

INCH-POUND

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25 April 1994
SUPERSEDING
MIL-B-6812D
20 February 1986

MILITARY SPECIFICATION

BOLTS, AIRCRAFT

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

1. SCOPE

1.1 Scope. This specification covers bolts used in the manufacture of aircraft and aircraft accessories.

1.2 Classification. The bolts covered by this specification shall be of the types and sizes designated (see 6.2).

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

QQ-A-200 Aluminum Alloy Bar, Rod, Shapes, Structural Shapes, Tube and Wire, Extruded, General Specification for.

Beneficial comments (recommendations, addition, deletions) and pertinent data which may be of use in improving this document should be addressed to: Defense Industrial Supply Center (Code DISC-EPP) 700 Robbins Avenue, Philadelphia, PA 19111-5096 by using the self addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 5306

AMSC N/A

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

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SPECIFICATIONS

FEDERAL (continued)

QQ-A-225	Aluminum and Aluminum Alloy Bar, Rod, Wire, or Special Shapes, Rolled, Drawn, or Cold Finished, General Specification for.
QQ-A-430	Aluminum Alloy Rod and Wire, for Rivets and Cold Heading.
QQ-P-416	Plating, Cadmium (Electrodeposited).
PPP-H-1581	Hardware (Fasteners and Related Items) Packaging of.

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MIL-C-5541	Chemical Conversion Coatings on Aluminum Alloys
MIL-S-5626	Steel, Chrome-Molybdenum (4140) Bars, Rods, and Forging Stock (for Aircraft Application).
MIL-S-6049	Steel, Chrome-Nickel-Molybdenum (8740) Bars, Rods, and Forging Stock (for Aircraft Applications).
MIL-S-6050	Steel, Chrome-Nickel-Molybdenum (8630) Bars, Rods, and Forging Stock (for Aircraft Applications).
MIL-H-6088	Heat Treatment of Aluminum Alloys.
MIL-S-6098	Steel, Chrome Nickel-Molybdenum (8735) Bars, and Reforging Stock (Aircraft Quality).
MIL-S-6758	Steel, Chrome-Molybdenum (4130) Bars, and Reforging Stock (Aircraft Quality).
MIL-H-6875	Heat Treatment of Steels, Process for.
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series, General Specification for.
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter General Specification for.
MIL-S-18732	Steel Bars, Billets, Forgings, Tubing, (431) Special Quality.

STANDARDS

MILITARY

	MIL-STD-105	Sampling Procedures and Tables for.
	MIL-STD-129	Marking for Shipment and Storage.
	MIL-STD-147	Palletized Unit Load.
	MIL-STD-410	Nondestruction Testing Personnel Qualification and Certification (Eddy Current, Liquid Penetrant, Magnetic Particle, Radiographic and Ultrasonic)
*	MIL-STD-970	Standards and Specifications, Order of Preference for the Selection of.
*	MIL-STD-2073-1	DoD Material Procedures for Development and Application of Packaging Requirements

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STANDARDS

MILITARY (continued)

*	MIL-STD-1312/6	Fastener Test Methods, Method 6, Hardness
*	MIL-STD-1312/8	Fastener Test Methods, Method 8, Tensile Strength
*	MIL-STD-1312/9	Fastener Test Methods, Method 9, Stress Corrosion
*	MIL-STD-1312/13	Fastener Test Methods, Double Shear Test
	MIL-STD-6866	Inspection, Penetrant Method of.
	MIL-STD-45662	Calibration System Requirements.
	AN3 thru AN20	Bolt - Machine, Aircraft.
	AN21 thru AN37	Bolt and Clevis.
	AN42 thru AN49	Bolt, Eye.
	AN173 thru AN186	Bolt and Machine, Close Tolerance, Aircraft.
	AN315	Nut, Plain, Airframe.
	MS20073	Bolt, Machine, Aircraft, Drilled Head, Fine Thread.
	MS20074	Bolt, Machine, Aircraft, Drilled Head, Coarse Thread.
	MS21083	Nut, Self-Locking, Hexagon, Non-Metallic Insert, Low Height, 250 degrees F.

