MIL-P-87988
26 July 1989

MILITARY SPECIFICATION

PIN-RIVET, THREADED WITH HEX SOCKET 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 defines the requirements for pin-rivet, threaded, flush head, pin-rivet, threaded, flush crown head and pin-rivet, threaded, protruding head, alloy steel, corrosion resistant steel, titanium and aluminum alloy pins intended for use with a threaded, self-locking collar with a controlled torque feature.

1.2 Classification. Pins furnished under this specifiction shall be of the following head types and material classes.

1.2.1 Head types.

Type I	-	Pin-Rivet, Threaded, Protruding Tension Head
Type II	-	Pin-Rivet, Threaded, 100° Flush Reduced Shear Head
Type III	-	Pin-Rivet, Threaded, 100° Flush Crown Shear Head
Type IV	-	Pin-Rivet, Threaded, 100° Flush MS20426 Shear Head
Type V	-	Pin-Rivet, Threaded 100° Flush MS24694 Tension Head
Type VI	-	Pin-Rivet, Threaded, Protruding Shear Head

1.2.2 Material classes.

Class 1	-	7075 Aluminum, 45 KSI Fsu and 75 KSI Ftu
Class 2	-	6AL-4V Titanium, 95 KSI Fsu and 160 KSI Ftu
Class 3	-	Alloy Steel, 95 KSI Fsu and 160-180 KSI Ftu
Class 4	-	A-286 High Temperature Alloy, 95-115 KSI Fsu and 160 KSI Ftu
Class 5	-	Alloy Steel, 108 KSI Fsu and 180-200 KSI Ftu
Class 6	-	PH13-8 Mo Corrosion Resistant Steel, 125 KSI Fsu and 220 KSI Ftu

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: SA-ALC/MMEDO, Kelly AFB, TX 78241-5990, 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 5320

DISTRIBUTION STATEMENT A. Approved for public release; distribution unlimited.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-A-225	-	Aluminum Alloy Bar, Rod and Wire; Rolled, Drawn, or Cold Finished, 1100.
QQ-A-430	-	Aluminum Alloy Rod and Wire, for Rivets and Cold Heading.
QQ-P-35	-	Passivation Treatments for Corrosion Resisting Steel.
QQ-P-416	-	Plating, Cadmium (Electrodeposited).
PPP-H-1581	-	Hardware (Fasteners and Related Items), Packaging of.

MILITARY

MIL-S-5000	-	Steel, Chrome-Nickel-Molybdenum (E4340) Bars and Reforging Stock.
MIL-S-5626	-	Steel, Chrome-Molybdenum (4140) Bars, Rods and Forging Stock (for Aircraft Applications).
MIL-S-6049	-	Steel, Chrome-Nickel-Molybdenum (8740) Bars, and Reforging Stock (for Aircraft Quality).
MIL-H-6088	-	Heat Treatment of Aluminum Alloys.
MIL-I-6875	-	Heat Treatment of Steel, Process 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-L-46010	-	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting.
MIL-H-81200	-	Heat Treatment of Titanium and Titanium Alloys.
MIL-C-85614	-	Coating Aluminum Pigment Fastener
MIL-L-87132	-	Lubricant, Cetyl Alcohol, 1-Hexadecanol, Application to Fasteners.

STANDARDS

FEDERAL

Federal Test Method - Metals: Test Methods.
Standard No. 151
FED-STD-H28

MILITARY

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

(See Supplement 1 for list of associated specifications)

(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.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the non-Government documents which is current on the date of the solicitation.

SOCIETY OF AUTOMOTIVE ENGINEERS

AMS4928 - Titanium Alloy Bars, Forgings, and Rings 6A1-4V Annealed, 120,000 psi (825 MPa) Yield Strength.
AMS4967 - Titanium Alloy Bars, Forgings and Rings 6A1-4V Annealed, Heat Treatable.
AMS5629 - Steel Bars, Forgings, Rings, and Extrusions, Corrosion Resistant 13Cr-8.0Ni-2.2Mo-1.1A1 Vacuum Induction Plus Consumable Electrode Melted.
AMS5731 - Steel Bars, Forgings Tubing and Rings, Corrosion and Heat Resistant, 15Cr-25.5Ni-1.3Mo-2.1Ti-0.006B-0.30V Consumable Electrode Melted, 1800°F (980°C) Solutiion Heat Treated.
AMS5737 - Steel Bars, Forgings, and Tubing, Corrosion and Heat Resistant 15Cr-25.5Ni-1.3Mo-2.1Ti-0.006B-0.30V Consumable Electrode Melted, 1650°F (900°C) Solution and Precipitation Heat Treated.

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

AMERICAN NATIONAL STANDARDS INSTITUTE

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

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

ASTM

ASTM E-120 - Chemical Analysis of Titanium and Titanium Alloys.

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

NATIONAL AEROSPACE STANDARDS COMMITTEE

NAS526 - Flushness Gage and Stylus for 100° Countersunk Flush Fasteners.
NAS527 - Inspection Procedure for Flush Fasteners.
NAS1069 - Tension Fatigue Test Procedure for Aerospace Fasteners.

(Application for copies should be adressed to the Aerospace Industries Association of America, Inc., 1725 DeSales Street, Washington, DC 20036.)

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references, other than specification sheets, cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

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

3.2 Qualification. The pins (see 6.4) furnished under this specifiction shall be products which are qualified for listing on the applicable Qualified Products List at the time set for opening of bids (see 4.1 and 6.5).

3.3 Materials. The pins shall be manufactured from the material specified on the applicable specification sheet and as shown in TABLE I.

3.4 Design and construction.

3.4.1 Dimensions. Dimensions and tolerances of pins shall conform to the applicable specification sheet and shall apply after plating or coating.

3.4.2 Construction. The pin shall be of one piece construction consisting of a manufactured head, shank, threads, and a hexagon socket as shown in FIGURE 1. All pins except the Class 1 aluminum alloy pins shall have a transitional radius between the shank and the threads.

