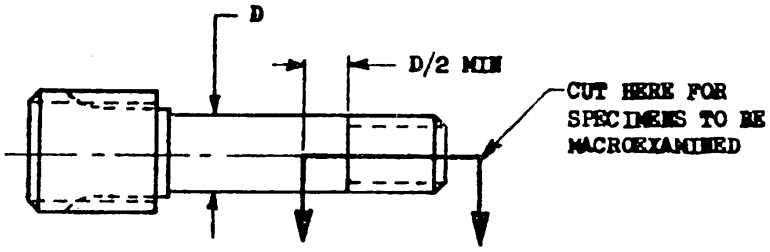


FIGURE 6. Metallurgical Specimen

5. PREPARATION FOR DELIVERY.

5.1 Preservation, packaging, packing and marking. Unless otherwise specified, preservation, packaging, packing and marking shall be in accordance with PPP-H-1581.

5.2 Levels. Levels of packaging and packing shall be as specified by the procuring activity. (See 6.2.)

6. NOTES

6.1 Intended Use. Studs covered by this specification are intended as a general purpose fastener with a mechanical lock to resist rotation when installed.

6.2 Order data. Procurement documents should specify the following:

a. Title, number and date of this specification.
b. Title and number of applicable Military Specification Sheet.
c. Material if other than as specified herein (see 3.2).
d. Left-hand threads (see 3.6).
e. Thread sizes, as specified (3.6).
f. Quantity required.
g. Selection of applicable levels of preservation, packaging and packing required (5.1).

6.3 Definitions.

6.3.1 Crack. A crack is defined as a clean crystalline break passing through the 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.

Custodians:

Army - WC
Navy - AS
Air Force - 82

Review activities:

Army - AT, AV, EL
Navy - None
Air Force - 11
DSA-IS
NSA

Preparing activity:

Army - WC

Project No. 5307-0160

User activities:

Army - GL, ME, MU
Navy - MC, SH
Air Force - None

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the spec ification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for ob taining information on the use of this specification which will insure that suitable products can be procured with minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity *(as indicated on reverse hereof)*.

SPECIFICATION

ORGANIZATION *(Of submitter)*	CITY AND STATE

CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT
		$

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.

. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)*	DATE

FOLD

DEPARTMENT OF THE NAVY

POSTAGE AND FEES P/
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