(Copies of specifications, standards, and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following document forms 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 nongovernment documents which is current on the date of the solicitation.

SOCIETY OF AUTOMOTIVE ENGINEERS AEROSPACE MATERIAL SPECIFICATION

AMS6300 Steel, .25 Mo (.35-.40C)

(Copies of SAE publications may be obtained from the Society of Automotive Engineers, Inc. 400 Commonwealth Drive, Warrendale, PA 15096.)

SOCIETY OF AUTOMOTIVE ENGINEERS

- * AS3062 Bolts, Screws and Studs, Screw Thread Requirements

(Copies of SAE publications may be obtained from the Society of Automotive Engineers, Inc. 400 Commonwealth Drive, Warrendale, PA 15096.)

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- * ASTM-D3951 Packing, Commercial
- * ASTM D3953 Steel Flat and Seals Strapping.
- * ASTM E1444 Magnetic Particle Examination, Standard Practice For.

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, (except for associated detail specifications, specification sheets or MS standards) the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Material.

3.1.1 Non-corrosion-resistant steel. Non-corrosion-resistant steel bolts shall be manufactured from steel conforming to MIL-S-5626, MIL-S-6049, MIL-S-6050, MIL-S-6098, MIL-S-6758, or AMS 6300 (see 6.1.1).

3.1.2 Corrosion-resistant steel. Corrosion-resistant steel bolts shall be manufactured from material conforming to MIL-S-18732.

3.1.3 Aluminum alloy. Aluminum alloy bolts shall be manufactured from material conforming to QQ-A-225, or QQ-A-430.

3.1.4 Selection of materials. Specifications and standards for all materials, parts, and Government certification and approval of processes and equipment, which are not specifically designated herein and which are necessary for the execution of this specification, shall be selected in accordance with MIL-STD-970.

3.2 Heat treatment. Heat treatment of steel shall be in accordance with MIL-H-6875. Heat treatment of aluminum alloy shall be in accordance with MIL-H-6088.

3.2.1 Material conforming to MIL-S-18732 shall not be tempered in the range of 700 degrees to 1,000 degrees Fahrenheit (F).

3.3 Heads.

3.3.1 Bearing surface. The bearing surface of bolt heads shall be at right angles to the shank within 2 degrees for bolts 1/2 inch in diameter and less, and within 1 degree for bolts larger than 1/2 inch in diameter.

3.3.2 Eccentricity of head to shank. Eccentricity of head to shank shall be within a tolerance of 3 percent of the width across flats, or 3 percent of the diameter of the head in the case of clevis and eye bolts.

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3.3.3 Top surface. The top surface of hexagon head bolts shall be flat and chamfered with the diameter of the top flat circle from 85 to 100 percent of the width across flats.

3.3.4 Depth of slots. The depth of slots in the heads of clevis bolts is measured from the highest part of the head to the intersection of the bottom of the slot with the head surface.

3.4 Straightness of shank. The straightness of shank shall be within the values specified in Table I when the bolt is rolled on a surface plate and the point of greatest deviation is measured with a feeler gage of 1/4 inch width.

TABLE I. Straightness of Shank.

Bolt size	Deviation of bolt shank from plates, max (inches per inch of bolt length)
No. 10 and smaller	.0040
1/4, 5/16	.0030
3/8, 7/16	.0025
1/2 and larger	.0020

3.5 Physical properties.

3.5.1 Tensile strength. The tensile strength of hexagon head, eye, and clevis bolts shall be as specified in Table II when tested in accordance with 4.5.2.

3.5.2 Shear strength. The shear strength of all bolt types shall be as specified in Table II when tested in accordance with 4.5.3.