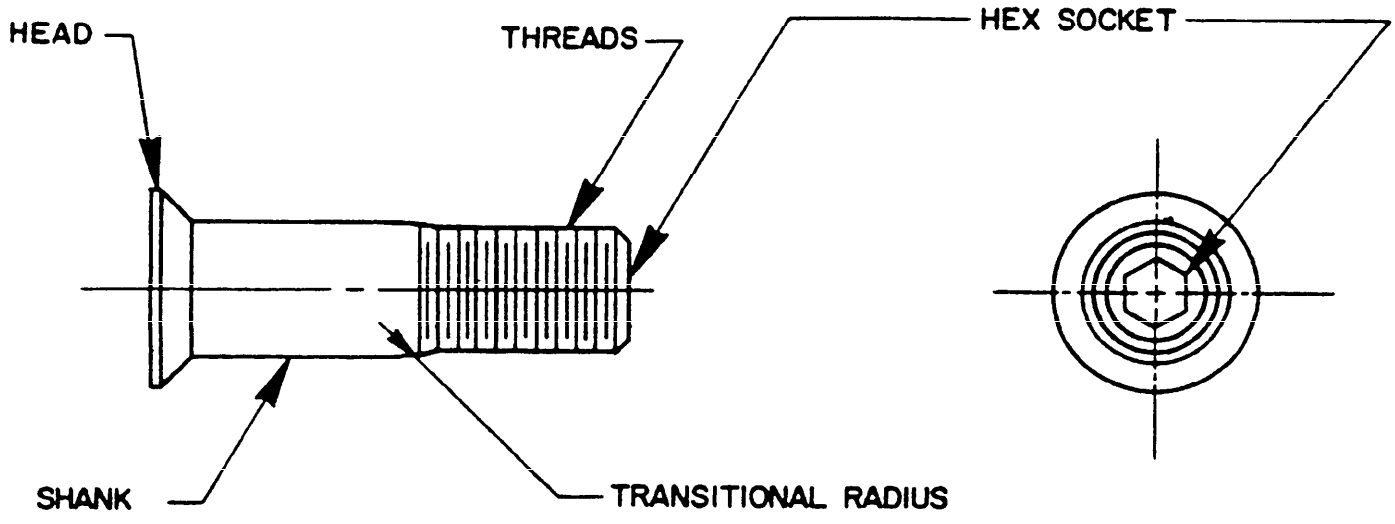


FIGURE 1. TYPICAL PIN CONSTRUCTION

3.4.3 Threads. The thread dimensions and designations shall be in accordance with MIL-S-8879.

3.4.3.1 Rolling. The threads shall be fully formed by a single rolling process before or after heat treatment as defined in the following items (a), (b), and (c) for the pin materials and sizes, unless otherwise specified in the individual specification sheet.

TABLE I. MATERIAL REQUIREMENTS

CLASS	MATERIAL			TENSILE STRENGTH psi	SHEAR STRENGTH psi	ROCKWELL C	
	ALLOY	SPECIFICATION	DIAMETER			MAX	MIN
1	7075 ALUMINUM	QQ-A-225/9 QQ-A-430	All	75,000 Min.	45,000 Min.	N/A	N/A
2	6AL-4V Titanium	AMS4928 AMS4967	All	160,000 Min.	95,000 Min.	N/A	N/A
3	4140 Steel 8740 Steel 4340 Steel	MIL-S-5626 MIL-S-6049 MIL-S-5000	thru 1/2" nom dia thru 3/4" nom dia any size	160,000 to 180,000	95,000 Min.	40	36
4	A-286 High Temp Alloy	AMS5731 AMS5737	All	160,000 Min.	95,000 to 115,000	N/A	N/A
5	4140 Steel 8740 Steel 4340 Steel	MIL-S-5626 MIL-S-6049 MIL-S-5000	thru 3/8" nom dia thru 1/2" nom dia any size	180,000 to 200,000	108,000 Min.	44	40
6	PH13-8Mo	AMS5629	All	220,000 Min.	125,000 Min.	48	N/A

NOTE: N/A - not applicable

(a) After heat treatment

Titanium, shear and tension

Alloy steel, tension head 10-32 thread and larger

PH13-8Mo, tension head 10-32 thread and larger

(b) Either before or after heat treatment

Alloy steel, tension head 8-32 thread and smaller and shear head all sizes

PH13-8Mo, tension head 8-32 thread and smaller and shear head all sizes

A-286, all heads and sizes

(c) Before solution treatment

Aluminum, all heads and sizes

3.4.3.2 Incomplete threads. Threads adjacent to chamfer and adjacent to shank as illustrated in FIGURE 2 may be incomplete. Incomplete threads may be out of tolerance at major, pitch and minor diameters, but the transition from complete to no thread shall be smooth and gradual.

3.4.3.3 Runout thread. The incomplete thread next to the shank shall include a thread runout as illustrated in Figure 3. This runout shall terminate at the end of the grip dimension length as specified on the applicable specification sheet.

3.4.3.4 Grain flow. The grain flow in the threads shall be continuous and shall follow the general thread contour with the maximum density at the bottom of the root radius as illustrated in Figure 4. Evaluation to be conducted at 50X or greater.

3.4.4 Heads. The heads shall be formed by upset forging method. The bearing surface of the pin heads shall be oriented relative to the shank within the limits shown on the individual pin specification sheet. The bearing surface on the Type I protruding head pins shall be perpendicular to the shank within plus or minus one degree.

3.4.4.1 Head structure and grain flow. A metallographic cross section of the head shall show no detrimental defects (see 4.6.13) and shall exhibit grain flow lines substantially as illustrated in FIGURE 4. The flow lines may be broken by the finish machining or grinding operation. Evaluation to be conducted at 10X or greater magnification.

3.4.5 Fillet radius (head-to-shank). The juncture of the pin head and shank shall conform to the individual specification sheet. The fillet radius on the following head types and material classes of pins shall be cold worked after heat treatment:

Type I Protruding Head: Classes 2-Titanium, 5-Alloy Steel 180-200 ksi Tension, 6-PH13-8Mo

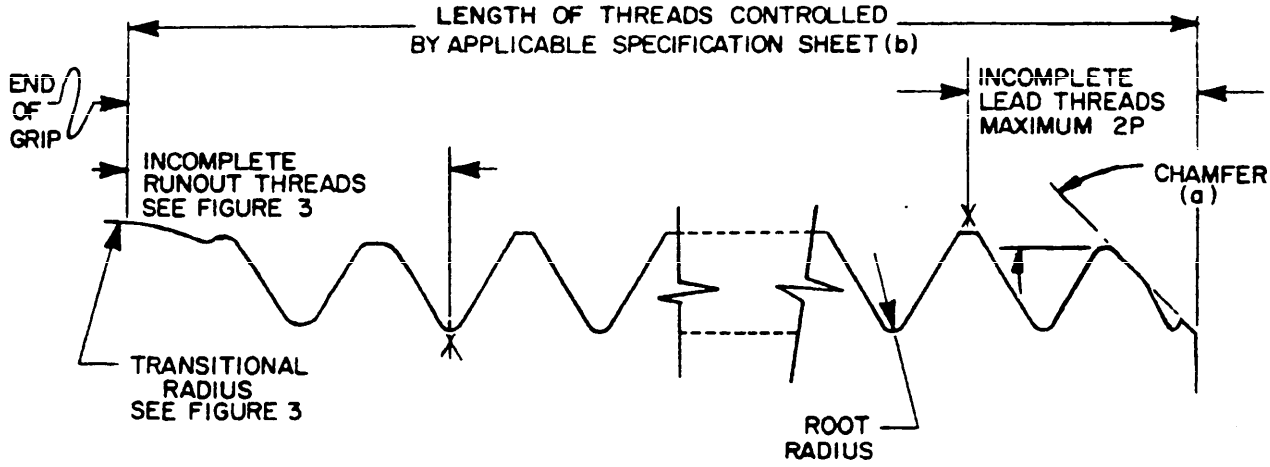
Type II 100° Flush Reduced Shear Head: Classes 2 - Titanium, 6-PH13-8Mo

Type III 100° Flush Crown Shear Head: Classes 2 - Titanium, 6-PH13-8Mo

Type IV 100° Flush MS20426 Shear Head: Classes 2 - Titanium, 6-PH13-8Mo

Type V 100° Flush MS24694 Tension Head: Classes 2 - Titanium, 5-Alloy Steel 180-200 ksi Tension, 6-PH13-8Mo

Distortions shall not exceed the limits given in FIGURE 5. Pins with a grip of less than two diameters shall show evidence of cold working under microexamination at 50X magnification or greater, and longer pins shall meet the tension-tension fatigue requirement of 3.5.4.

