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

AEROSPACE MATERIAL SPECIFICATION

AMS 7458D
Superseding AMS 7458C
Issued 6-30-60
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STUDS, STEEL, LOW-ALLOY, HEAT-RESISTANT
Normalized and Tempered, Roll Threaded
135,000 psi (931 MPa) Tensile Strength

1. SCOPE:

1.1 Type: This specification covers high quality studs made of a low-alloy, heat-resistant steel.

1.2 Application: Primarily for joining parts where studs having high strength up to 900° F (480° C) are required.

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 2372 - Quality Assurance Sampling of Bolts and Screws
AMS 6304 - Steel Bars, Forgings, and Tubing, Low Alloy, Heat Resistant, 0.95Cr - 0.55Mo - 0.30V (0.40 - 0.50C)

2.1.2 Aerospace Standards:

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 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM A370 - Mechanical Testing of Steel Products

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

2.3.1 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 AMS 6304 steel, unless otherwise specified.

3.2 Fabrication:

3.2.1 Blanks: Shall be machined sufficiently to remove surface defects and decarburization except as noted in 3.4.3.3. The smaller diameter or nut end of blanks for stepped studs may be reduced as necessary by extruding, machining, or both but the larger diameter or stud end shall not be upset. Upsetting to produce a shoulder or shoulders between the threaded ends is permissible provided grain flow in the stud end is not distorted.

3.2.1.1 The metal removed from the bearing surface of the shoulder or shoulders shall be as little as practicable to obtain clean, smooth surfaces.

3.2.2 Heat Treatment: Machined blanks, unless machined from heat treated stock, shall, before finishing the shank and rolling the threads, be heat treated as follows:

3.2.2.1 Heating Equipment: Furnaces may be any type ensuring uniform temperature throughout the parts being treated and shall be equipped with, and operated by, automatic temperature controllers. The heating medium or atmosphere shall cause neither surface hardening nor decarburization other than that permitted by 3.4.3.2 and 3.4.3.3.

3.2.2.2 Normalizing: Blanks of AMS 6304 shall be heated uniformly to 1750° F ± 25 (954° C ± 15), held at heat for 1 - 1.5 hr, and cooled in still air or in a cooling chamber of the furnace.

3.2.2.3 Tempering: Normalized blanks of AMS 6304 shall be tempered by heating uniformly to the temperature necessary to produce the specified hardness and microstructure but not lower than 1100° F (593° C), holding at heat for not less than 6 hr, and cooling in air.

3.2.2.4 For steels other than AMS 6304, heat treatment shall be as agreed upon by purchaser and vendor.

3.2.3 Oxide and Decarburization Removal: The heat treated blanks, before cold rolling the threads, shall have all surfaces to be rolled free from surface oxide, oxide penetration, and decarburization except as permitted in 3.4.3.3. The removal process shall produce no intergranular attack or corrosion of the blanks.

3.2.4 Thread Rolling: Threads shall be formed on the heat treated and finished blanks by a single rolling process for each end after removal of oxide and decarburization as in 3.2.3.

3.3 Properties: Parts shall conform to the requirements of 3.3.1 and 3.3.2. Threaded members of gripping fixtures for tensile tests shall be of sufficient size and strength to develop the full strength of the part without stripping the thread. The loaded portion of the part shall have a minimum of two full thread turns from thread runout at each end exposed between the loading fixtures during tensile tests. Finished parts shall be tested in accordance with the following applicable test methods of MIL-STD-1312:

Requirement	Test Method
Hardness	No. 6
Tensile Strength	No. 8

3.3.1 Tensile Properties:

3.3.1.1 Finished Parts: Parts having hardness as in 3.3.2 shall have breaking load not lower than that specified in Table II for the applicable thread size. Unless the part is of such size and shape that failure would occur outside the threaded section, such as parts having a shank diameter equal to or less than the thread minor diameter (smaller thread minor diameter for parts with unequal size threads) or having an undercut, parts shall fail in one of the threaded sections as specified in 3.3.1.1.1 through 3.3.1.1.3. If the size or shape of the part is such that failure would occur outside the threaded section, as specified above, parts shall conform to only the tensile strength requirement of 3.3.1.2; for such parts, the diameter on which stress is based shall be the actual measured minimum diameter of the part.

