



Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 7473D

Superseding AMS 7473C

Issued 8-15-55

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BOLTS AND SCREWS Roll Threaded

1. SCOPE:

- 1.1 Type: This specification covers high quality bolts and screws made from carbon steels, alloy steels, or corrosion and heat resistant steels or alloys.
- 1.2 Application: Primarily for parts of carbon and low-alloy steels, corrosion and heat resistant steel and alloys, and high-expansion steels not subjected to heat treatment during manufacture. Parts of steels such as AMS 5061 are generally for use up to 800°F (470°C) where stresses are low. Parts of corrosion and heat resistant steels and alloys such as AMS 5645 are generally for use up to 1200°F (650°C) where stresses are low. Parts of high-expansion steels such as AMS 5624 or AMS 5625 are generally for use at lower temperatures where expansion approaching that of aluminum and magnesium alloys is required.
- 1.2.1 This specification may also be used to control the manufacture, characteristics, and quality of parts subjected to heat treatment during manufacture but the stage of manufacture at which heat treatment shall be performed, the actual heat treatment, and the mechanical properties of such parts are not specified.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) and Aerospace Standards (AS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2373 - Quality Assurance Sampling of Bolts and Screws
AMS 5061 - Steel Bars and Wire, Low Carbon
AMS 5624 - Steel Bars, High Expansion, 12.5Ni - 4.5Mn - 4.0Cr (0.50 - 0.60C)
AMS 5625 - Steel, High Expansion, 5.5Mn - 9.5Ni (0.55 - 0.65C), Cold Drawn
AMS 5645 - Steel Bars, Forgings, Tubing, and Rings, Corrosion and Heat Resistant,
18Cr - 10Ni - 0.40Ti

2.1.2 Aerospace Standards:

AS 1132 - Design Parameters for Bolts and Screws, External Wrenching, Unified Thread
Inch Series
AS 1177 - Nondestructive Inspection Standards for Bolts and Screws
AS 3062 - Bolts, Screws, and Studs, Screw Thread Requirements
AS 3063 - Bolts, Screws, and Studs, Geometric Control Requirements

- 2.2 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

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2.2.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of
MIL-STD-1312 - Fasteners, Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be as specified on the drawing.

3.2 Fabrication:

3.2.1 Blanks: Heads shall be formed by hot forging, cold forging, or machining.

3.2.2 Oxide and Decarburization Removal: Surface oxide, oxide penetration, and decarburization resulting from prior heat treatment shall be removed from the full body diameter and the bearing surface of the head prior to cold working the fillet radius when specified and rolling the threads. The oxide and decarburization removal process shall produce no intergranular attack or corrosion of the blanks. The metal removed from the bearing surface of the head and the full body diameter of the shank shall be as little as practicable to obtain a clean, smooth surface and, in no case, shall be so great as to produce more cutting of flow lines in the head-to-shank junction than shown in Fig. 1B.

3.2.3 Cold Working of Fillet Radius: After removal of oxide and decarburization as in 3.2.2, the head-to-shank fillet radius of parts having the radius complete throughout the circumference of the part shall, when specified, be cold worked sufficiently to remove all visual evidence of grinding or tool marks. Distortion due to cold working shall not raise metal more than 0.002 in. (0.05 mm) above the contour at "A" or depress metal more than 0.002 in. (0.05 mm) below the contour at "B" as shown in Fig. 2; distorted areas shall not extend beyond "C" as shown in Fig. 2. In configurations having an undercut associated with the fillet radius, the cold working will be required only for 90 deg of fillet arc, starting at the point of tangency of the fillet radius and the bearing surface of the head.

3.2.4 Thread Rolling: Threads shall be formed on the finished blanks by a single rolling process after removal of oxide and decarburization as in 3.2.2.