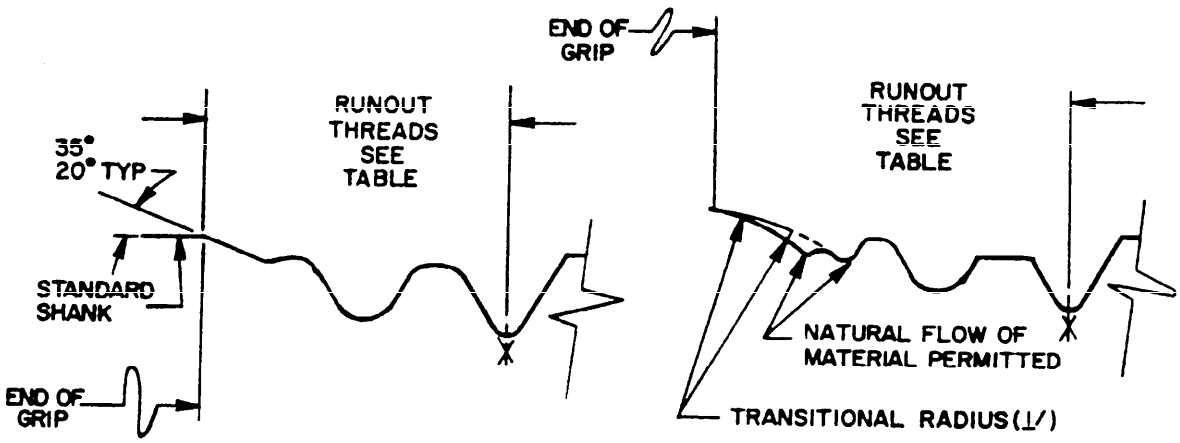


a. Point to be flat and chamfered. The angle of the chamfer on titanium alloy pins to be approximately 37°, and on other materials the angle shall be approximately 45°.

b. Acceptability of dimensions for root radius, incomplete threads, lead error and angle error shall be based on comparator measurement. Acceptability of other thread dimensions at maximum metal condition shall be based on virtual (or effective) diameter gaging with gage dimensions per applicable thread specification. Acceptability of other thread dimensions at minimum metal conditions shall be based on actual (or single element) measurement. Acceptability of grain flow or discontinuities shall be based on metallurgical examination or fatigue test, or both.

THREAD SIZE	THREADS IN ACCORDANCE WITH MIL-S-8879	P THREAD PITCH	ROOT RADIUS		TRANSITIONAL RADIUS ±.010
			MIN	MAX	
8-32	.1640-32 UNJC-3A	.03125	.0047	.0056	.075
10-32	.1900-32 UNJF-3A	.03125	.0047	.0056	.125
1/4-28	.2500-28 UNJF-3A	.03571	.0054	.0064	.175
5/16-24	.3125-24 UNJF-3A	.04167	.0063	.0075	.225
3/8-24	.3750-24 UNJF-3A	.04167	.0063	.0075	.295
7/16-20	.4375-20 UNJF-3A	.05000	.0075	.0090	.345
1/2-20	.5000-20 UNJF-3A	.05000	.0075	.0090	.395
9/16-18	.5625-18 UNJF-3A	.05556	.0083	.0100	.445

FIGURE 2. INCOMPLETE THREADS, ROOT RADIUS AND TRANSITIONAL RADIUS



ALUMINUM ALLOY PIN

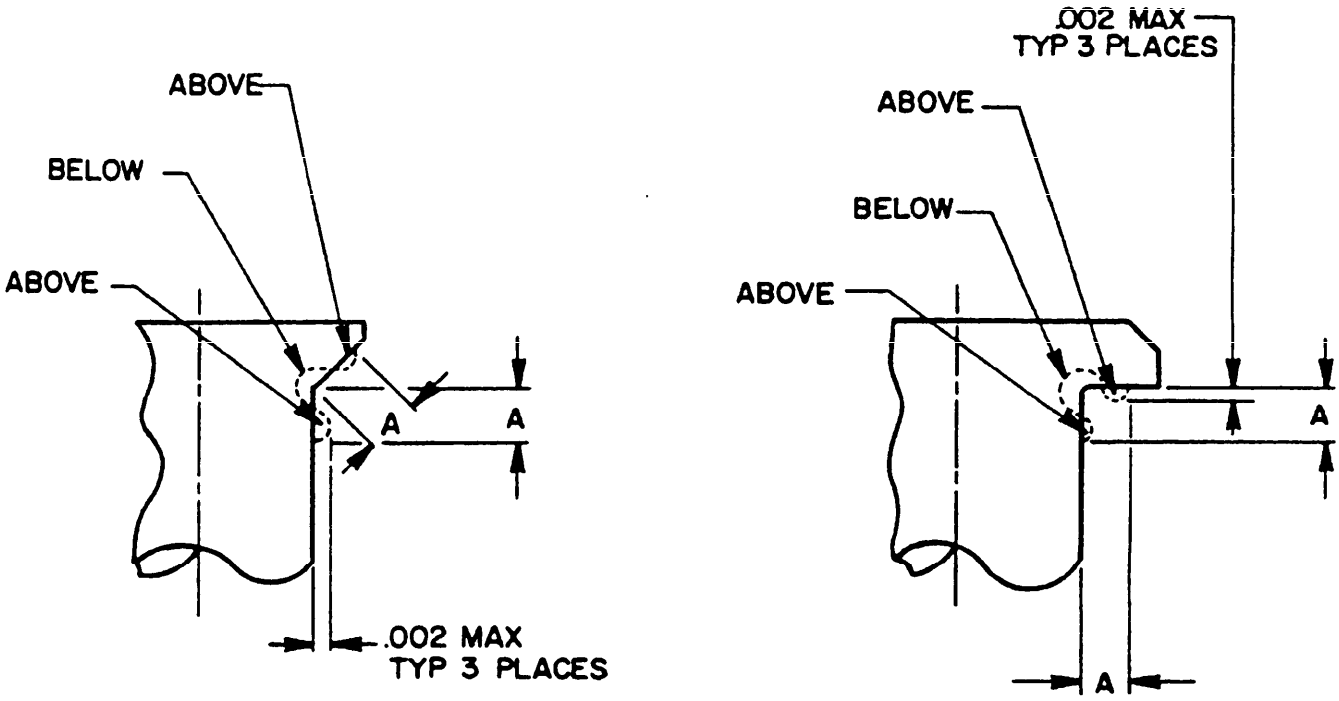
STEEL, TI, A-286, AND PH13-8MO PINS

1/ The transitional radius shall fair to the cylindrical shank with no visible mismatch and shall continue to a theoretical cylinder diameter at least .006-inch less than the shank diameter. The transitional radius is not applicable to aluminum alloy pins.

LENGTH OF THREAD RUNOUT		
Size (Diameter)		
Standard	1/64 Oversize	1/32 Oversize
2.0 Pitch	2.5 Pitch	3.0 Pitch

FIGURE 3. THREAD RUNOUT

FIGURE 4. GRAIN FLOW IN THREAD AND HEAD



A MAXIMUM			
NOMINAL SIZE	TYPE I PROTRUDING TENSION HEAD AND TYPE V FLUSH MS24694 TENSION HEAD	TYPE II FLUSH REDUCED SHEAR HEAD TYPE III FLUSH CROWN SHEAR HEAD AND TYPE IV FLUSH MS20426 SHEAR HEAD	TYPE VI PROTRUDING SHEAR HEAD
5/32, 3/16, 1/4	.062	.030	.035
5/16, 3/8	.094	.030	.035
7/16, 1/2	.125	.035	.040
9/16	.125	.035	.040

Cold working of head-to-shank fillet may cause distortion of fillet area. Distortion shall not exceed .002 above or below contour shown on pin specification sheet. Distorted area shall not extend beyond "A" as illustrated above.

