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SUPERSEDING
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MILITARY SPECIFICATION

BOLTS, RECESS DRIVE, 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 describes requirements for aerospace bolts (see 6.3) of ultimate tensile stress 160-180 KSI and 180-200 KSI whose heads contain a recess for internal wrenching.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

Federal

PPP-H-1581	Hardware (Fasteners and Related Items), Packaging and Packing For Shipment and Storage of

Military

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-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-F-8961	Fasteners, Externally Threaded, 450°F and 1200°F, Self Locking Element for
MIL-I-17214	Indicator, Permeability, Low-Mu (Go-No-Go)
MIL-F-18240	Fasteners, Externally Threaded, 250°F, Self Locking Element for
MIL-H-81200	Heat Treatment of Titanium and Titanium Alloys

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ASD/ENESS, Wright-Patterson AFB, OH 45433 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 5305
FSC 5306

STANDARDS

Federal

FED-STD-H28 Screw Thread Standards for Federal Services
FED-STD-151 Metals, Test Methods

Military

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-1312 Fasteners, Test Methods

HANDBOOKS

Military

MIL-HDBK-5 Metallic Materials and Elements for Aerospace Vehicle Structures

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

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

AMERICAN NATIONAL STANDARDS INSTITUTE

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

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM E-112 Estimating Average Grain Size in Metals
ASTM E-120 Chemical Analysis of Titanium and Titanium Based Alloys, Methods For

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

NATIONAL AEROSPACE STANDARDS COMMITTEE

NAS526 Flushness Gage and Stylus for 100° Countersunk Flush Fasteners
NAS527 Inspection Procedure for Flush Fasteners
NAS1347 Identification of Fasteners

(See supplement 1 for list of additional associated National Aerospace Standards (NAS's) for detail parts.)

(Application for copies should be addressed to: National Standards Association, Inc., 4827 Rugby Av, Washington, DC 20014.)

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

3. REQUIREMENTS

3.1 Specification sheets and standards. The individual item requirements shall be as specified herein and in accordance with the applicable detail specifications, hereafter called part standards. In the event of any conflict between requirements of this specification and the part standard, the latter shall govern.

3.2 Material.

3.2.1 Composition. Chemical composition of the bolt material shall be in accordance with the material specification listed on the part standard. (See 4.3.1)

3.2.1.1 Hydrogen. (Applicable to titanium alloy bolts only.) Hydrogen content shall be not greater than .0125% (125 parts per million [ppm]). (See 4.2.2.1 and 4.3.1.1)

3.2.2 Metallurgical properties.

3.2.2.1 Discontinuities.

3.2.2.1.1 Cracks. There shall be no cracks in any location. A crack is defined as a clean, crystalline break passing through grain or grain boundary. (See 4.3.2)

3.2.2.1.2 Inclusions. Inclusions are only permitted in recess surfaces and nonbearing surfaces of the head to a depth not greater than .003 inch. Inclusions are particles of non-metallic impurities (such as oxides, sulphides, or silicates) which are in the metal during solidification. (See 4.3.3)

3.2.2.1.3 Surface irregularities. Laps, seams and similar surface irregularities are permitted as shown on figure 1 and listed in table I. Laps and seams are material discontinuities (folded metal) which do not cross grain boundaries. (See 4.3.2)

3.2.2.2 Microstructure.

3.2.2.2.1 Grain size. (Applicable to austenitic steels only.) The austenitic grain size, as defined in ASTM E-112, shall be predominantly number 5 or finer with grains as large as number 3 permissible. (See 4.3.3)

3.2.2.2.2 Grain flow. Grain flow in the threads shall be continuous and shall follow the general thread contour as illustrated on figure 2. The maximum density of flow lines shall be at the bottom of the thread root radius. Grain flow in the head shall be continuous as illustrated on figure 3 but may show minor interruption resulting from finish machining operation. Grain flow lines shall not terminate in the head to shank fillet. (See 4.3.3)

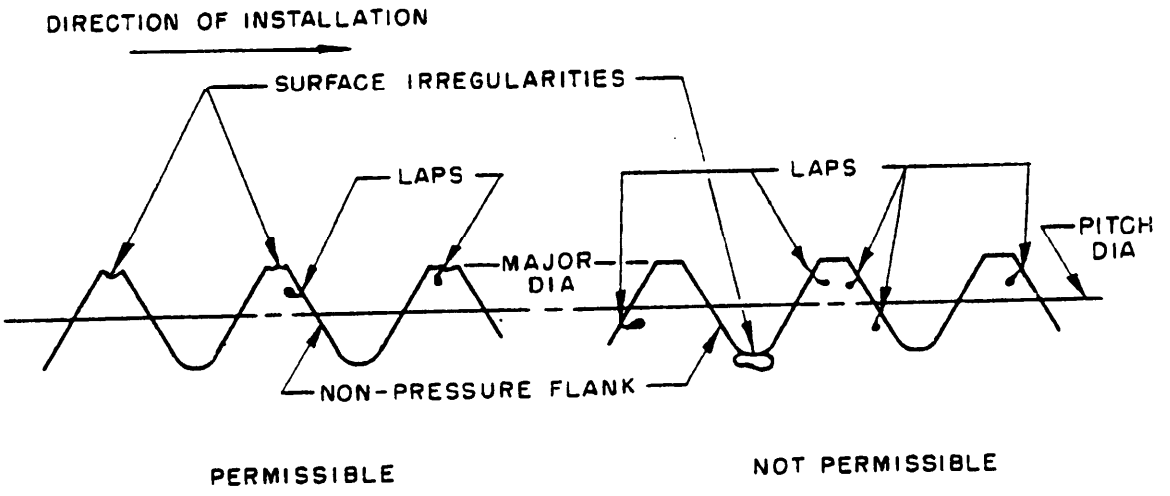


FIGURE 1. Discontinuities in thread area.

