AEROSPACE MATERIAL SPECIFICATIONS

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York 17, N.Y.

AMS 7459

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Revised

BOLTS AND SCREWS, STEEL, LOW ALLOY HEAT RESISTANT
195,000 psi Tensile Strength
Hardened and Tempered, Roll Threaded

1. ACKNOWLEDGMENT: A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

2. APPLICATION: Premium quality bolts and screws having controlled root radius of 0.15011 - 0.18042 p where p is the pitch, for use up to 900 F (480 C) in highly stressed locations.

3. MATERIAL: Shall be AMS 6304 steel.

4. FABRICATION:

4.1 Blanks: Heads shall be formed by hot or cold upsetting; machined heads will not be permitted.

4.2 Heat Treatment: Headed blanks shall, before finishing the shank and the bearing surface of the head and rolling the head to shank fillet radius and the threads, be heat treated as follows:

4.2.1 Heating Equipment: Furnaces may be any type ensuring uniform temperature throughout the parts being heated 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 5.7.

4.2.2 Hardening: Blanks shall be uniformly heated to 1725 F $\pm$ 25 (940.6 C $\pm$ 14), held at heat for 60 - 90 min., and quenched in oil.

4.2.3 Tempering: Hardened blanks shall be tempered by heating uniformly to not lower than 1000 F (538 C), holding at heat for 6 hr, and cooling in air.

4.3 Oxide and Decarburization Removal: The heat treated blanks, before cold working, shall have the body, thread portion, and bearing surface of the head free from all surface oxide, oxide penetration, and decarburization caused by prior heat treatment. The metal removed from the bearing surface of the head shall be as little as practicable to obtain a clean, smooth surface.

4.4 Cold Working of Fillet Radius: After removal of oxide and decarburization as in 4.3, the head to shank fillet radius of parts shall be cold worked sufficiently to remove all visual evidence of grinding or tool marks and to produce the fatigue strength specified in 5.5.3. Distortion due to cold working shall not raise metal more than 0.001 in. above the contour at "A" or depress metal more than 0.001 in. below the contour at "B" as shown in Fig. 1; distorted areas shall not extend beyond "C" as shown in Fig. 1.

4.5 Thread Rolling: Threads shall be formed on the heat treated and finished blanks by a single rolling process after removal of oxide as in 4.3.

5. TECHNICAL REQUIREMENTS:

5.1 Flow Lines: Flow lines of upset heads shall conform to the general arrangement shown in Figure 2A, 2B, or 2C. The intersection of the longitudinal axis of the part and the approximate transverse axis of the flow lines shall be not less than D/4 in. from the bearing surface for hexagonal, round, and square head parts and not less than D/7 in. from the bearing surface for 12 point head parts where D is the nominal diameter of the shank after heading.

5.1.1 Examination for Internal Defects: Visual examination of a longitudinal section of a head and 1/4 in. or more of the shank, after etching in approximately equal volumes of hydrochloric acid (sp gr 1.19) and water at 160 - 180 F (71.1 - 82.2 C) for 10 - 15 min., shall reveal no cracks, laps, or porosity.

5.2 Threads:

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

5.2.2 Root defects such as notches, slivers, folds, roughness, or oxide scale are not permitted (See Fig. 4).

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

5.2.4 A single lap is permissible along the side of the thread below the pitch diameter on the non-pressure side provided the lap does not originate less than 20% of the basic thread height from the root and extends toward the crest and generally parallel to the side (See Fig. 7). A single lap is permissible along the side of the thread above the pitch diameter on either the pressure or non-pressure side (one lap per thread) provided it extends toward the crest and generally parallel to the side (See Fig. 8). Basic thread height is defined as being equivalent to 0.650 times the pitch (See Table I).

5.2.5 Crest craters, crest laps, or a crest lap in combination with a crest crater are permissible, provided the imperfection does 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. 9). The major diameter of the thread shall be measured prior to sectioning. As the major diameter of the thread approaches maximum size, values for crest crater or crest lap imperfections listed in Table I may be increased by 1/2 the difference between the minimum major diameter and the actual major diameter as measured on the part.

5.2.6 Slight deviations from thread contour are permissible at the crest of the thread within the major diameter limits as shown in Fig. 10 and at the incomplete thread at each end of the threaded section.

5.2.7 Parts having holes for locking devices are permitted to have slight ovalization of the hole and the countersink and slight flattening of the crest of the thread at the countersink, provided the diameter of the hole is within specified tolerances.

5.2.8 Parts shall have a minimum thread run-out of one thread and a maximum of two threads. The run-out shall fair onto the shank eliminating any abrupt change in cross sectional area. Root and sides of threads contained in run-out shall be filleted, smooth, and devoid of abrupt tool stop marks.