FIGURE 5. FILLET RADIUS PERMISSIBLE DISTORTION

3.4.6 Hex socket wrenching element. The hex socket located in the threaded end of the pin as illustrated in FIGURE 1 shall be in accordance with the applicable specifiction sheet. Concentricity of the hex socket to the thread pitch diameter is defined in TABLE II.

3.4.7 Concentricity (thread to shank). The concentricity of the thread pitch diameter with the shank shall be within the values specified in TABLE II.

3.4.8 Straightness of shank. The straightness of the pin shank shall be within the limits of TABLE II.

TABLE II. STRAIGHTNESS AND CONCENTRICITY

NOMINAL DIAMETER	STRAIGHTNESS OF SHANK WITHIN VALUES FIM PER INCH OF LENGTH	CONCENTRICITY OF HEX SOCKET TO THREAD PITCH DIA WITHIN VALUES FIM	THREAD PITCH DIA TO SHANK DIA WITHIN VALUES FIM
5/32	.0040	.010	.0045
3/16	.0040	.010	.0045
1/4	.0030	.010	.0045
5/16	.0030	.012	.0045
3/8	.0025	.014	.0060
7/16	.0025	.017	.0060
1/2	.0020	.020	.0060
9/16	.0020	.023	.0060

3.4.9 Surface texture. The surface roughness shall be in accordance with the requirements of the applicable pin specification sheet. Surface roughness shall be measured in accordance with ANSI-B46.1.

3.4.10 Heat treatment. Heat treatment shall develop tensile, shear and fatigue properties as specified herein and on the applicable pin specification sheet without adverse effect on required metallurgical properties. Test of mechanical and metallurgical properties shall verify the heat treatment.

3.4.11 Finish and lubrication. The protective finish and lubrication of pins shall be in accordance with the applicable documents indicated in 3.4.11.1 thru 3.4.11.5 inclusive, as specified (see 3.1).

3.4.11.1 Anodic coatings of pins shall be in accordance with MIL-A-8625.

3.4.11.2 Aluminum coatings of pins shall be in accordance with MIL-C-85614.

3.4.11.3 Cadmium plating of pins shall be in accordance with QQ-P-416, Type II, Class 2.

3.4.11.4 Passivation of pins shall be in accordance with QQ-P-35.

3.4.11.5 Lubrication of pins shall be in accordance with MIL-L-8937, and MIL-L-87132.

3.5 Mechanical properties.

3.5.1 Ultimate tensile strength. The pins shall develop the ultimate tensile load listed in TABLE III when tested in accordance with 4.6.4.

3.5.2 Double shear strength. The pins shall conform to the double shear values listed in TABLE IV when tested as specified in 4.6.5.

3.5.3 Hardness. The pins shall have a Rockwell hardness within the values specified in TABLE I. The test shall be performed after heat treatment, but prior to plating. Pins with the thread rolled after heat treatment shall have the hardness tested before thread rolling.

3.5.4 Tension-tension fatigue strength. The pins specified in TABLE V when loaded within the values specified and tested in accordance with 4.6.7 shall be capable of withstanding a minimum fatigue life of 45,000 cycles. If no failure has occurred at 130,000 cycles, testing may be discontinued. This test is not applicable to pins having a grip less than two diameters.

3.5.5 Embrittlement. Electrocadmium plated Classes 3 and 5 pins shall not develop cracks or a failure after a 72-hour stress durability test using the dead weight loading method in accordance with MIL-STD-1312, Test 5 with the load at least 85% of the minimum ultimate tensile strength per TABLE III.

3.5.5.1 Embrittlement relief. The Class 3 and Class 5 cadmium plate pins shall be baked at 191° ± 14°C (375° ± 25°F) for not less than 23 hours within two hours after plating for hydrogen embrittlement relief.

3.6 Metallurgical properties.

3.6.1 Decarburization and carburization. Decarburization and carburization on Class 3 and 5 pins shall not exceed the limit specified in TABLE VI when tested in accordance with 4.6.9.

TABLE III. TENSILE STRENGTH REQUIREMENTS (LBS MIN)

NOMINAL DIAMETER	CLASS 1 & TYPES			CLASSES 2, 3, 4 & TYPES			CLASS 5 & TYPES		
	IV	I & V	VI	II & III	IV	I & V	II & III	IV	I & V
5/32	860	1,030	940	1,290	1,730	2,180	1,750	2,100	2,450
3/16	1,150	1,640	1,240	2,000	2,590	3,180	2,340	3,090	3,850
1/4	2,000	2,950	2,170	3,700	4,760	5,820	4,200	5,370	6,550
5/16	2,800	4,660	3,020	5,000	7,100	9,200	6,500	8,420	10,350
3/8	3,900	7,200	4,370	7,200	10,000	14,000	9,230	12,490	15,750
7/16	6,000	9,350	6,000	10,000	14,450	18,900	13,200	17,200	21,200
1/2	7,600	13,000	7,600	13,500	19,550	25,600	16,800	22,800	28,800
9/16				17,000	24,700	32,400	19,000	27,700	36,400

NOMINAL DIAMETER	CLASS 6 & TYPES		
	II & III	IV	I & V
5/32	1,700	2,320	2,940
3/16	2,600	3,470	4,350
1/4	4,400	6,070	7,750
5/16	7,000	9,650	12,300
3/8	10,000	14,550	19,100
7/16	13,500	19,650	25,800
1/2	18,000	26,150	34,300
9/16	22,500	33,000	43,500

TABLE IV. DOUBLE SHEAR STRENGTH REQUIREMENTS (LBS MIN)

NOMINAL DIAMETER	CLASS 1 STANDARD SIZE	CLASSES 2, 3 AND 4 STANDARD SIZE	CLASS 5 STANDARD SIZE	CLASS 6 STANDARD SIZE
5/32	1,760	4,010	4,560	5,280
3/16	2,540	5,380	6,125	7,060
1/4	4,500	9,300	10,600	12,260
5/16	7,050	14,600	16,600	19,160
3/8	10,100	21,000	23,900	27,600
7/16	13,800	28,600	32,500	37,500
1/2	18,000	37,300	42,000	49,100
9/16		47,200	53,700	62,100

TABLE V. TENSION-TENSION FATIGUE LOADING
(High Load is given. Low load = High Load - 10%)

NOMINAL DIAMETER	CLASS 2 & TYPES			CLASS 5
	II & III	IV	I & V	TYPE I & V
5/32	615	665	715	800
3/16	900	975	1,050	1,200
1/4	1,250	1,600	1,950	2,200
5/16	1,920	2,530	3,140	3,500
3/8	3,000	3,900	4,850	5,400
7/16	4,000	5,270	6,540	7,400
1/2	5,450	7,175	8,900	10,000
9/16	6,900		11,300	12,400

NOMINAL DIAMETER	CLASS 6 & TYPES		
	II & III	IV	I & V
5/32	650	650	
3/16	970	1,250	1,560
1/4	1,750	2,450	2,800
5/16	2,750	3,500	4,420
3/8	4,000	4,900	6,840
7/16	5,300	7,200	9,270
1/2	7,000	9,600	12,300
9/16	8,900		15,700

3.6.2 Discontinuities. Pins having discontinuities equal to or exceeding the limitations as specified in TABLE VI shall be rejected when examined by either magnetic inspection or the penetrant method and as defined in 4.6.10. Care must be exercised to avoid confusing cracks with other discontinuities.