TABLE I. Permissible surface irregularities.

Location	Permissible irregularity	Maximum depth normal to the surface (inches)			
		Shank dia. ≤.312	.312<shank dia.≤.438	.438<shank dia≤.875	shank dia>.875
Head to shank fillet . . .	None	--	--	--	--
Thread					
Root . . .	None	--	--	--	--
Flank . .	1/	.005	.006	.008	.010
Crest . .	Laps, seams, and other irregularities	.005	.006	.008	.010
Head					
Bearing surface .	Seams	.005	.006	.008	.010
Nonbearing surface .	Folds, seams, or nicks	.010	.012	.016	.020
	Overheating 2/	.080	.080	.140	.140
Pan head .	Overheating 2/	.060	.060	.110	.110
100° head					
Shank . . .	Seams	.005	.006	.008	.010

1/ Laps, seams, and other surface irregularities are not permissible on the pressure flank, on the nonpressure flank below the pitch diameter, or on the nonpressure flank above the pitch diameter on two or more consecutive pitches. They are permissible on the nonpressure flank above the pitch diameter. (See figure 1)

2/ See 3.2.2.5.2

FIGURE 2. Grain flow in threads.

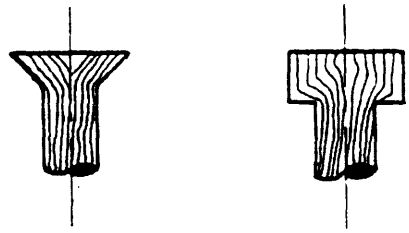


FIGURE 3. Grain flow in heads.

3.2.2.2.3 Defects. Microstructure shall be free from bursts or voids. Alloy segregation which does not adversely affect mechanical properties is acceptable. For titanium alloys, microstructure shall also be free from indications that it has been heated to a temperature above beta transus without subsequently receiving significant mechanical reduction within the alpha-beta temperature range. (See 4.3.3)

3.2.2.3 Carburization. (Applicable to alloy steel bolts only.) Only the nonload bearing surfaces of the head, the surfaces of the recess, and the chamfered end of the bolts (including the chamfered surface) may show signs of carburization, decarburization, or recarburization within the limits specified in MIL-H-6875. All other surfaces shall be free of these effects. Bolts are considered carburized, decarburized or recarburized if the difference in Vickers microhardness between the suspect area and the core of the bolt is greater than 45 points. (See 4.3.3 and 4.3.9.2)

3.2.2.4 Magnetic permeability. (Applicable only when listed on the part standard.) Magnetic permeability shall be less than 2.00 (Air = 1.00) for a field strength H = 200 Oersteds. (See 4.3.4)

3.2.2.5 Heat treatment. Heat treatment shall be in accordance with the following paragraphs or the part standard such that the mechanical properties of 3.2.3 are met.

3.2.2.5.1 Alloy and corrosion resistant steel. Heat treatment shall be in accordance with MIL-H-6875. Alloy steel bolts that are exempted from the requirements of 3.2.3.1 and 3.2.3.2 and the provisions of 4.2.1 shall have a Rockwell C-scale hardness of 36-40 for 160-180 KSI bolts or 39-43 for 180-200 KSI bolts. (See 4.3.9.1)

3.2.2.5.2 Titanium alloy. Heat treatment shall be in accordance with MIL-H-81200. Slight overheating of the head is permissible providing the greatest depth of overheating does not exceed the limits of table I when measured normal to the top surface of the head. Structure of 6Al-4V alloys which has outlines of equiaxial prior all beta grains and no primary alpha is considered overheated. (See 4.3.3)

3.2.3 Mechanical properties.

3.2.3.1 Tensile strength. (Not applicable to full thread bolts [see 6.3] with nominal length less than three times the nominal diameter, or bolts with grip length less than two times the nominal diameter.) Bolts shall have the minimum ultimate tensile strength in accordance with table II and the part standard. (See 3.2.2.5.1, 4.2.2.2, 4.3.5 and 4.3.9.1)

TABLE II. Tension and shear values.