3.5.3 Bend. Bolts shall withstand cold bending when tested in accordance with 4.5.4.

* 3.5.4 Hardness. Unless other wise specified, all corrosion and noncorrosion-resistant steel bolts shall be within the hardness range C-26 to C-32 HRC when tested in accordance with 4.5.5.

3.6 Decarburization. Decarburization of noncorrosion-resistant steel bolts shall not exceed the limits shown in Table III, when tested in accordance with 4.5.6.

3.7 Head structure. A section of the head shall show no detrimental defects when inspected in accordance with 4.5.7.

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

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TABLE II. Strength Requirements.

	Ultimate tensile strength (min) <u>1/</u> (pounds)				Double shear strength (min) <u>2/</u> (pounds)	
*		Hexagon head bolts			All types of bolts	
		Steel		Al Alloy <u>3/</u> fine thread	Steel	Al Alloy
Size	Eyebolt s steel	Fine <u>3/</u> thread	Coarse <u>3/</u> thread			
No. 6	-	-	-		2,120	1,080
No. 8	-	-	-	-	3,000	1,570
No. 10	1,150	2,210	1,800	-	4,250	2,092
1/4	2,450	4,080	3,360	1,100	7,360	3,650
5/16	3,910 (AN44)	6,500	5,660	2,030	11,500	5,700
5/16 <u>4/</u>	5,290 (AN45)	6,500	5,660	3,220	11,500	5,700
3/8	7,015	10,100	8,470	3,220	16,560	8,250
7/16	9,200	13,600	11,680	5,020	22,500	11,200
1/2	14,375	18,500	15,730	6,750	29,400	14,600
9/16	20,125	23,600	20,300	9,180	37,400	18,500
5/8	-	30,100	25,100	11,700	46,000	22,800
3/4	-	44,000	37,800	14,900	66,300	33,000
7/8	-	60,000	-	21,800	90,100	45,000
1	-	80,700	-	29,800	117,800	58,500
1-1/8	-	101,800	-	40,000	147,500	74,000
1-1/4	-	130,200	-	50,500	182,100	91,000
				64,400		

1/ The values shown for the ultimate tensile strength are for minimum values and are based on:

- a. 125,000 psi for noncorrosion-resistant and corrosion-resistant steel.
- b. 62,000 psi for aluminum alloy.

The strength values shown for the eyebolts are based on the strength of the eye. The root area of the thread is the basis of calculation for the tensile strength of hexagon head bolts.

Clevis bolts shall have tensile strengths equal to one-half of the requirements for hexagon-head bolts when used with AN320 or MS21083 nuts. Clevis bolts are intended primarily for use in shear applications.

2/ Ultimate shear strengths are computed on the basis of 60 percent of the ultimate tensile strengths.

3/ Class of thread is as specified on the applicable standard drawing.

4/ Different from size 5/16 above in the design of the eye section.

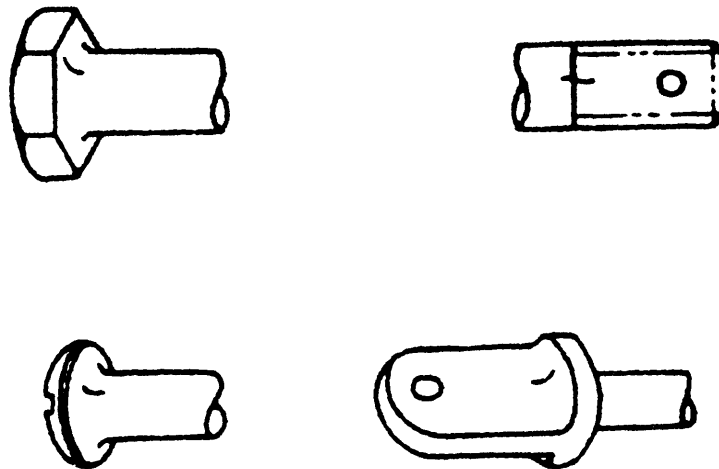
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TABLE III. Decarburization Limits.