3.6.2.1 Cracks. Pins shall be free of cracks in any direction or location. A crack is defined as a clean crystalline break passing through the grain or grain boundary without the inclusion of foreign elements.

3.6.2.2 Laps and seams. Pins may not possess laps and seams, except in the location specified in 3.6.2.5 and TABLE VI. A lap is a surface defect appearing as a seam, caused by folding over hot metal pins or sharp corners and then rolling or forging them into the surface, but not welding them. A seam is an unwelded fold or lap which appears as an opening in the raw material as received from the source.

3.6.2.3 Inclusions. Pins shall show no evidence of surface or sub-surface inclusions at the thread root or head-to-shank fillet. Small inclusions in other parts of the pin not indicative of unsatisfactory quality shall not be cause for rejection.

TABLE VI. DISCONTINUITIES - CARBURIZATION - DECARBURIZATION - INTERGRANULAR OXIDATION - SURFACE CONTAMINATION

LOCATION	PERMISSIBLE CONDITIONS	MAXIMUM DEPTH NORMAL TO SURFACE (INCHES) NORMAL SIZE OR DIAMETER OF FASTENER						SURFACE CONTAMINATION
		5/32 & 3/16	1/4	5/16	3/8	7/16	1/2 & Over	
Head-to-Shank Fillet Root of Bolt Threads	No Discontinuities	.000						None
Pin Thread Locations per Figure 6	Laps and Surface Irregularities	.005	.005	.005	.006	.007	.008	None
Transition from Thread Runout to Transitional Radius	Laps and Foldbacks	.005						None
Transitional Radius	No Discontinuities	.000						None
Grip or Shank Diameter	Seams - not extending into Head-to-Shank Fillet or Threads	.005	.005	.005	.006	.007	.008	None
Non-Bearing Surfaces of Head	Laps, Seams, Nicks or Gouges	.010	.010	.010	.012	.014	.016	.003
Any location except Head-to-Shank Fillet or Root of the Threads	Inclusions not indicative of unsatisfactory quality	Not Applicable						Not Applicable
Hex Socket	No cracks	.000						Not Applicable
Any location	Complete plus partial Decarburization	.003						Not Applicable
Any location	Carburization	Nonacceptable						Not Applicable
Any location	Intergrandular oxidation	.0005						None

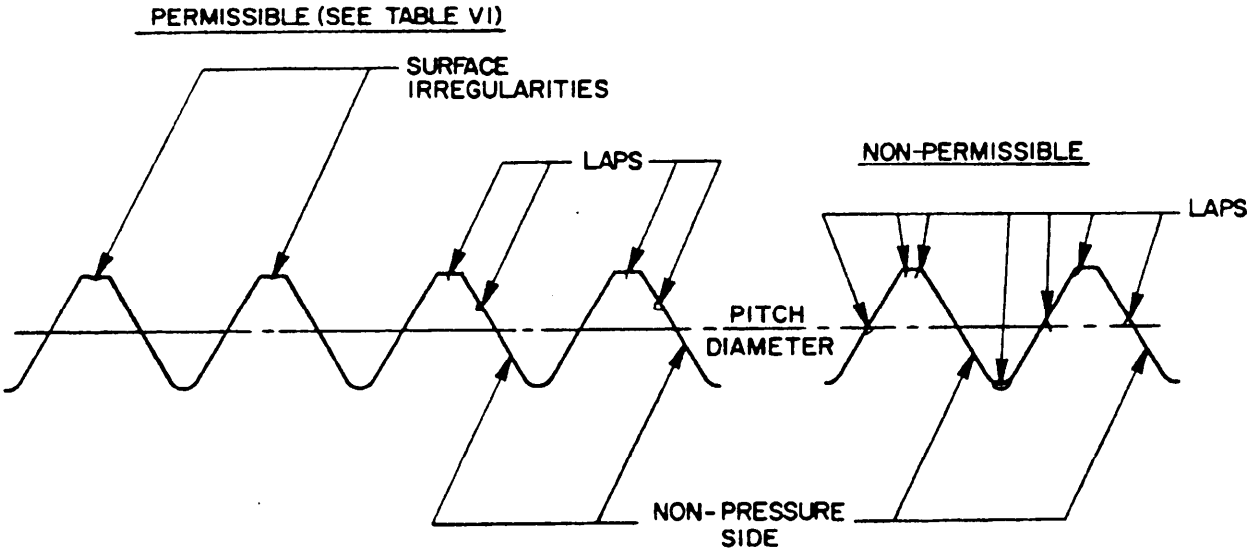


FIGURE 6. LAPS AND SURFACE IRREGULARITIES IN THREADS

3.6.2.4 Head and shank discontinuities (seams, inclusions, or folds). The pin heads and shanks shall not possess discontinuities exceeding the depth limits shown in TABLE VI. The non-bearing surfaces of pin heads shall not have more than three discontinuities.

3.6.2.5 Thread discontinuities (laps, seams, and surface irregulaities). Threads shall have no laps at the root or along the flanks as shown on FIGURE 6. Since laps are sometimes formed in the rolling of the threads, small irregularities on the crest of the threads are permissible providing the total depth of the irregularity and adjacent seam, if any, does not exceed that defined in TABLE VI.

3.6.3 Hydrogen content (Class 2). Hydrogen content in Class 2 pins may be as high as 0.0125% by weight (125 ppm) when tested in accordance with 4.6.12.

3.6.4 Microstructure and overheating (Class 2). Microstructure shall be free from bursts, voids, or gross alloy segregation. Microstructure shall also be free from indications that it has been heated to a temperature above Beta Transus without subsequently receiving sufficient mechanical reduction in the Alpha Beta temperature range. The structure shall be considered overheated when it exhibits all prior Beta grains and has no primary Alpha grains. Structure of Class 2 titanium alloy which has outlines of equiaxial prior all Beta grains and no primary Alpha is considered overheated.

3.6.5 Surface contamination (Class 2). Except as specified in TABLE VI the titanium pins shall be free of any oxygen-rich layer, such as Alpha case, or other surface contamination. Examination shall be performed microscopically at 250X to 500X magnification.

3.6.6 Intergranular corrosion (Class 1). Local intergranular corrosion shall not exceed .012 inch in depth in aluminum alloy pins, and general intergranular corrosion shall not exceed .008 inch in depth.

3.6.7 Plating burns (Classes 3 and 5). Plated surfaces shall be uniform in appearance and free of harmful imperfections in accordance with the requirements of the applicable plating specification.

3.6.8 Grinding burns (Classes 3, 4, 5 and 6). The pins show no evidence of grinding burns when examined as specified in 4.6.18.

3.6.9 Intergranular oxidation (Classes 3 and 5). Surfaces shall show no evidence of intergranular oxidation when examined as specified in 4.6.17.

3.7 Surface texture. Pins shall have a surface texture indicated on the applicable specification sheet.

3.8 Workmaship. Pins shall be of uniform quality and free from defects affecting their serviceability.

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 as specified herein. Except as otherwise specified in the contract or 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 the specification where such inspections are deemed necessary to assure supplies, and services conform to perscribed requirements.