3.2.5 Cleaning: Parts made of corrosion and heat resistant steels and alloys, after finishing, shall be degreased and then immersed in one of the following solutions for the time and at the temperature shown:

3.2.5.1 One volume of nitric acid (sp gr 1.42) and 9 volumes of water for not less than 20 min. at room temperature.

3.2.5.2 One volume of nitric acid (sp gr 1.42) and 4 volumes of water for 30 - 40 min. at room temperature.

3.2.5.3 One volume of nitric acid (sp gr 1.42) and 4 volumes of water for 10 - 15 min. at 140° - 160°F (60° - 70°C).

3.3 Quality: Parts shall be uniform in quality and condition, clean, sound, smooth, and free from burrs and foreign materials and from internal and external imperfections detrimental to their performance. Parts shall conform to AS 1177.

3.3.1 Dimensional Examination: Parts shall conform to the following:

3.3.1.1 Straightness, Concentricity, and Squareness: Parts shall be within the limits of the drawing, determined in accordance with AS 3063.

Ø 3.3.1.2 Threads: Shall be as specified on the drawing and shall conform to AS 3062.

3.3.2 Macroscopic Examination: Parts or sections of parts, as applicable, etched in a solution of approximately 50% hydrochloric acid (sp gr 1.19) and 50% water, or other suitable etchant for sufficient time to reveal flow lines but not longer than 15 min., shall be examined at a magnification of approximately 20X to determine conformance to the following requirements, except that examination for the thread imperfections of 3.3.2.3 may be made by microscopic examination of specimens polished and etched as in 3.3.3.

3.3.2.1 Flow Lines:

3.3.2.1.1 If parts have upset heads, examination of a longitudinal section through the part shall show flow lines in the shank, head-to-shank fillet, and bearing surface which follow the contour of the part as shown in Fig. 1A, except that slight cutting of flow lines by the oxide and decarburization removal process of 3.2.2 is permissible, as shown in Fig. 1B; excessive cutting of flow lines in the shank, head-to-shank fillet, and bearing surface, as shown in Fig. 1C, is not permissible except when an undercut is associated with the fillet radius. The head style shown in Figs. 1A through 1C is for illustrative purposes only but other symmetrical head styles shall conform to the above requirements. Flow lines in upset heads on parts having special heads, such as Dee- or Tee-shaped heads or thinner-than-standard heads as in AS 1132, shall be as agreed upon by purchaser and vendor.

3.3.2.1.2 Flow lines in threads shall be continuous, shall follow the general thread contour, and shall be of maximum density at root of thread (See Fig. 3).

3.3.2.2 Internal Defects: Examination of longitudinal sections of the head and shank and of the threads shall reveal no cracks, laps, or porosity except laps in threads as permitted by 3.3.2.3.3 and 3.3.2.3.4. The head and shank section shall extend not less than $D/2$ from the bearing surface of the head and the threaded section shall extend not less than $D/2$ beyond the thread runout where "D" is the nominal diameter of the shank after heading. If the two sections would overlap, the entire length of the part shall be sectioned and examined as a whole.

3.3.2.3 Threads:

3.3.2.3.1 Root defects such as laps, seams, notches, slivers, folds, roughness, and oxide scale are not permissible (See Fig. 4).

3.3.2.3.2 Multiple laps on the flanks of threads are not permissible regardless of location. Single laps on the flanks of threads that extend toward the root are not permissible (See Figs. 5 and 6).

3.3.2.3.3 There shall be no laps along the flank of the thread below the pitch diameter (See Fig. 7). A single lap is permissible along the flank of the thread above the pitch diameter on either the pressure or non-pressure flank (one lap at any cross-section through the thread) provided it extends toward the crest and generally parallel to the flank (See Fig. 7).

3.3.2.3.4 Crest craters, crest laps, or a crest lap in combination with a crest crater are permissible provided that the imperfections do not extend deeper than 20% of the basic thread height (See Table I) as measured from the thread crest when the thread major diameter is at minimum size (See Fig. 8). The major diameter of the thread shall be measured prior to sectioning. As the major diameter of the thread approaches maximum size, values for depth of crest crater and crest lap imperfections listed in Table I may be increased by one-half of the difference between the minimum major diameter and the actual major diameter as measured on the part.