Nominal Dia (inch)	Thread UNJF-3A	Minimum ultimate load (lbs)					
		160-180 KSI Bolts			180-200 KSI Bolts		
		Double Shear 1/	Tension		Double Shear 1/	Tension	
			Flush Tension and Pan Head 2/	Flush Reduced Head 3/		Flush Tension and Pan Head 2/	Flush Reduced Head 3/
0.190	.1900-32	5,400	3,180	2,000	6,120	3,600	2,130
0.250	.2500-28	9,330	5,820	3,700	10,600	6,500	3,930
0.312	.3125-24	14,600	9,200	5,000	16,500	10,400	5,670
0.375	.3750-24	21,000	14,000	7,200	23,800	15,800	8,130
0.438	.4375-20	28,600	18,900	9,000	32,400	21,300	10,500
0.500	.5000-20	37,300	25,600	13,500	42,400	28,700	15,000
0.562	.5625-18	47,200	32,400	17,000	53,600	36,500	18,800
0.625	.6250-18	58,300	41,000	21,000	66,200	46,000	23,300
0.750	.7500-16	83,900	59,500	30,700	95,400	63,200	33,800
0.875	.8750-14	114,000	81,500	42,000	130,000	86,300	
1.000	1.0000-12	149,000	106,000	55,000	170,000	112,000	
1.125	1.1250-12	189,000	137,000		214,000	144,000	
1.250	1.2500-12	233,000	171,000		266,000	180,000	

1/ Based on MIL-HDBK-5 shear stress areas.
2/ Based on FED-STD-H28 tensile stress areas.
3/ Based on head strength.

3.2.3.2 Shear strength. (Not applicable to full thread bolts.) Bolts shall have the minimum ultimate shear strength in accordance with table II and the part standard. (See 3.2.2.5.1, 4.2.2.2, 4.3.6 and 4.3.9.1)

3.2.3.3 Tensile fatigue life. (Not applicable to bolts with full threads, drilled heads, drilled shanks, or grip length less than three times the nominal shank diameter.) The bolt shall be capable of sustaining the high tensile fatigue load specified (percentage of the minimum ultimate tensile strength) on the part standard and the low tensile fatigue load of ten percent of the high load applied alternately for the average number of cycles specified below and a minimum of 45,000 cycles. The first sample lot is acceptable if the average

life is greater than 100,000 cycles; the lot is rejectable if the average life is less than 65,000 cycles. The combined first and second sample lot (required if the first sample lot is neither accepted nor rejected) is acceptable if the average life is greater than 80,000 cycles; the lot is rejectable if the average life is less than 65,000 cycles. The combined first, second, and third sample lot (required if the combined first and second sample lot is neither accepted nor rejected) is acceptable if the average life is greater than 65,000 cycles. (See 4.2.2.3 and 4.3.7)

3.2.3.4 Stress durability. (Applicable only when listed on the part standard.) Bolts shall sustain a load of 75 percent of the minimum ultimate tensile strength for a minimum of 23 hours. (See 4.3.8)

3.2.3.5 Recess strength. With a 20*0.5 pounds-force (lbf) axial load, the recess shall be capable of transmitting the torque loads specified in table III in both the installation and removal directions (one cycle) and then meeting the requirements of 3.3.1 and 3.3.1.2. (See 4.3.10)

3.3 Configuration. Bolt configuration shall be in accordance with the following paragraphs and the part standard. (See 4.3.11)

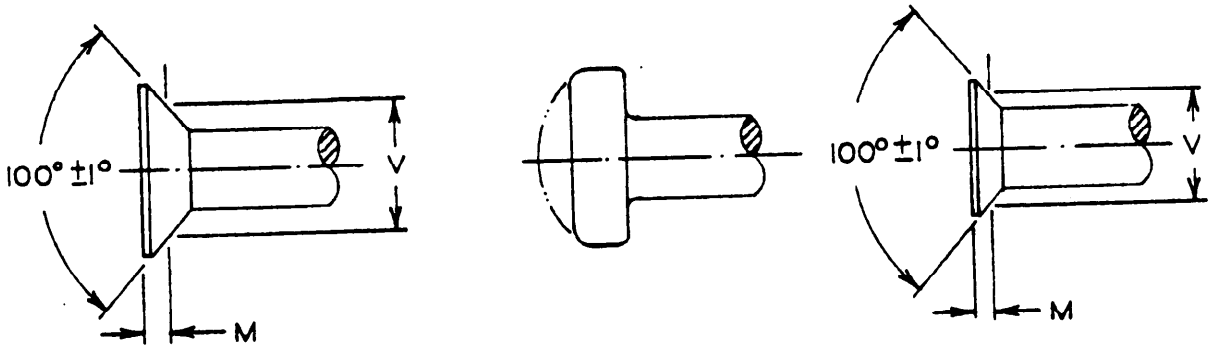
3.3.1 Head. The bolt head shall have form and dimensions in accordance with the part standard and as determined using table III. (See 4.3.11 and 4.3.11.1)

3.3.1.1 Forming. The bolt head shall be formed by forging. The recess may be forged or machined. (See 4.3.3)

3.3.1.2 Recess. Configuration of the recess shall be in accordance with the part standard. (See 4.3.11.2)

3.3.2 Fillet. Unless otherwise specified on the part standard, the juncture of the bolt head and the shank shall be cold worked by a rolling process after the completion of all machining, grinding and thermal treatments. The fillet may be distorted a maximum of .002 inch above or below the basic contour. This distortion, shown as the shaded areas A and B on figure 4, shall be within the limits given in table IV. A short tapered lead into the fillet area is permissible providing the dimensions are within the limits of table IV. Fillet radius shall be in accordance with the part standard. (See 4.3.3, 4.3.11, and 4.3.11.3)

TABLE III. Head, shank, and torque values.