	Complete decarburization (inches)	Complete plus partial decarburization (inches) ^{1/}
Up to 3/8 incl	.004	.010
Over 3/8 to 1/2 incl	.005	.012
Over 1/2 to 5/8 incl	.006	.014
Over 5/8 to 3/4 incl	.006	.017

^{1/} The permissible values shown are based on measurements of the entire periphery of the cross section and the average depth determined. The decarburization limits apply to the shank.

3.9 Seams. Bolts may possess seams, except in the locations noted herein-after, which do not exceed the tolerances in Table IV. Seams extending through fillets or threads as shown in Figure 1 that exceed the limits shown in Table IV shall not be acceptable. Seams up to the depth indicated which have been rolled beneath the root of the threads shall not be cause for rejection.

FIGURE 1. Seams extending through fillets or threads.

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TABLE IV. Limits for Seam Depth.

Bolt size (inches)	5/16 and under	3/8	7/16	1/2 through 1-1/4
Depth in shank (inches)	.005	.006	.007	0.008

* 3.10 Inclusions. Bolts shall show no evidence of surface or subsurface inclusions at the thread root or head to shank fillet, when examined in accordance with 4.5.8 or 4.5.9 as applicable. Small inclusions on other parts of the bolt which are not indicative of unsatisfactory quality shall not be cause for rejection.

3.11 Defects on bolt heads. Bolt heads shall not possess more than three openings such as are described in 3.11.1.

3.11.1 Seams, inclusions, nicks, or gouges. Bolt heads shall not possess seams, inclusions, nicks or gouges on the following:

- a. On the top of the bolt head exceeding twice the depth limits shown in Table IV, or
- b. On the periphery of the bolt head exceeding twice the depth limits shown in Table IV for hexagon-head bolts or four times the depth limits shown in Table IV for bolts with other than hexagon heads.

3.11.2 Defects on washer faces. Washer faces shall not possess seams exceeding the limits shown in Table IV. Bolts shall not possess mutilation of the washer face sufficient to prevent firm seating.

3.12 Bolt head shank junction. Only longitudinal seams of the depths permitted in Table IV shall be permitted. Slight longitudinal or transverse tool marks or undercuts of depth not to exceed the limits in Table V will be permitted, provided they fair into the shank with no sharp scratches, gouges, or corners.

TABLE V. Limits for Depth of Tool Marks or Undercuts.

Bolt size (inches)	Depth of tool marks or undercuts (inches, max)
Up to 3/8 incl.	.003
Over 3/8 to 5/8 incl.	.004
Over 5/8 to 7/8 incl.	.005
Over 7/8	.006

* 3.13 Threads. Unless specified otherwise, threads of all bolts shall conform to MIL-S-8879, and shall be of the sizes specified on the applicable standard. Unless specified otherwise, threads shall be right-hand. Threads shall be formed by rolling. Thread runout shall be in accordance with AS3062.

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3.13.1 Length of thread. The length of the thread shall be the shank length minus the grip length, as specified on the applicable standard drawings. The grip length of bolts shall be measured from the underside of the head to the end of the full cylindrical portion of the shank.

* 3.14 Dimensions. After plating and finishing, the dimensions shall conform to those specified in the following standards: AN3 thru AN20, AN21 thru AN37, AN42 thru AN49, AN173 thru AN186, MS20073, and MS20074 or the applicable standard drawing

3.15 Finish. Noncorrosion-resistant steel bolts shall be cadmium plated in accordance with QQ-P-416, type II, class 2. When plating is specified, the entire bolt, including the threaded portion, shall be plated, unless otherwise specified on the applicable standard drawings. Aluminum alloy bolts shall be anodized in accordance with MIL-A-8625 or chemically surface treated in accordance with MIL-C-5541. Corrosion-resistant steel bolts shall be passivated.

* 3.15.1 Passivating process for corrosion-resistant steel bolts. Corrosion-resistant steel shall be passivated in accordance with QQ-P-35.