- 3.3.3 Microscopic Examination: Specimens cut from parts shall be polished, etched, and examined at a magnification not lower than 100X to determine conformance to the following requirements; the etchant shall be 2% Nital for parts made of carbon or low-alloy steels and Kalling's reagent (100 mL of absolute ethyl alcohol, 100 mL of hydrochloric acid (sp gr 1.19), and 5 g of cupric chloride), Marble's reagent (20 mL of hydrochloric acid (sp gr 1.19), 20 mL of water, and 4 g of cupric sulfate pentahydrate), or other suitable etchant for parts made of corrosion and heat resistant steels and alloys.
- 3.3.3.1 Surface Hardening: Except for parts whose strength is obtained only by cold working, parts shall have no surface hardening except as produced during cold working of the head-to-shank fillet radius when specified and during rolling of threads. There shall be no evidence of carburization or nitriding. In case of dispute over results of the microscopic examination, microhardness testing performed in accordance with MIL-STD-1312, Test Method No. 6, shall be used as a referee method; a Vickers hardness reading within 0.003 in. (0.08 mm) of the surface more than 30 points higher than the reading in the core will be evidence of non-conformance to this requirement.
- 3.3.3.2 Decarburization: Parts made of carbon or low-alloy steels shall not be decarburized more than the following:
- 3.3.3.2.1 The bearing surface of the head, the head-to-shank fillet radius, the shank, and the threads shall be free from decarburization.
- 3.3.3.2.2 Depth of decarburization on those surfaces of the head which are the original surfaces of the bar shall be not greater than that permitted by the applicable material specification.
- 3.3.3.2.3 Depth of decarburization on the OD of the head of cylindrical head parts made by upsetting is not restricted.
- 3.3.3.2.4 Depth of decarburization at any point on any surface not covered by 3.3.3.2.1, 3.3.3.2.2, or 3.3.3.2.3 shall not exceed 0.002 in. (0.05 mm).
4. QUALITY ASSURANCE PROVISIONS:
- 4.1 Responsibility for Inspection: The vendor of parts shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the parts conform to the requirements of this specification.
- 4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each lot.
- 4.3 Sampling: Shall be in accordance with AMS 2373; a lot shall be all parts of one size and configuration made from a single heat of steel or alloy processed in one continuous run and submitted for vendor's inspection at one time.
- 4.4 Reports: The vendor of parts shall furnish with each shipment three copies of a report stating that the chemical composition of the parts conforms to the applicable material specification and that the parts conform to the other technical requirements of this specification. This report shall include the purchase order number, this specification number and its revision letter, contractor or other direct supplier of material, part number, nominal size, and quantity.

- 4.5 Resampling and Retesting: If any part or specimen used in the above tests fails to meet the specified requirements, disposition of the parts may be based on the results of testing three additional parts or specimens for each original nonconforming specimen. Failure of any retest part or specimen to meet the specified requirements, shall be cause for rejection of the parts represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

Ø 5.1.1 Parts having different part numbers shall be packed in separate containers.

Ø 5.1.2 Each container of parts shall be marked to show the following information:

FASTENERS, ROLL THREADED _____
 AMS 7473D _____
 PART NUMBER _____
 PURCHASE ORDER NUMBER _____
 QUANTITY _____
 MANUFACTURER'S IDENTIFICATION _____

5.1.3 Containers of parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.1.4 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1.1 and 5.1.3 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Parts not conforming to this specification or to authorized modifications will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