Flush tension head Pan head Flush reduced head

Nominal Dia (inch)	100° Flush tension and pan head bolt				100° Flush reduced head bolt			
	M Gage protrusion (inch) 1/	V Gage Dia (inch) 1/	Shank straightness (inches per inch)	Recess minimum torque (lbf-in)	M Gage protrusion (inch)	V Gage Dia (inch)	Shank straightness (inches per inch)	Recess minimum torque (lbf-in)
0.190	.0300 .0275	.3147 .3145	.0030	50	.0220 .0195	.2441 .2439	.0030	35
0.250	.0360 .0330	.4245 .4243	.0030	125	.0255 .0225	.3315 .3313	.0030	50
0.312	.0410 .0375	.5389 .5387	.0030	250	.0295 .0260	.4047 .4045	.0030	125
0.375	.0460 .0420	.6532 .6530	.0025	430	.0320 .0285	.4854 .4852	.0025	250
0.438	.0465 .0425	.7784 .7782	.0025	925	.0415 .0375	.5697 .5695	.0025	430
0.500	.0535 .0490	.8902 .8900	.0020	1250	.0425 .0380	.6499 .6497	.0020	750
0.562	.0590 .0540	1.0028 1.0026	.0020	1650	.0490 .0440	.7200 .7198	.0020	1100
0.625	.0660 .0610	1.1124 1.1122	.0020	2400	.0515 .0460	.8011 .8009	.0020	1400
0.750	.0760 .0700	1.3440 1.3438	.0020		.0550 .0490	.9702 .9700	.0020	
0.875	.0855 .0785	1.5732 1.5730	.0020		.0890 .0820	1.1124 1.1122	.0020	
1.000	.0955 .0890	1.8026 1.8024	.0020		.0980 .0915	1.2896 1.2894	.0020	
1.125	.1600 .1515	1.9214 1.9212	.0020					
1.250	.1810 .1715	2.1286 2.1284	.0020					

1/ Not applicable to pan head bolts

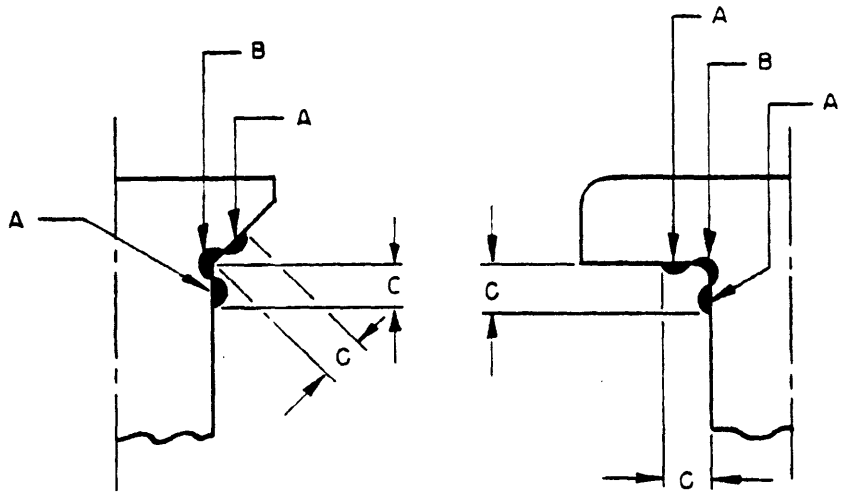


FIGURE 4. Distortion in head to shank fillet area.

TABLE IV. Limits of distortion due to fillet rolling.

Nominal shank diameter	C maximum (inches)	
	Pan and flush tension heads	Flush reduced heads
0.190 and 0.250	.062	.031
0.312 and 0.375	.094	.047
0.438 thru 0.625	.125	.062
0.750 thru 1.000	.156	.078
1.125 and 1.250	.188	---

3.3.3 Shank.

3.3.3.1 Shank diameter. The shank diameter for bolts without oversize shanks shall be in accordance with the part standard. For first oversize, shank diameter shall be .0156 inch greater than the standard value (including tolerance). For second oversize, shank diameter shall be .0312 inch greater than the standard value (including tolerance). (See 4.3.11)

3.3.3.2 Straightness. The straightness of the bolt shank shall be within the limits of table III or the part standard. (See 4.3.11.4)

3.3.3.3 Concentricity. The thread pitch diameter shall be concentric with the shank within .005 inch Full Indicator Movement (FIM). The conical surface of the flush head shall be concentric with the shank within .003 inch FIM. The outside diameter of the flat pan head shall be concentric with the shank within .008 inch FIM. The driving recess shall be concentric with the shank within .016 inch FIM. (See 4.3.11.5)

3.3.3.4 Grip length. Grip length shall be in accordance with the part standard. Grip length shall be measured as shown on figures 5 and 6, i.e., from the end of the full cylindrical portion of the shank to (a) the bearing surface of the head for pan head bolts or (b) to the top of the head for flush head bolts. (See 4.3.11)

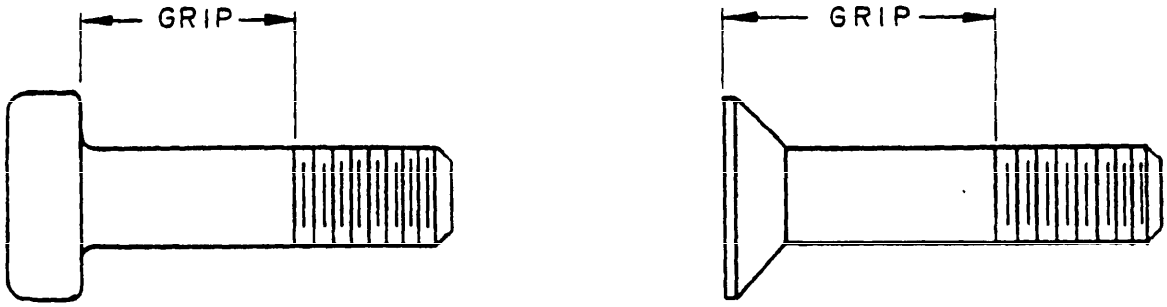


FIGURE 5. Grip length.