5.2.9 All thread elements shall be within specified limits starting at a length 2 times the pitch from the end, including chamfer, and extending for the specified full thread length.

5.2.10 Unless otherwise specified, threads may be 0.0012 in. under the specified limits before plating but shall conform to the gage requirements after plating.

5.3 Straightness, Concentricity, and Squareness: For purposes of these inspections, shank and threads shall be included but shall be considered as separate elements of the part.

5.3.1 Straightness of Shank and Threads: Shank and threads shall be straight within the limits specified on the drawing for the total length (L) of the part under the head (See Fig. 11). Visibly abrupt changes in diameter or shape of the shank and threads which might cause stress concentrations are not permissible.

5.3.2 Concentricity of Thread Pitch Diameter: The concentricity of thread pitch diameter in relation to shank diameter shall be within the limits specified on the drawing for a distance of not less than 1.5 times the nominal part diameter away from the last full thread along the shank (See Fig. 12). For parts having a shank length less than 1.5 times the nominal part diameter, the concentricity of the shank diameter over its full length in relation to the thread pitch diameter shall be within the limits specified on the drawing.

5.3.3 Concentricity of Head: The concentricity of the head in relation to the shank diameter shall be within the limits specified on the drawing for a distance of not less than 1.5 times the nominal part diameter away from the washer face along the shank (See Fig. 13). For parts threaded to the head and for parts having shank length less than 1.5 times the nominal part diameter, concentricity of head shall be measured in relation to thread pitch diameter in lieu of shank diameter.

5.3.4 Squareness of Washer Face: The squareness of the washer face with the shank diameter shall be within the limits specified on the drawing for a distance of not less than 1.5 times the nominal part diameter away from the washer face along the shank (See Fig. 13). For parts threaded to the head and for parts having a shank length less than 1.5 times the nominal part diameter, squareness of washer face shall be measured in relation to thread pitch diameter in lieu of shank diameter.

5.4 Structure: Parts shall have microstructure of tempered martensite. Structure of the head to shank fillet area shall show evidence of cold work.

5.5 Properties: Parts shall conform to the requirements of 5.5.1.1 and 5.5.2 and shall be capable of meeting the requirements of 5.5.1.2, 5.5.3, 5.5.4, and 5.5.5.

5.5.1 Tensile Strength:

5.5.1.1 Room Temperature: Finished parts shall have tensile strength not lower than 195,000 psi when aligned in fixtures so that at least 3 threads are exposed in the gage section. Threaded member of the gripping fixtures shall be of sufficient size and strength to develop the full strength of the part without stripping the thread. The diameter of the area on which stress is based shall be the mean pitch diameter of the thread or the shank diameter, whichever is smaller. If parts have an unthreaded shank shorter than the nominal diameter of the part, tensile tests are not required and acceptability shall be based on the hardness test of 5.5.2.

5.5.1.2 At 900 F (482.2 C): Parts heated to 900 F ± 3 (482.2 C ± 1.7), held at heat for 30 min. before testing, and tested at 900 F ± 3 (482.2 C ± 1.7) shall have tensile strength not lower than 145,000 psi. Fixturing and area on which stress is based shall be as in 5.5.1.1.

5.5.2 Hardness: Shall be Rockwell C 42 - 46, or equivalent.

5.5.3 Fatigue Strength: Parts tested in tension-tension fatigue at room temperature with stresses cycled between 10,000 and 100,000 psi shall have average life of 65,000 cycles with no part having life less than 45,000 cycles. Tests need not be run beyond 130,000 cycles. The diameter of the area on which stresses are based shall be the basic minor (design form) diameter of the part. Life of parts which do not fail in less than 130,000 cycles shall be taken as 130,000 cycles for purposes of computing average life.

5.5.4 Stress-Rupture Test at 900 F (482.2 C): Parts, maintained at 900 F ± 3 (482.2 C ± 1.7) while an axial stress of 115,000 psi is applied continuously, shall not rupture in less than 100 hours. Fixturing and area on which stress is based shall be as in 5.5.1.1.

5.5.5 Stability: Parts, after being heated to 900 F ± 15 (482.2 C ± 8.3), held at heat for 100 hr, and cooled to room temperature, shall have tensile strength not lower than 195,000 psi when tested as in 5.5.1.1.

5.6 Surface Hardening: Parts shall have no surface hardening except as produced during rolling of threads and head to shank fillet radius. Determination of surface hardening may be made by microscopic method or by a sensitive hardness testing instrument.

5.6.1 This requirement prevents heat treating procedures such as uncontrolled atmosphere for heating, bath heating medium, carbon restoration, and other similar processes.