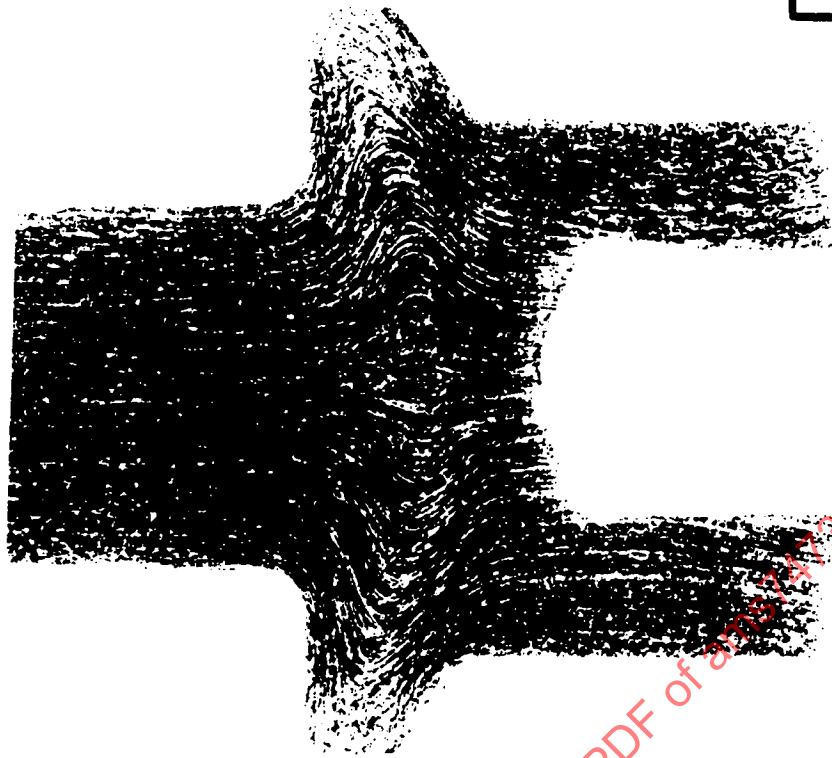
8.2 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification
 Part number or size of parts desired
 Quantity of parts desired
 Applicable level of packaging (See 5.1.4).

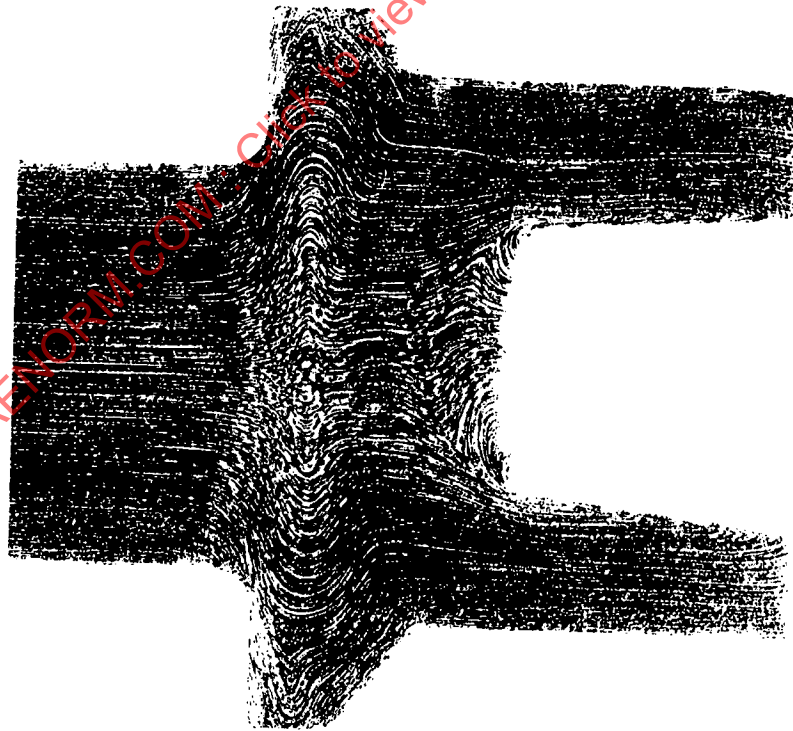
TABLE I

Threads Per Inch	Basic Thread Height Ref (See Note 1)		20% Basic Thread Height	
	Inch	(Millimetres)	Inch	(Millimetre)
80	0.0081	(0.206)	0.0016	(0.041)
72	0.0090	(0.229)	0.0018	(0.046)
64	0.0102	(0.259)	0.0020	(0.051)
56	0.0116	(0.295)	0.0023	(0.058)
48	0.0135	(0.343)	0.0027	(0.069)
44	0.0148	(0.376)	0.0030	(0.076)
40	0.0162	(0.411)	0.0032	(0.081)
36	0.0180	(0.457)	0.0036	(0.091)
32	0.0203	(0.516)	0.0041	(0.104)
28	0.0232	(0.589)	0.0046	(0.117)
24	0.0271	(0.688)	0.0054	(0.137)
20	0.0325	(0.826)	0.0065	(0.165)
18	0.0361	(0.917)	0.0072	(0.183)
16	0.0406	(1.031)	0.0081	(0.206)
14	0.0464	(1.179)	0.0093	(0.236)
13	0.0500	(1.270)	0.0100	(0.254)
12	0.0541	(1.374)	0.0108	(0.274)
11	0.0590	(1.499)	0.0118	(0.300)
10	0.0650	(1.651)	0.0130	(0.330)
9	0.0722	(1.834)	0.0144	(0.366)
8	0.0812	(2.062)	0.0163	(0.414)