3.3.1.1.1 Parts having both ends threaded with the same diameter/pitch series may fail in either threaded section.

3.3.1.1.2 Parts having both ends threaded to the same diameter but different pitches shall fail in the coarser threaded section.

3.3.1.1.3 Parts having threads of unequal diameter, whether of the same pitch or not, shall fail in the smaller diameter threaded section.

3.3.1.2 Machined Test Specimens: If the size or shape of the part is such that a tensile test cannot be made on the part, tensile tests shall be conducted in accordance with ASTM A370 on specimens machined from finished parts or from coupons of the same heat of material heat treated with the parts. Specimens shall conform to the following requirements:

Tensile Strength, min	135,000 psi (931 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	15%
Reduction of Area, min	40%

3.3.2 Hardness: Shall be uniform and within the range 30 - 38 HRC or equivalent; hardness of the threaded sections may be higher than that of other areas as a result of the cold working operations.

3.4 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.

3.4.1 Dimensional Examination: Parts shall conform to the following:

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

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

3.4.2 Macroscopic Examination: Parts or sections of parts as applicable, taken through the axis, shall be ground, etched in a solution of approximately 50% hydrochloric acid (sp gr 1.19) and 50% water for a sufficient time to reveal the flow lines, and examined at approximately 20X magnification to determine conformance to the following requirements, except that examination for thread imperfections of 3.4.2.3 may be made by microscopic examination of specimens polished and etched as in 3.4.3.

3.4.2.1 Flow Lines: Flow lines in threads shall be continuous, shall follow the general thread contour and shall be of maximum density at the root of the thread (See Fig. 1). Below the thread roots, flow lines not affected by forming shall be parallel to the axis except that on the nut end of parts formed by extruding the flow lines may be oblique to the axis for a distance from the end equal to 1.5 times the B dimension of Table II of AS 3062.

3.4.2.2 Internal Imperfections: Examination of longitudinal sections of parts shall reveal no cracks or other injurious imperfections.

3.4.2.3 Threads:

3.4.2.3.1 Root defects such as notches, slivers, folds, roughness, and oxide are not permissible (See Fig. 2).

3.4.2.3.2 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 Fig. 3 and 4).

3.4.2.3.3 There shall be no laps along the flanks of the thread below the pitch diameter (See Fig. 5). 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. 6).

3.4.2.3.4 Crest craters, crest laps, or a crest lap in combination with a crest crater are permissible, provided the imperfections do not extend deeper than 20% of the basic thread height (See Table I), measured from the thread crest when the thread major diameter is at minimum size (See Fig. 7). 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 1/2 of the difference between the minimum major diameter and the actual major diameter measured on the part.

3.4.3 Microscopic Examination: Specimens taken from parts shall be polished, etched in 2% Nital, and examined at not lower than 100X magnification to determine conformance to the following:

3.4.3.1 Microstructure: Parts shall have a normalized and tempered structure with finely divided carbides. Ferrite may be in a typical Widmanstatten pattern or randomly dispersed. Presence of tempered martensite, particularly in small diameter parts, will be acceptable.

3.4.3.2 Surface Hardening: Parts shall have no surface hardening except as produced by rolling of threads. There shall be no evidence of carburization, recarburization, or nitriding. In case of dispute over results of the microscopic examination, microhardness testing shall be used as a referee method; a Vickers hardness reading within 0.003 in. (0.08 mm) of an unrolled surface more than 30 points higher than the reading in the core shall be evidence of nonconformance to this requirement.