3.16 Identification of product. When required, bolts shall be marked for identification purposes as shown on the applicable standard drawing. It is required that the bolt manufacturer include their identification marking on the bolt heads (unless impractical due to size or part configuration.)

3.17 Workmanship. Bolts shall be made in conformance with high-grade bolt manufacturing practice.

3.18 Surface roughness. Unless otherwise specified, the shank of all close tolerance bolts will have a maximum surface roughness of 63 microinches; the shanks of all other bolts will have a maximum surface roughness of 125 microinches.

3.19 Reclaimed materials. The use of reclaimed materials shall be encouraged to the maximum extent possible.

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 purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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4.2 Classification of inspection. The examination and testing of bolts shall be classified as quality conformance inspection.

4.3 Lot. A lot shall consist of finished bolts which are of the same type and size, fabricated by the same process, heat treated in the same manner, and produced as one continuous run or order, or part thereof.

4.4 Sampling.

* 4.4.1 Sampling for visual and dimensional attributes. Sampling for visual and dimensional attributes shall be at random in accordance with MIL-STD-105. The Inspection Levels for major, minor A, and minor B classes of characteristics shall be as follows:

- * a. Major S-4
- * b. Minor A S-3
- * c. Minor B S-2

Failure of any sample to meet the specified requirements shall be cause for rejection of the lot.

4.4.1.1 Definitions of defect classes. Major and minor defects are defined in MIL-STD-105. Minor defects are broken down into two classes, minor A and minor B. Definitions for minor A and minor B defects are as follows:

4.4.1.1.1 Minor A. A minor A defect is classified as a defect which has a slight effect on usability.

4.4.1.1.2 Minor B. A minor B defect is classified as a defect which has no effect on usability but which does not conform to workmanship standards.

4.4.1.2 Classification of defects. All dimensional characteristics are considered defective when out of tolerance.

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4.4.1.2.1 AN3 thru AN20 -bolt aircraft and AN173 thru AN186 bolt - aircraft, close tolerance. The classification of defects for AN3 thru AN20 and AN173 thru AN186 bolts shall be as follows:

Critical:

None

Major:

- 101 Thread size and form (see 4.5.1)
- 102 Shank diameter, oversize (unthreaded portion)
- 103 More than two imperfect threads
- 104 Grip length
- 105 Fillet under head
- 106 Cotter pin hole location (where required)
- 107 Hole in head missing (where required)
- 108 Dimension across flats
- 109 Straightness of shank
- 110 Angle of bearing surface to shank
- 111 Plating (where required) (visual inspection)
- 112 Identification
- 113 Burrs in cotter pin hole or on washer face
- 114 Microinch finish of shank above maximum tolerances specified in 3.18

Minor A:

- 201 Length
- 202 Head thickness
- 203 Shank diameter, undersize (unthreaded portion)
- 204 Hole in head, diameter and location (where required)
- 205 Cotter pin hole diameter (where required)

Minor B:

- 301 30-degree chamfer on head
- 302 45-degree chamfer on thread end
- 303 Eccentricity of head to shank
- 304 Burrs, general
- 305 Washer face diameter and thickness

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4.4.1.2.2 AN21 thru AN37 bolt and clevis. The classification of defects for AN21 thru AN37 bolts shall be as follows:

Critical

None

Major:

- 101 Thread size and form (see 4.5.1)
- 102 Shank diameter (unthreaded portion)
- 103 Grip length
- 104 Fillet under head
- 105 Slot missing
- 106 Cotter pin hole location (where required)
- 107 Straightness of shank
- 108 Angle of bearing surface to shank
- 109 Plating (where required) (visual inspection)
- 110 Identification
- 111 Burrs in cotter pin hole or under head

Minor A:

- 201 Length
- 202 Head diameter
- 203 Slot dimensions
- 204 Flat on OD of head
- 205 Head thickness
- 206 Cotter pin hole diameter (where required)
- 207 Thread undercut dimensions

Minor B:

- 301 45-degree chamfer on thread end
- 302 Eccentricity of head to shank
- 303 Burrs, general