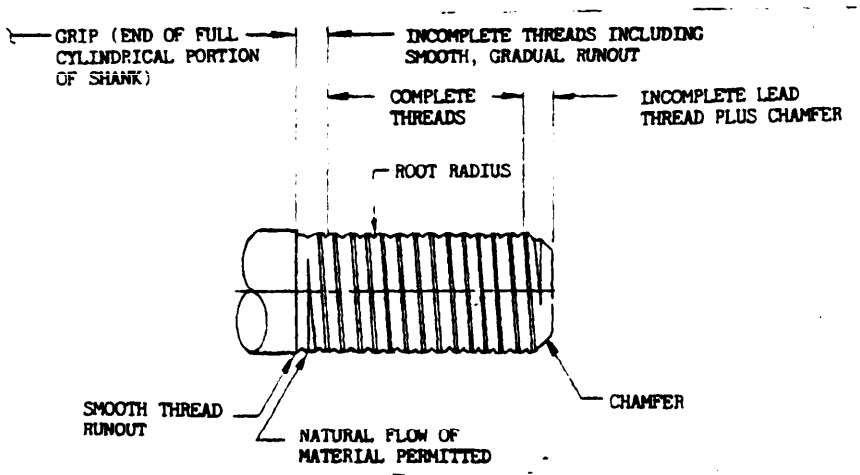


FIGURE 6. Incomplete threads.

3.3.4 Threads. Thread form and dimensions shall be in accordance with MIL-S-8879, UNJF series and the part standard. (See 4.3.11.6)

3.3.4.1 Forming. Threads shall be fully formed after final heat treatment by a rolling process or as noted in the part standard. (See 4.3.3 and 4.3.11.6)

3.3.4.2 Incomplete threads. Thread lead and runout shall be in accordance with MIL-S-8879. Incomplete thread pitches are permissible at the chamfered end of the bolt and at the juncture of the unthreaded portion of the shank as shown on figure 6. The incomplete lead thread shall be not less than one-half pitch wide and the incomplete lead thread plus chamfer shall be not more than two pitches wide. The incomplete thread next to the shank shall include a thread runout not less than one pitch wide nor more than: (a) two pitches wide for standard shank; (b) two pitches plus 0.0167 inch wide for first oversize; or (c) two pitches plus 0.0334 inch wide for second oversize. For other than full thread bolts, the runout shall terminate not less than one-quarter pitch from the grip dimension. For full thread bolts, the runout shall terminate at the end of the full cylindrical portion of the shank, but not extend into the fillet. Thread runout shall blend smoothly into the shank diameter so as to eliminate any abrupt change in cross-sectional area. [Note: Figure 6 shows a standard shank.] (See 4.3.11 and 4.3.11.6)

3.3.4.3 Thread length. Thread length shall be in accordance with the part standard. (See 4.3.11)

3.3.5 Self locking element. When self locking element is required, it shall be in accordance with MIL-F-18240 or MIL-F-8961 and the part standard. (See 4.3.12)

3.4 Finish.

3.4.1 Surface texture. Surface texture of the bearing surface of the head, head to shank fillet radius, shank, and threads shall be not greater than 32 Roughness Height Rating (RHR). Surface texture of all other surfaces shall be not greater than 125 RHR. (See 4.3.13)

3.4.2 Surface treatment. Surface treatment shall be in accordance with the part standard. (See 4.3.14)

3.5 Marking. Bolt identification shall be in accordance with NAS1347 type IV or the part standard. (See 4.3.11)

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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 prescribed requirements.

4.2 Quality conformance inspection. Quality conformance inspections shall be as specified in table V to verify that the requirements of Section 3 are met.

4.2.1 Inspection lot. Inspection lot shall consist of parts of the same diameter, head and recess styles, fabricated from the same mill heat of material, heat treated and finished in one continuous run, and submitted for inspection at the same time. Each inspection lot shall be identified by a control number. For the purpose of reducing the number of samples used for destructive tests, it will be permissible to consider two or more sub-lots of bolts of the same diameter and head style (but different length) and made from the same heat of material as one lot. In such cases, the number of specimens for destructive test shall be based on the combined totals of the sub-lots. Test specimens shall be selected from each sub-lot on a proportional basis and each sub-lot shall be represented by at least one part except where parts are too short for mechanical tests, then these tests shall apply to sub-lots of longer parts.

TABLE V. Quality conformance inspection.