Note 1. Basic thread height is defined as being equivalent to 0.650 times the pitch.



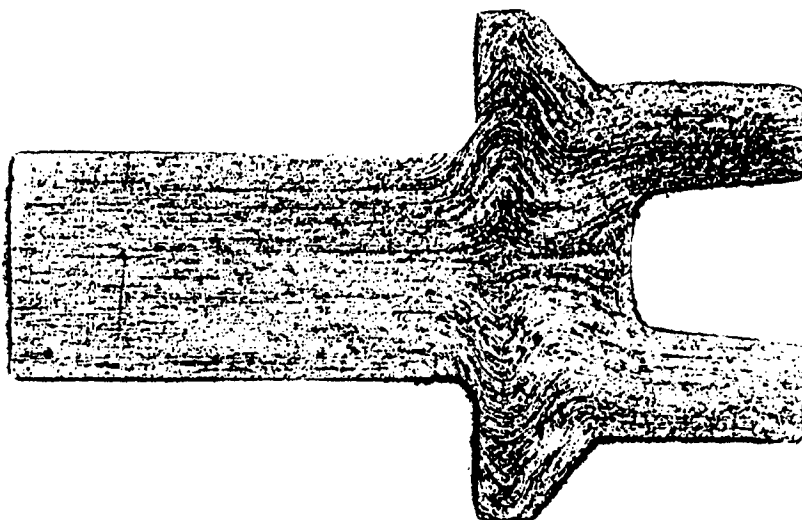
SATISFACTORY GRAIN FLOW
FIGURE 1A



MINIMUM ACCEPTABLE STANDARD

Showing maximum permissible cutting of flow lines after
machining to remove oxide and decarburization as in 4. 3.

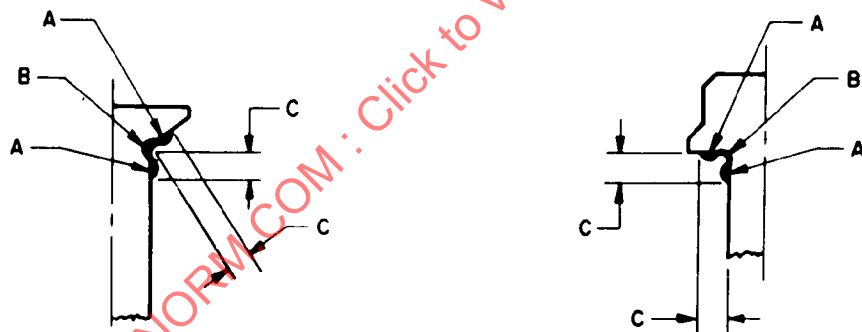
FIGURE 1B



UNACCEPTABLE GRAIN FLOW

Excessive cutting of flow lines in the shank, head to shank fillet, and bearing surface is not permissible.

FIGURE 1C



Nominal Bolt Diameter		C, max	
Inches	(Millimetres)	Inch	(Millimetres)
Up to 0.3125, excl	(Up to 7.94, excl)	0.062	(1.57)
0.3125 and 0.375	(7.94 and 9.52)	0.094	(2.39)
0.4375 - 0.625, incl	(11.11 - 15.88, incl)	0.125	(3.18)
0.750 - 1.000, incl	(19.05 - 25.40, incl)	0.156	(3.96)
Over 1.000	(Over 25.40)	0.188	(4.78)

PERMISSIBLE DISTORTION FROM FILLET WORKING

FIGURE 2