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4.4.1.2.3 AN42 thru AN49 bolt - eye. The classification of defects for AN42 thru AN49 bolts shall be as follows:

Critical:

None

Major:

- 101 Thread size and form (see 4.5.1)
- 102 Shank diameter, oversize (unthreaded portion)
- 103 More than two imperfect threads
- 104 Grip length
- 105 Fillet under head
- 106 Cotter pin hole location
- 107 Eye hole diameter and location
- 108 Diameter of flange
- 109 Length of tongue and flange
- 110 Tongue end radius
- 111 Thickness of tongue
- 112 Radius tongue to flange
- 113 Straightness of shank
- 114 Angle of bearing surface to shank
- 115 Surface finish, plating (visual inspection)
- 116 Identification
- 117 Burrs

Minor A:

- 201 Length
- 202 Shank diameter undersize
- 203 Eccentricity of head to shank
- 204 Cotter pin hole diameter
- 205 Flange thickness

Minor B:

- 301 Chamfer, thread end

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4.4.1.2.4 MS20073 and MS20074 bolt, machine, aircraft, drilled head. The classification of defects for MS20073 and MS20074 bolts shall be as follows:

Critical

None

Major:

- 101 Thread size and form (see 4.5.1)
- 102 Shank diameter, oversize (unthreaded portion)
- 103 More than two imperfect threads
- 104 Grip length
- 105 Fillet under head
- 106 One or more radial holes in head missing
- 107 Dimension across flats
- 108 Straightness of shank
- 109 Angle of bearing surface to shank
- 110 Plating (where required) (visual inspection)
- 111 Identification
- 112 Burrs in cotter pin hole or on washer face
- 113 Radial holes in head, diameter and location
- 114 Axial hole in head, diameter, depth, and location

Minor A:

- 201 Length
- 202 Shank diameters, undersize (unthreaded portion)
- 203 Head thickness

Minor B:

- 301 30-degree chamfer on head
- 302 45-degree chamfer on thread end
- 303 Eccentricity of head to shank
- 304 Burrs, general
- 305 Washer face diameter and thickness

* 4.4.2 Sampling for tension, shear, and hardness tests. A separate sample shall be randomly selected from each lot for tension, shear and hardness tests. Each sample will be selected in accordance with MIL-STD-105, Inspection level S-3 and failure of any sample to meet specified requirements will be cause for rejection of the lot.

* 4.4.3 Sampling for head structure, bend, and decarburization tests. Sampling shall be in accordance with MIL-STD-105, inspection level S-3, acceptance number zero.

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* 4.4.4 Sampling for magnetic particle inspection. Samples for magnetic particle inspection shall be selected at random. The number of samples will be in accordance with Inspection Level S-4 of MIL-STD-105. Samples revealing magnetic particle indications will be subjected to a microexamination to determine whether the indicated discontinuities are defective or in nonconformance with the requirements contained herein. Failure of any sample to meet the requirements after microexamination will be cause for rejection of the lot. Magnetic particle inspection shall not be required for bolts less than 1/4 inch in diameter.

* 4.4.5 Sampling for penetrant inspection. Sampling for penetrant inspection shall be at random in accordance with Inspection Level S-4 of MIL-STD-105. Samples revealing penetrant inspection indications will be subjected to a microexamination to determine whether the indicated discontinuities are defective or in nonconformance with the requirements contained herein. Failure of any sample to meet the requirements after microexamination will be cause for rejection of the lot. Penetrant inspection shall not be required for bolts less than 1/4 inch in diameter.

4.5 Inspections.

4.5.1 Dimensions. Dimensions shall be measured by gages or measuring instruments calibrated in accordance with MIL-STD-45662. In case of controversy, gages and instruments from recently certified government laboratories shall be employed. Screw threads shall be checked as specified in MIL-S-7742 or MIL-S-8879 as applicable. Consideration should be given to the possibility of minor differences between various gages which could result in borderline discrepancies.