Inspection	Requirements paragraph	Test method paragraph
Composition	3.2.1	4.3.1
Hydrogen	3.2.1.1	4.3.1.1
Discontinuities	3.2.2.1.1, 3.2.2.1.3	4.3.2
Macro and Micro examinations	3.2.2.1.2, 3.2.2.2.1, 3.2.2.2.2, 3.2.2.2.3, 3.2.2.3 3.3.1.1, 3.3.2, 3.3.4.1	4.3.3, 4.3.9.2
Magnetic permeability	3.2.2.4	4.3.4
Heat treatment	3.2.2.5	4.3.3, 4.3.9.1
Tensile strength	3.2.3.1	4.3.5, 4.3.9.1
Shear strength	3.2.3.2	4.3.6, 4.3.9.1
Tensile fatigue life	3.2.3.3	4.3.7
Stress durability	3.2.3.4	4.3.8
Recess strength	3.2.3.5	4.3.10
Configuration	3.3, 3.3.1, 3.3.2, 3.3.3.1, 3.3.3.4, 3.3.4.2, 3.3.4.3, 3.5	4.3.11
Head height	3.3.1	4.3.11.1
Recess dimensions	3.3.1.2	4.3.11.2
Fillet	3.3.2	4.3.11.3
Shank straightness	3.3.3.2	4.3.11.4
Concentricity	3.3.3.3	4.3.11.5
Head to shank	3.3.3.3	4.3.11.5.1
Thread to shank	3.3.3.3	4.3.11.5.2
Drive recess to shank	3.3.3.3	4.3.11.5.3
Thread examinations	3.3.4, 3.3.4.1, 3.3.4.2	4.3.11.6
Self locking element	3.3.5	4.3.12
Surface texture	3.4.1	4.3.13
Surface treatment	3.4.2	4.3.14

4.2.2 Sampling. Sampling shall be in accordance with MIL-STD-105 except for hydrogen, tensile, shear, and fatigue testing. Samples for inspection shall be selected at random except as noted under table VI. The same sample may be used for inspection of configuration, thread dimensions, surface texture, and marking. If this sample passes these inspections, the sample for destructive tests may be selected at random from this group. The sample used for tensile test may also be used for shear test, provided there is at least three diameters of undamaged and unthreaded shank available for the shear test. A separate sample is necessary for metallurgical examination.

TABLE VI. Sampling plan.

Test method paragraph	Level	AQL
4.3.2, 4.3.11.3, 4.3.11.6	II	0.65
4.3.11.4, 4.3.11.5	II	1.0
All other except 4.3.1.1, 4.3.5, 4.3.6, 4.3.7	S-2	2.5

Note: Any sample showing indications of cracks or surface irregularities when tested in accordance with 4.3.2 shall also be microexamined to confirm the presence of those defects. Any sample showing indications of carburization, decarburization, or recarburization when examined in accordance with 4.3.3 shall also have a microhardness test to confirm the presence of those defects.

4.2.2.1 Sampling for hydrogen. Sampling shall be one bolt per lot selected at random. If the hydrogen content is greater than specified, two additional bolts per lot shall be tested.

4.2.2.2 Variable sampling for tensile and shear tests. Sample size for first and second sample shall be as listed in table VII. A second sample is required when the lot is neither accepted nor rejected on the first sample; that is, $X_1 - K_a S_1 < M$ and $X_1 - K_r S_1 \geq M$. (See 3.2.3.1, 3.2.3.2 and 6.3)

TABLE VII. Variable sampling for tensile and shear and associated K values.

Lot size	N_1	K_a	K_r	Second sample size	N_t	K_t
Less than 201	5	2.21	0.89	10	15	1.74
201 thru 500	6	2.22	0.94	12	18	1.70
501 thru 1300	7	2.32	1.10	14	21	1.78
1301 thru 3200	8	2.48	0.99	16	24	1.81
3201 thru 8000	10	2.34	1.31	20	30	1.80
Greater than 8000	15	2.20	1.42	30	45	1.83

4.2.2.3 Attribute sampling for fatigue tests. Sample size for first, second, and third samples shall be as listed in table VIII. A second sample is required if the lot is not accepted or rejected on testing of first sample, and a third sample is required if the lot is not accepted or rejected on the combined first and second sample. (See 3.2.3.3)

TABLE VIII. Attribute sampling for fatigue test.

Lot size	Sample no.	Sample size	Total
Less than 301	First	3	3
	Second	2	5
	Third	5	10
301 thru 500	First	4	4
	Second	3	7
	Third	7	14
501 thru 1300	First	5	5
	Second	4	9
	Third	9	18
1301 thru 3200	First	6	6
	Second	5	11
	Third	11	22
3201 thru 8000	First	7	7
	Second	5	12
	Third	12	24
Greater than 8000	First	8	8
	Second	6	14
	Third	14	28

4.2.3 Report of tests. The manufacturer shall maintain a record of the results of all tests required by this specification. The record shall be available to the procuring activity and to government inspectors in the performance of their duty. Unless otherwise specified, these records shall be maintained for seven years.

4.3 Methods of examination and test.

4.3.1 Composition. Samples shall be tested for chemical composition in accordance with FED-STD-151 Method 112.1, Spectrochemical Analysis. If results of test are doubtful, FED-STD-151 Method 111.1, Chemical Analysis, shall be used. A certification of compliance, including mill test report, may be accepted in lieu of this test as evidence that the material complies with its specification requirements.