4.1.1 Inspection records. Inspection records of the examinations and tests shall be maintained and shall be available to the customer on request for a minimum of five years from shipment of pins.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

a. Material inspection (see 4.3).
b. Qualification test (4.4).
c. Quality conformance inspection (see 4.5).

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials used in fabricating the pins are in accordance with the applicable specifications and standards.

TABLE VII. QUALIFICATION AND QUALITY CONFORMANCE TESTS

TEST REQUIREMENTS		CLASSIFICATION OF APPLICABLE PINS		TEST METHOD (PARA)	SAMPLE SIZE	
CHARACTERISTICS	(PARA)	TYPE (s) HEAD	CLASS (s) MATERIAL		QUALIFICATION TEST	QUALITY CONFORMANCE INSPECTION
Dimensional Examination	3.4.1	All	All	4.6.3	1/	TABLE IX
Protective Finish and Lubrication	3.4.11	All	All	4.6.15	1/	TABLE IX
Mechanical Properties						
Tensile Strength	3.5.1	Table III	All	4.6.4	7 each	TABLE VIII
Double Shear	3.5.2	Table IV	All	4.6.5	7 each	TABLE VIII
Hardness	3.5.3	All	3,5,6	4.6.6	2 each	TABLE VIII
Fatigue	3.5.4	Table V	2,5,6	4.6.7	7 each	TABLE VIII
Embrittlement	3.5.5	All	5	4.6.8	4 each	TABLE VIII
Metallurgical Properties						
Grain Flow-Threads	3.4.3.4	All	All	4.6.12	5 each	TABLE VIII
Grain Flow-Head	3.4.4.1	All	All	4.6.12	5 each	TABLE VIII
Cold Worked Fillet	3.4.5	All	All	4.6.12	5 each	TABLE VIII
Carburization	3.6.1	All	3,5	4.6.9	5 each	TABLE VIII
Decarburization	3.6.1	All	3,5	4.6.9	5 each	TABLE VIII
Discontinuities	3.6.2	All	All	4.6.10	5 each	TABLE VIII
Hydrogen Content	3.6.3	All	2	4.6.11	1 each	1 each
Microstructure	3.6.4	All	All	4.6.12	5 each	TABLE VIII
Surface Contamination	3.6.5	All	2,4	4.6.12	5 each	TABLE VIII
Intergranular Corrosion	3.6.6	All	1	4.6.13	5 each	TABLE VIII
Plating Burns	3.6.7	All	3,5	4.6.14	5 each	TABLE VIII
Grinding Burns	3.6.8	All	3,4,5 & 6	4.6.18	5 each	TABLE VIII
Intergranular Oxidation	3.6.9	All	3,5	4.6.17	5 each	TABLE VIII

1/ All samples tested in the Qualification Test must be inspected.

4.4 Qualification test. Qualification tests shall consist of all tests listed in TABLE VII and as specified under 4.5.

4.4.1 Qualification sample. Qualification test samples shall consist of pins of the same diameter, type, and class for which qualification is desired and in the quantities specified in TABLE VII under "Qualification Test."

4.4.1.1 Tensile and shear tests. Acceptance for qualification of both ultimate tensile tests and double shear tests shall require that:

$$\bar{X} - 1.45\ (\sigma) \quad \geq M$$

DEFINITION OF TERMS:

M	Minimum tensile or shear value per drawing
X	Individual value in sample
$\bar{X}$	Average of X values
$\sum X^2$	Sum of squares of X values
$(\sum X)^2$	Square of sum of X values
N	Number of parts in sample (7 for qualification)
σ	Best estimate of standard deviation = $\sqrt{\frac{N \sum X^2 - (\sum X)^2}{N \quad (N-1)}}$
	1.45 K factor for qualification sample size of seven (7) specimens
$\geq$	is equal to or greater than
$\sqrt{}$	Square root of

4.4.2 Certified test report. The qualification tests shall be supported by a certified test report with the actual data for the tests specified in TABLE VII and drawings including the following details: dimensions, tolerances, material identification, coating or plating applied, and heat teatment.

4.5 Quality conformance inspection. Quality conformance inspection pertains specifically to production lots, and shall be accomplished on every production lot of the specific pin represented in a shipment. The inspection shall consist of the examinations, tests, and the sample size specified in TABLE VII under "Quality Conformance Inspection."

4.5.1 Inspection lot. An inspection lot is a production lot which is a defined quantity of finished pins of identical configuration, fabricated from a single mill heat or melt of material, produced as one continuous run or order or part thereof, and presented for inspection at the same time.

4.5.2 Sample. A sample consists of one or more pins drawn at random from the inspection lot without regard to their quality. The total number of pins in the sample constitutes the sample size.

4.5.3 Production lot inspection report. Each production lot of pins shall have an authorized inspection report on file. The report shall state that the pins are from a production lot(s) which were manufactured, inspected and accepted in accordance with the requirements of this specification. The report shall identify the part number and the production lot number(s) and shall include the actual test results or certification of conformance as required by the applicable test method on all production lots represented in the shipment.

TABLE VIII. SAMPLE SIZE

SAMPLING FOR DESTRUCTIVE, TENSILE, SHEAR AND FATIGUE TEST, AND FOR METALLURGICAL PROPERTIES			
LOT SIZE	SAMPLE SIZE FOR EACH TEST	ACCEPTANCE NUMBER	REJECTION NUMBER
Under 500	2	0	1
501 to 2,500	4	0	1
2,501 to 10,000	5	0	1
10,001 to 50,000	10	0	1
50,001 to 100,000	15	0	1
100,001 and Over	27	1	2
SAMPLE FOR HARDNESS TESTING (Attribute plan based on Inspection Level S2 from Appendix to MIL-STD-105)			
LOT SIZE	SAMPLE SIZE	ACCEPTANCE NUMBER	REJECTION NUMBER
Under 181	2	0	1
181 to 500	3	0	1
501 to 800	5	0	1
801 to 1,300	7	0	1
1,301 to 3,200	10	0	1
3,201 to 8,000	15	0	1
8,001 and Over	25	0	1

4.5.4 Screening. Screening (100% inspection, accompanied by rejection of defective parts) may be applied at the inspector's discretion to any lot of pins which is not acceptable by the sampling plans described herein. Screening may be applied only to characteristics inspected by nondestructive tests. For characteristics inspected by destructive tests, the entire lot shall be accepted or rejected according to the test results of the prescribed sample.

4.5.5 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective pins, and resubmit for reinspection in accordance with MIL-STD-105. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.5.6 Packaging inspection. The sampling and inspection of the preservation, packaging, packing and container shall be in accordance with PPP-H-1581.

4.6 Test methods.

4.6.1 Material certification. Mill certification on all material shall be kept on file and available to the government.

4.6.2 Sampling. Identical sample items may be used for any of the inspections and tests, provided selection of random samples is maintained and that none of the characteristics of the sample items are altered during the examination procedure.

4.6.3 Visual and dimensional inspection. The dimensional characteristics of the pins shall be inspected for conformance to the applicable specification sheet in accordance with the procedures and criteria as specified in TABLE IX. All dimensional characteristics are considered defective when out of tolerance.