3.4.3.3 Decarburization:

3.4.3.3.1 The bearing surface of the shoulder, the shoulder-to-shank fillet radius, the shank, and the threads shall be free from decarburization.

3.4.3.3.2 The periphery of the shoulder of shouldered studs may be decarburized to a depth not exceeding that permitted by the applicable material specification for the size used to make the part.

3.4.3.3.3 Depth of decarburization at any point on any surface not covered by 3.4.3.3.1 or 3.4.3.3.2 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.

4.3 Sampling: Shall be in accordance with AMS 2373.

4.4 Reports: The vendor of parts shall furnish with each shipment three copies of a report stating that the chemical composition conforms to the applicable material specification, showing the results of tests to determine conformance to the hardness and tensile strength requirements, and stating 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, 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:

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

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

STUDS, LOW-ALLOY STEEL, HEAT RESISTANT_____
AMS 7458D_____
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 to ensure carrier acceptance and safe transportation to the point of 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 5.1.3 will be acceptable if it meets the requirements of Level C.

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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 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.

TABLE II

Bolt Size	Tensile Breaking Load, min: Standard Pitch Diam UN and UNJ Threads, Pounds	(Newtons)	Reduced Pitch Diam UN Threads Only, Pounds	(Newtons)
0.112 -40	934	(4,150)	876	(3,900)
0.112 -48	987	(4,390)	928	(4,130)
0.138 -32	1,410	(6,270)	1,340	(5,960)
0.138 -40	1,510	(6,720)	1,440	(6,410)
0.164 -32	2,100	(9,340)	2,020	(8,980)
0.164 -36	2,170	(9,650)	2,060	(9,160)
0.190 -24	2,700	(12,000)	2,590	(11,500)
0.190 -32	2,930	(13,000)	2,830	(12,600)
0.250 -20	4,920	(21,900)	4,790	(21,300)
0.250 -28	5,240	(23,300)	5,100	(22,700)
0.3125-18	7,940	(35,300)	7,770	(34,600)
0.3125-24	8,300	(36,900)	8,120	(36,100)
0.375 -16	11,900	(52,900)	11,600	(51,600)
0.375 -24	12,800	(56,900)	12,600	(56,000)
0.4375-14	16,200	(72,100)	16,000	(71,200)
0.4375-20	17,400	(77,400)	17,100	(76,100)
0.500 -13	21,500	(95,600)	21,200	(94,300)
0.500 -20	23,200	(103,000)	22,900	(102,000)
0.5625-12	27,400	(122,000)	27,100	(121,000)
0.5625-18	29,400	(131,000)	29,000	(129,000)
0.625 -11	34,000	(151,000)	33,600	(150,000)
0.625 -18	36,800	(164,000)	36,400	(162,000)
0.750 -10	49,800	(222,000)	49,300	(219,000)
0.750 -16	53,400	(238,000)	52,600	(234,000)
0.875 -9	68,300	(304,000)	67,800	(302,000)
0.875 -14	72,800	(324,000)	72,300	(322,000)
1.000 -8	89,300	(398,000)	88,900	(395,000)
1.000 -12	94,900	(422,000)	94,000	(418,000)

Note 1. Requirements above apply to parts with UNC, UNF, UNJC, or UNJF threads, as applicable to the sizes shown and having hardness within the range 30 - 38 HRC or equivalent; requirements for reduced pitch diameter parts are based on 0.003 in. (0.08 mm) reduction below standard. Area upon which stress is based is 98% of standard or reduced basic pitch diameter for nominal thread major diameters up to 0.3125 in. (7.938 mm), incl, and the standard or reduced basic pitch diameter for larger sizes. Tensile breaking load is based on 135,000 psi (931 MPa) stress.

Note 2. For sizes not shown, tensile breaking loads for parts tested as parts, not as specimens machined from parts or from coupons of the stock, shall be based upon the respective areas and stress given in Note 1 above.