4.3.1.1 Hydrogen. Samples shall have lubricant, if any, removed. Material sufficient for analysis shall be removed from the fillet. Analysis shall be by the vacuum fusion method in accordance with ASTM E-120. Equipment shall be capable of analyzing hydrogen to .0010% (10 ppm). Reject the lot if one or more bolts of the second sample has hydrogen content greater than specified. (See 3.2.1.1)

4.3.2 Discontinuities. Samples shall be examined using magnetic particle inspection in accordance with MIL-I-6868 or fluorescent penetrant inspection in accordance with MIL-I-6866 as appropriate. Magnetic or penetrant indications of themselves shall not be cause for rejection. Samples showing indications of discontinuities shall be microscopically examined (see 4.3.3).

4.3.3 Macro and micro examination. Samples other than those to be examined for cracks or surface irregularities shall be sectioned as shown on figure 7. The sections shall be etched with an etchant appropriate to the material and the examination to be performed. Specimens shall be examined at a magnification not less than the values in table IX.

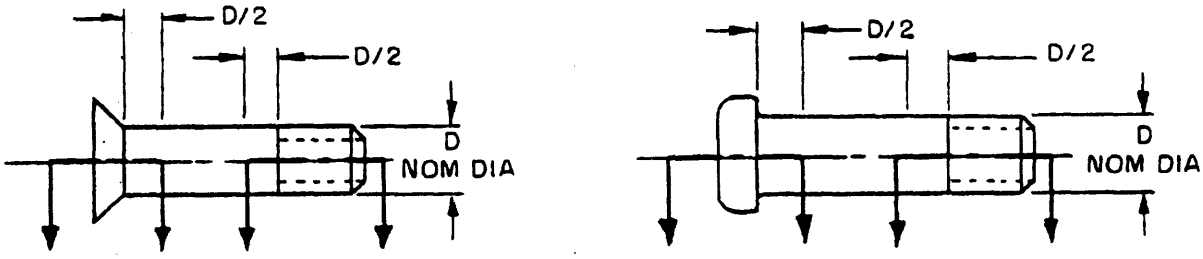


FIGURE 7. Sectioning of samples.

TABLE IX. Magnification for macro and micro examination.

Property	Magnification
Cracks (See 4.3.2)	6X
Surface irregularities (See 4.3.2)	6X
Inclusions	6X
Grain flow in head	6X
Microstructural defects	25X
Fillet	25X
Carburization, decarburization, and recarburization (See 4.3.9.2)	50X
Overheating (See 3.2.2.5.2)	50X
Grain size and type	50X
Grain flow in thread	50X

4.3.4 Magnetic permeability. Magnetic permeability shall be tested using indicator meeting the requirements of MIL-I-17214.

4.3.5 Tensile strength. Ultimate tensile strength shall be tested in accordance with MIL-STD-1312 Test 8, Tensile Strength. When specified by the procuring activity, MIL-STD-1312 Test 18, Elevated Temperature Tensile Strength, shall also be performed.

4.3.6 Shear strength. Ultimate shear strength shall be tested in accordance with MIL-STD-1312 Test 13, Double Shear. When grip length is too short for Test 13, use either MIL-STD-1312 Test 20, Single Shear, on the bolt or Test 13 on a specimen of the bolt material processed with the production lot.

4.3.7 Fatigue life. Tension fatigue life shall be tested in accordance with MIL-STD-1312 Test 11, Tension Fatigue. If the item does not fail by 130,000 cycles, the value used for the average shall be 130,000 cycles.

4.3.8 Stress durability. Stress durability shall be tested in accordance with MIL-STD-1312 Test 5, Stress Durability, for a minimum of 23 hours. Samples completing Test 5 shall be examined using magnetic particle inspection per MIL-I-6868 or fluorescent penetrant inspection per MIL-I-6866 as appropriate.

4.3.9 Hardness. Samples requiring a hardness test shall be prepared in accordance with MIL-STD-1312 Test 6, Hardness.

4.3.9.1 Macrohardness. A hardness test in accordance with MIL-STD-1312 Test 6 shall be performed. Bolts are rejectable if the hardness reading is not within the range specified in 3.2.2.5 or on the part standard.

4.3.9.2 Microhardness. If the sample shows indications of carburization, decarburization, or recarburization, a microhardness test in accordance with MIL-STD-1312 Test 6 shall be performed. Reading shall be taken in three locations in the suspect area and three locations in the center of the bolt. Bolts are rejectable if the difference in Vickers microhardness is greater than specified in 3.2.2.3.

4.3.10 Recess strength. The recess shall be torque tested in both installation and removal directions using a driver bit meeting the requirements of the applicable driver bit specification. Axial end load shall be not less than 19.5 lbf and not greater than 20.5 lbf. Axis of the driver shall be aligned within 3° of the centerline of the bolt.

4.3.11 Configuration. Visual and dimensional examinations shall be performed by the inspector using conventional measuring equipment (micrometer, calipers, etc.) and additional equipment as specified in the following paragraphs.

4.3.11.1 Head height examination. (Applicable to 100° flush head bolts only.) Height of the 100° flush head shall be examined in accordance with NAS527 using the gage specified in NAS526 and the gage hole diameters listed in table III.

4.3.11.2 Recess dimensions. The recess configuration shall be measured to determine acceptability in accordance with 3.3.1.2. A gage applicable to the recess style shall be used to measure those recess dimensions for which the gage was designed.