4.6.4 Ultimate tensile strength. Pins subjected to tensile test shall be installed and fully assembled in tension fixtures meeting the requirements of MIL-STD-1312 Test 8. When testing countersunk head pins an alternate tension cup must be used which provides a countersunk seat for the pin head. Loading rates shall not exceed 100,000 psi per minute. This test is not applicable on production lots of pins having a grip less than two times the nominal diameter but a tensile test shall be performed on the wire or bar of sufficient length from which the short pins are formed, after it is heat treated.

4.6.5 Double shear strength. Pins subjected to shear test may be installed in a double shear test fixture substantially meeting the requirements of MIL-STD-1312 Test 13. When testing pins having other than a protruding head configuration, the bearing surface of the head shall not contact the shear fixture. Loading rates shall not exceed 100,000 psi per minute. This test is not applicable on production lots of flush head pins having a grip less than two and one half times the nominal diameter and on production lots of protruding head pins having a grip less than two times the nominal diameter but a double shear test shall be performed on the wire or bar of sufficient length from which the short pins are formed, after it is heat treated.

4.6.6 Hardness. The pins shall be tested for Rockwell hardness on a smooth, flat, prepared surface in accordance with Test 6, MIL-STD-1312. The tests shall be performed after heat treatment, but prior to plating. If pins should have thread rolled after heat treatment, the hardness shall be performed prior to thread rolling (see 3.4.3.1).

TABLE IX. CLASSIFICATION OF DIMENSIONAL DEFECTS.

(Sampling and Acceptance at Random per MIL-STD-105)

CATEGORY	DEFECTS	INSPECTION METHOD	CRITERIA
101	Diameter (Shank)	Dimensional Measurement	Major A 1.5% AQL
102	Grip	Dimensional Measurement	
103	Radius (Head-to-Shank Fillet)	Comparator Measurement	
104	Thread	Gaging in Accordance with MIL-S-8879, FED-STD-H28 and FIGURE 2	
105	Concentricity of Head and Thread-to-Shank	Dimensional Measurement	
106	Straightness of Shank	In Accordance with TABLE II	
107	Head Angle for Flush Head	Dimensional Measurement	
108	Surface Texture	ANSI B46.1	
109	Protective Finish	Dimensional Measurement	
110	Squareness of Head Bearing Surface to Shank for Protruding Head	Dimensional Measurement	
201	Length	Dimensional Measurement	Minor A 2.5% AQL
202	Protruding Head-Diameter and Thickness	Dimensional Measurement	
203	Hex Socket	Dimensional Measurement	
204	Concentricity of Hex socket to Pitch Diameter	Dimensional Measurement	
205	Lubrication	Visual and Feel	
	Flush Head Gaging	In Accordance with NAS526 Modified for Stylus and Block Usages for These Head Styles and TABLE X	In Accordance with NAS527
206	Thread Chamfer	Dimensional Measurement	Minor B 4.0% AQL
207	Protruding Head Chamfer	Dimensional Measurement	

4.6.7 Tension-tension fatigue strength. The pins specified in TABLE V to be subjected to the fatigue test shall be installed in a test fixture substantially meeting the requirements of MIL-STD-1312 Test 11. The pins shall be tested in maximum grip when engaged to the internal threads of the test collar, and the collar or nuts shall be installed with only sufficient torque to overcome the self-locking torque characteristics. This test is not applicable to pins having a rip less than two diameters.

4.6.7.1 Fatigue loads. The test loads shall be applied at 300 to 18,000 cycles per minute at room temperature. The applicable high load and low load (in pounds) shall be in accordance with TABLE V and within the tolerance as specified by NAS1069. The fatigue life shall be over the number of cycles indicated below:

Average All Samples	Minimum Individual Sample	Continue Test to Not Over	Calculate Average on Failure or
65,000	45,000	130,000	130,000 Max

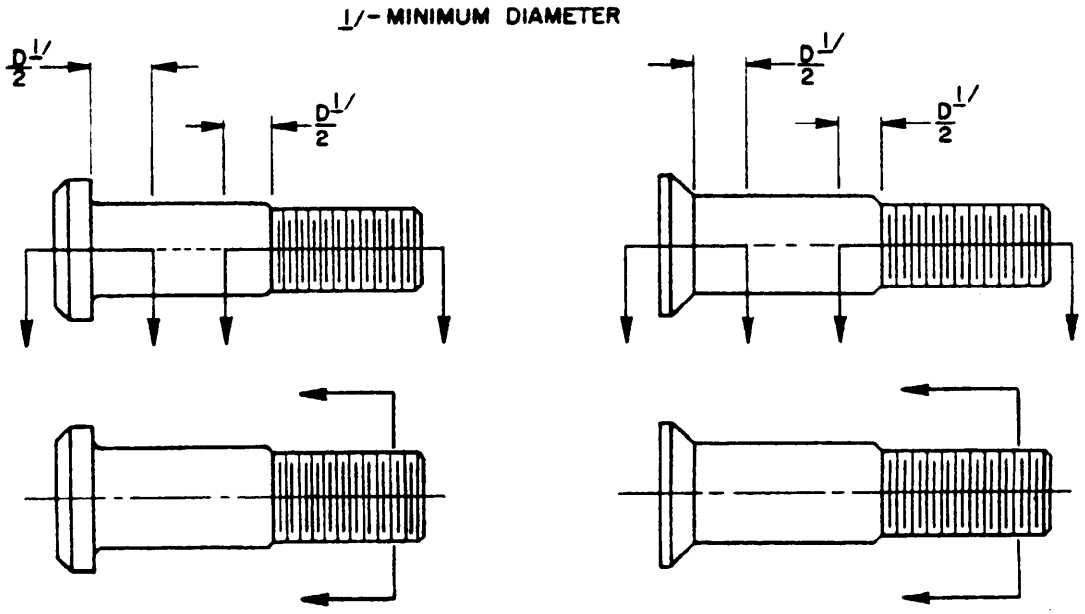
4.6.8 Embrittlement. Upon completion of the stress durability test in accordance with 3.5.5, the Class 5 pins shall be checked for the presence of cracks by magnetic particle inspection per MIL-STD-1949.

4.6.9 Decarburization and carburization. Decarburization and carburization on the bearing surface of the head, head-to-shank fillet, shank and threads on the Class 3 and 5 pins shall be determined by microexamination. Logitudinal specimens shall be taken from the finished pin as shown in FIGURE 7 and the microscopic examination made at 100X magnification. A micro hardness traverse shall be taken on all questionable samples. The readings at .003 inch shall convert to the same Rockwell "C" range as that of the core, within the limits of TABLE I.

4.6.10 Discontinuities. The Class 1, 2, 4, and 6 pins shall be examined for discontinuities by the penetrant method specified in MIL-STD-6866, Type I, Method B, except that penetration time shall not be less than 30 minutes. The Class 3 and 5 pins shall be magnetic inspected per MIL-STD-1949. Indications shall be evaluated by metallurgical examination as specified hereunder. Marking of individual pins is not required.

4.6.10.1 No indications present. When no penetrant indication or magnetic particles are present, whichever is applicable, microscopically examine the random sample size at 50X to 100X magnification for conformance to the limits of TABLES VI and VIII. This sample may also be used for examination of surface contamination, microstructure, grain growth, grain flow and decarburization.