* 4.5.2 Ultimate tensile load. Bolts shall be tested in tension between the head of the bolt and an internally threaded member in accordance with MIL-STD-1312/8. In the event a noncorrosion resistant bolt is too short to conduct the tensile test, acceptance shall be based on the hardness test. Corrosion resistant and aluminum alloys having a grip less than one diameter of the bolt shank acceptance shall be based on a test coupon of the same material, diameter and heat treatment.

* 4.5.2.1 Eye bolts. Eye bolts shall be tested between the eye of the bolt and a threaded member in accordance with MIL-STD-1312/8.

* 4.5.3 Double shear strength. The double shear strength shall be performed on the unthreaded portion of the bolt in accordance with MIL-STD-1312/13. Bolts having a grip length of less than twice their shank diameter need not be tested.

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4.5.4 Bend. Bolts shall be bent cold in the unthreaded portion through an angle of 180 degrees over a diameter equal to the bolt diameter for steel bolts and equal to six times the bolt diameter for aluminum alloy bolts. The bending shall be accomplished by the gradual application of pressure in a suitable fixture. The acceptability of the bolts which are of insufficient length in the unthreaded portion to conduct the bend test shall be based on the hardness test.

* 4.5.5 Hardness. Hardness shall be determined in accordance with MIL-STD-1312/6.

4.5.6 Decarburization. Decarburization shall be determined by microexamination. Specimens shall be taken from a transverse section of the shank of the finished bolt. The etchant shall be 5 percent nital. Microscopic examination shall be made at a magnification of 100 diameters.

4.5.7 Head structure. A longitudinal macro-section of the head, not less than 1/4 inch from the upper portion of shank, after the head-forming and heat treating process, shall be examined for internal structure.

4.5.7.1 Steel bolts. Steel bolts shall be etched in an aqueous solution containing 50 percent (by volume) of hydrochloric acid held at 160 degrees to 180 degrees F (71 degrees to 82 degrees C) for a time sufficient to reveal the macrostructure properly.

4.5.7.2 Aluminum alloy bolts. Aluminum alloy bolts shall be etched in a 5- to 15-percent (by weight) aqueous caustic soda (NaOH) solution at approximately 180 degrees F (82 degrees C) for a time sufficient to reveal the macrostructure properly. This shall be followed by washing in water and dipping in a 10-percent (by weight) nitric acid solution to remove black stains. Water washing and drying shall follow.

4.5.8 Magnetic particle inspection. The indication of discontinuities in ferromagnetic bolts, such as cracks, seams, and inclusions, shall be determined by magnetic particle inspection. Magnetic particle indications of themselves shall not be cause for rejection. If, in the opinion of the inspector, the indications may be cause for rejection, representative samples shall be taken from those bolts showing indications which shall be further examined by micro-examination to determine whether the indicated discontinuities are in accordance with the limits specified herein.

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* 4.5.8.1 Method. Magnetic particle inspection shall be performed in accordance with ASTM E1444. Such inspection shall, in general, be performed on finished bolts, but in any case subsequent to any processing operation which could adversely affect testing of the part. The magnetizing field shall be parallel to the longitudinal axis of the bolt, primarily for the indication of transverse defects. Bolts shall not be dyed as an indication of magnetic particle inspection in accordance with the sampling requirements of this specification. Personnel conducting magnetic particle inspection shall be certified in accordance with MIL-STD-410.

4.5.9 Penetrant inspection. The indication of discontinuities in aluminum alloy bolts, such as cracks, seams, and inclusions open to the surface shall be determined by penetrant inspection. Penetrant indications of themselves shall not be cause for rejection. If, in the opinion of the inspector, the indications may be cause for rejection, representative samples shall be taken from those bolts showing indications which shall be further examined by microexamination to determine whether the indicated discontinuities are in accordance with the limits specified herein.