4.3.11.3 Fillet. The distortion due to fillet rolling shall be measured using an optical comparator with a magnification not less than 25X.

4.3.11.4 Shank straightness. Support each end of the shank in V blocks (maximum width of each block 0.250 inch). Rotate the shank and measure the point of greatest deviation with a dial indicator graduated in 0.001 of an inch.

4.3.11.5 Concentricity.

4.3.11.5.1 Head to shank. Support the shank in a V block or flat element tri-roll gage. The head to shank juncture shall be 1.0 to 1.5 times the shank diameter from the face of the block or rolls. Using a dial indicator touching the midsection of the conical surface of the 100° flush head or the periphery of the pan head, rotate the shank.

4.3.11.5.2 Thread to shank. Support the thread on a tri-roll screw thread comparator with funtional gaging elements ("Go" profile). Using a dial indicator touching the shank 1.0 to 1.5 times the shank diameter from the thread, rotate the thread. For bolts with grip length less than the shank diameter, center the indicator on the unthreaded portion of the shank.

4.3.11.5.3 Drive recess to shank. Support the shank in a V block. Using a dial indicator touching the bottom of the recess, rotate the shank.

4.3.11.6 Thread examinations. Threads shall be examined in accordance with MIL-S-8879 Method B.

4.3.12 Self locking element. Sample shall be tested in accordance with MIL-F-18240 or MIL-F-8961 as applicable.

4.3.13 Surface texture. Surface texture shall be tested in accordance with ANSI B46.1 by visual or fingernail comparison with standard surface texture specimens. If results are doubtful, a profilometer shall be used if surface is accessible.

4.3.14 Surface treatment. Thickness of the surface treatment of plated or coated bolts shall be determined in accordance with MIL-STD-1312 Test 12, Thickness of Metallic Coatings. When specified by the procurring activity, MIL-STD-1312 Test 1, Salt Spray, shall also be performed.

5. PACKAGING

5.1 Requirements. The items shall be packaged, packed, and marked Level A, B, or C as specified (see 6.2) in accordance with PPP-H-1581.

6. NOTES

6.1 Intended use. The bolts are intended for the assembly, repair, and maintenance of the structure of weapon systems (including aircraft and missiles) and supporting equipment.

6.2 Ordering data. Procurement documents shall specify:

a. Title, number and date of this specification

b. Part number of the bolt desired (see part standard)

c. Quantity

d. Applicable levels of packing (see 5.1)

e. Additional tests required (see 4.3.5 and 4.3.14)

f. Government inspection and acceptance at the source of manufacture for direct government procurements.

g. Inspection and acceptance at the source of manufacture or at the receiving point for nongovernment procured items intended for government applications.

6.3 Definitions.

6.3.1 Bolt. A headed, externally threaded fastener for installation into an internally threaded mating part used to clamp two or more pieces together. This includes items of Federal Supply Classifications (FSCs) 5305 and 5306.

6.3.2 Full thread. Thread extends to head-to-shank fillet. Also known as "threaded to the head" and "fully threaded".

6.3.3 Part standard. A military, industry, or aerospace company specification control drawing of a fastener approved for use in equipment for the Department of Defense.

6.3.4 Recess. An internal wrenching element, usually manufactured in the heads of bolts and screws, through which torque is applied by use of a driver.

6.3.5 N_1 Number of items in first sample lot

6.3.6 N_t Number of items in combined (i.e., first and second) sample lot

6.3.7 K_a Coefficient of S_1 used to determine acceptance of the first sample lot

6.3.8 K_r Coefficient of S_1 used to determine if second sample is required

6.3.9 K_t Coefficient of S_t used to determine acceptance of the combined sample lot

6.3.10 M Minimum ultimate tensile strength or minimum ultimate shear strength in accordance with table II

6.3.11 $\bar{X}_1$ Average of individual tensile or shear strength values of the first sample lot

6.3.12 $\bar{X}_t$ Average of individual tensile or shear stength values of the combined sample lot

6.3.13 ΣX_1^2 Sum of the squares of the individual tensile or shear strength values of the first sample lot

6.3.14 ΣX_t^2 Sum of the squares of the individual tensile or shear strength values of the combined sample lot

6.3.15 $(\Sigma X_1)^2$ Square of the sum of individual tensile or shear strength values of the first sample lot

6.3.16 $(\Sigma X_t)^2$ Square of the sum of individual tensile or shear strength values of the combined sample lot

6.3.17 S_1 $$S_1 = \sqrt{\frac{N_1 \Sigma X_1^2 - (\Sigma X_1)^2}{N_1(N_1-1)}}$$

6.3.18 S_t $$S_t = \sqrt{\frac{N_t \Sigma X_t^2 - (\Sigma X_t)^2}{N_t(N_t-1)}}$$

6.4 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

6.5 International agreements. Certain provisions (3.3.1.2, 3.3.4, and table III) of this specification are the subject of international standardization agreements (STANAG 3394, ASCC AIR STD 17/24, ASCC AIR STD 17/30, and ASCC AIR STD 17/40). When amendment, revision, or cancellation of this specification is proposed which will violate the international agreements concerned, the preparing activity will take appropriate reconcilliation action through international standardization channels, including departmental standardization offices, if required.

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