4.6.10.2 Indications present. When penetrant indications or magnetic particles are present, whichever is applicable, microscopically examine at 50X to 100X magnification to determine whether the indications reveal discontinuities exceeding the limits specified in TABLE VI. If one or more discontinuities are found, the entire lot may be rejected or recommend penetrant or magnetic particle screening to reject all pins with similar indications. Pins used for metallurgical examination of discontinuities may be used for part or all of the sample for examination of other metallurgical characteristics.



NOTES:

(1) Pins shall be sectioned as shown by the sectioning arrows as required for micro and macro examinations.

(2) To detect the presence of cracks in the corners of the hex socket, the hex-socket shall be sectioned at 90^{o} as shown.

(3) Pin shall be examined for internal and surface defects to the limits of TABLE VI.

FIGURE 7. METALLURGICAL SPECIMENS

4.6.11 Hydrogen content (Class 2). Material shall be removed from the head-to-shank fillet area from one (1) pin taken from the inspection lot. The hydrogen content shall then be determined from the sample by the wet chemical method in accordance with ASTM E120, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112.2 or other approved analytical methods.

4.6.12 Microscopic examination. To microscopically examine a specific area in a pin, the pin shall be cross-sectioned in accordance with FIGURE 7. The macroexamination or microexamination shall then be conducted at the magnification as specified for the individual test under examination.

4.6.13 Intergranular corrosion (Class 1). The aluminum pins shall be subjected to the intergranular corrosion test as specified in Federal Test Method Standard No. 151, Method 822. At the end of the immersion period the pins shall be cross-sectioned in accordance with FIGURE 7 and microscopic examination made at 100X as specified in Federal Test Method Standard No. 151, Method 822.1.

4.6.14 Plating burns (Class 3 and 5). The surface texture and condition shall be visually examined in accordance with the requirements of the applicable specification governing the plate coating.

4.6.15 Protective finish and lubrication. When specified (see 6.2) samples taken as specified in 4.6.2 shall be inspected for adequacy of the finish in accordance with the applicable specification of 3.4.11.

4.6.16 Surface texture. Pin samples taken as specified in 4.6.2 shall be examined for conformance with surface texture requirements specified in 3.7 and will be examined by a method of measurement in accordance with ANSI B46.1.

4.6.17 Intergranular oxidation. The presence of intergranular oxidation shall be determined by method in accordance with MIL-H-6875.

4.6.18 Grinding burns (Classes 3, 4, 5 and 6). Indications of grinding burns shall be cause for rejection. They are (untempered martensite) white streaks appearing on the surface of the test sample after the test is conducted as follows:

a. Remove all foreign matter from the pin such as grease, dirt, plating, or oxide fiber.

b. Rinse the pin in cold water. If water breaks occur, pins shall be recleaned.

c. Immerse and agitate the pin in a 4 percent solution of nitric acid for approximately 30 seconds.

d. Rinse in cold water and dry pin.

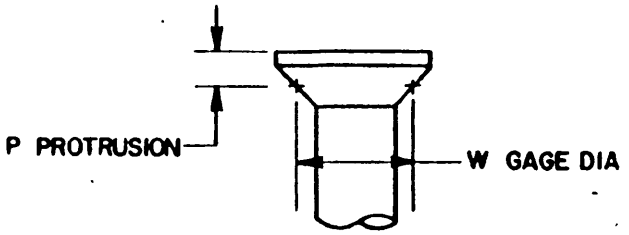
e. Immerse the pin in 2 percent solution of hydrochloric acid in acetone for 30 seconds.

f. Rinse in cold water.

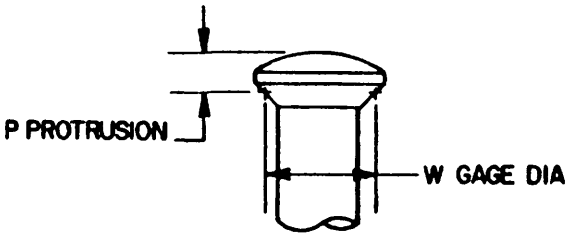
g. Rinse the pin in 5 percent sodium bicarbonate solution.

h. Rinse the pin in hot water and dry.

TABLE X. GAGE DIAMETERS AND PROTRUSION FOR FLUSH HEADS AND FLUSH CROWN HEADS



FLUSH HEAD GAGING



FLUSH CROWN HEAD GAGING

SIZE DASH NUMBER	REDUCED SHEAR HEADS		MS20426 HEADS		MS24694 HEADS		CROWN SHEAR HEADS	
	W +.0002 -.0000	P STD DIA	W +.0002 -.0000	P	W +.0002 -.0000	P	W +.0002 -.0000	P STD DIA
5 (.1640)	.2026	.0246 .0225	.2558	.0153 .0132	.2669	.0266 .0245	.2026	.0396 .0321
6 (.1900)	.2439	.0242 .0220	.2980	.0233 .0211	.3145	.0280 .0259	.2439	.0392 .0320
8 (.2500)	.3313	.0266 .0245	.4048	.0287 .0266	.4243	.0345 .0324	.3313	.0416 .0345
10 (.3125)	.4045	.0291 .0269	.4789	.0348 .0326	.5387	.0398 .0377	.4045	.0441 .0369
12 (.3750)	.4852	.0316 .0294	.5940	.0408 .0386	.6530	.0451 .0430	.4852	.0466 .0394
14 (.4375)	.5675	.0422 .0395	.7240	.0336 .0305	.7782	.0462 .0431	.5675	.0572 .0495
16 (.5000)	.6497	.0438 .0412	.8010	.0485 .0454	.8900	.0520 .0489	.6497	.0588 .0504
18 (.6250)	.7198	.0496 .0466	.9221	.0468 .0438	1.0026	.0580 .0549	.7198	.0646 .0566

5. PACKAGING

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

6. NOTES

6.1 Intended use. Pins procured to this specification are intended for joining airframe structural elements which require high strength and high fatigue strength. The pin is inserted from one side of the assembly with a collar threaded into place from the other side. The assembly of the fastener is completed by utilizing an installation tool which has a hex wrench that engages the hex socket of the pin, thereby holding the pin stationary while applying torsional force to the collar per MIL-C-XXXXX. After the tension preload is attained (to the prescribed torque) the driving portion of the collar shears off, thus completing the installation of the fastener. The installed assembly shall meet the specified strength requirements.

6.2 Ordering data. Acquisition requirements shall specify the following:

a. Title, number, and date of this specification and the applicable specification sheet.
b. Applicable specification sheet part number (see 3.1).
c. Degree of protection in accordance with PPP-H-1581, ordering data (see 5.1).

6.3 Pins procured under this specification for military use are to be limited to the varieties delineated within this specifiction and on the applicable specification sheet. Personnel of the military departments are requested to refer to these documents for guidance.

6.4 Definitions. Throughout this specification when the words "pin" or "pins" appear, they will mean the following:

"pin" - pin-rivet, threaded.
"pins" - pins-rivet, threaded

6.5 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List (QPL No.) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is ASD/ENES, Wright-Patterson AFB, OH 45433 and information pertaining to qualification of products may be obtained from that activity.

6.6 Key word listing:

a. Pin
b. Hi Lok Pin
c. Rivet
d. Threaded Rivet

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

Review activities:
Army - GL
DLA - IS
NSA - NS

User Activities:

Preparing activity:
Air Force - 82

Agent:
DLA - IS

(Project 5320-0541

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL P 87988	PIN RIVET,THREADED WITH HEX SOCKET,GENERAL SPECIFICATION FOR

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ 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)*

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