* 4.5.9.1 Method. Penetrant inspection shall be performed in accordance with MIL-STD-6866. Such inspection shall in general be performed on finished bolts, but in any case subsequent to any processing operations which could adversely affect the part. Bolts shall not be dyed as an indication of penetrant inspection in accordance with the sampling requirements of this specification. Personnel conducting penetrant inspection shall be certified in accordance with MIL-STD-410.

4.6 Resubmitted lots. Paragraph 6.4 of MIL-STD-105 shall apply, except that a resubmitted lot shall be inspected by the contractor under supervision of the Government inspector using tightened inspection. For attribute plans of MIL-STD-105, where the original acceptance number was zero, a sample size represented by the next higher sample size code letter shall be chosen with the acceptance number remaining zero. Before a lot is resubmitted, full particulars concerning the cause of previous rejection and the action taken to correct the defects found in the lot shall be furnished by the contractor to the Government inspector.

4.7 Inspection of packaging. The sampling and inspection of the preservation, packing and container marking shall be in accordance with the requirements of PPP-H-1581 and section 5 of this specification.

5. PACKAGING

5.1 Preservation. Preservation shall be level A, C or Commercial as specified (6.2.1).

5.1.1 Level A. The bolts shall be preserved in accordance with PPP-H-1581.

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* 5.1.2 Level C. The level C preservation for the bolts shall conform to the MIL-STD-2073-1 requirements for this level.

5.1.3 Commercial. The commercial preservation of the bolts shall be in accordance with the requirements of ASTM-D3951-82.

5.2 Packing. Packing shall be level A, B, C or commercial, as specified (see 6.2.1).

5.2.1 Level A and B. The preserved bolts shall be packed for shipment in accordance with PPP-H-1581, except fiberboard boxes shall not be used for level A packing.

* 5.2.2 Level C. The level C packing for the preserved bolts shall conform to the MIL-STD-2073-1 requirements of this level.

5.2.3 Commercial. The preserved bolts shall be packed in accordance with the requirements of ASTM-D3951-82.

5.2.4 Palletization. When specified (see 6.2) unitized loads, commensurate with the level of packing specified in the contract or order, shall be palletized in accordance with MIL-STD-147. Unitized loads shall be uniform in size and quantities to the greatest extent possible. If the container is of a size which does not conform to any of the pallet patterns specified in MIL-STD-147, the pallet pattern used shall first be approved by the contracting officer.

5.3 Marking.

5.3.1 Levels A, B, and C. In addition to any special or other identification marking required by the contract (see 6.2.1), each unit pack, intermediate and exterior container and unitized load shall be marked in accordance with MIL-STD-129.

5.3.2 Commercial. Commercial markings shall be in accordance with the requirements of ASTM-D3951-82.

5.4 General.

5.4.1 Exterior containers. Exterior containers (see 5.2.1, 5.2.2, 5.2.3, and 5.2.4) shall be of minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock numbered items to the greatest extent practicable.

5.4.2 Packaging Inspection. The inspection of these packaging requirements shall be in accordance with 4.5.

6. NOTES

6.1 Intended use. The bolts covered by this specification are intended for use in the manufacture of aircraft and aircraft accessories.

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6.1.1 Noncorrosion resistant steel conforming to MIL-S-6050 and AMS6300 may not be suitable for bolts larger than 1/2 inch in diameter.

6.2 Ordering Data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, Number, and date of this specification
- b. Part number of the bolt desired (type, material, thread, lengths).
- c. Quantity.
- d. Selection of applicable levels of preservation, packaging, marking and commercial/industrial (see 5.1, 5.2 and 5.3).
- e. When palletized loads are required (see 5.2.4).

6.3 Key word listing.

Bolt, Machine
 Bolt, Eye
 Bolt, Clevis
 Bolt, Noncorrosion-resistant steel
 Bolt, Corrosion resistant steel
 Bolt, Aluminum Alloy

6.4 Changes from previous issues. The margins of this specification are marked with an (*) to indicate where changes (additions, modifications, corrections) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the previous issues

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