5.7 Decarburization:

5.7.1 The bearing surface of the head, the fillet between head and shank, the shank, and threads shall be free from decarburization.

5.7.2 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, except as noted in 5.7.1.

5.7.3 Depth of decarburization on the OD of the head of cylindrical head parts is not restricted.

5.7.4 Depth of decarburization at any point on any surface not covered in 5.7.1, 5.7.2, or 5.7.3 shall not exceed 0.002 inch.

6. 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.

6.1 Parts subject to magnetic particle inspection shall conform to the following standards:

6.1.1 Discontinuities transverse to grainflow such as pipes, grinding checks, and quench cracks shall be cause for rejection.

6.1.2 Longitudinal indications of seams, forming laps, and nonmetallic inclusions parallel to grainflow are acceptable within the following limits, provided the separation between indications is not less than 1/16 in. in all directions.

6.1.2.1 Sides of Head: A maximum of 6 surface or subsurface indications per head is permitted and the length of each indication may be the full height of the surface. No indication shall break over either edge to a depth greater than 1/32 in. or the equivalent of the basic thread height (See Table I), whichever is less.

6.1.2.2 Top of Head and End of Stem: A maximum of 6 surface or subsurface indications in each area is permitted provided the length or diameter of any individual indication does not exceed 1/32 in. or the equivalent of the basic thread height, whichever is less.

6.1.2.3 Shank or Stem: A maximum of 10 subsurface and hairline surface indications is permitted. The length of any indication may be the full length of the surface but the total length of all indications shall not exceed twice the length of the surface. No indication shall break into a fillet or over an edge.

6.1.2.4 Threads: Threads shall not reveal indications of cracks, seams, pipes, or rolling laps as shown by Figs. 4, 5, and 6 except that indications of slight laps as shown by Figs. 7, 8, and 9 will be permitted.

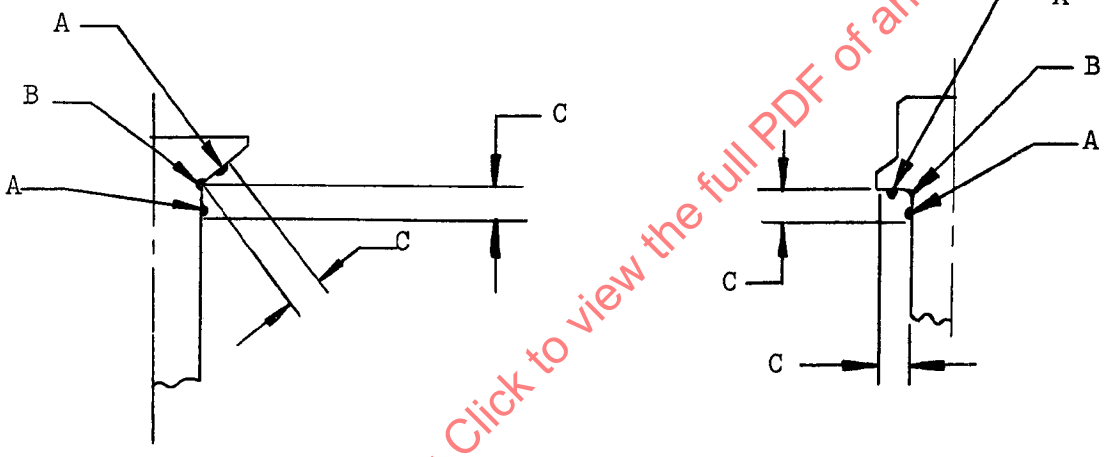
6.2 Any method of magnetic particle inspection may be used to determine conformance of the parts to the above requirements, but resolution of disputed rejections shall be based upon the wet, residual, black oxide suspension method using amperages shown in 6.2.1 and 6.2.2.

6.2.1 Circular Magnetization: 800 - 1000 amp per sq in. of smallest contact area passed through the part longitudinally.

6.2.2 Longitudinal Magnetization: Sufficient to produce 5000 amp-turns per inch of shank diameter with the part placed in a standard solenoid of appropriate size.

7. REPORTS: Unless otherwise specified, the vendor of parts shall furnish with each shipment three copies of report stating that the chemical composition of the parts conforms to the requirements of the applicable material specification and showing the results of tests to determine conformance to the hardness and room temperature tensile strength requirements of this specification. This report shall include the purchase order number, specification number, contractor or other direct supplier of material, part number, and quantity.

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



Nominal Bolt Diameter	C, max
Under 0.3125	0.062
0.3125 and 0.375	0.094
0.4375 - 0.625, incl	0.125
0.750 - 1.000, incl	0.156
Over 1.000	0.188

PERMISSIBLE DISTORTION FROM FILLET WORKING

Figure 1.

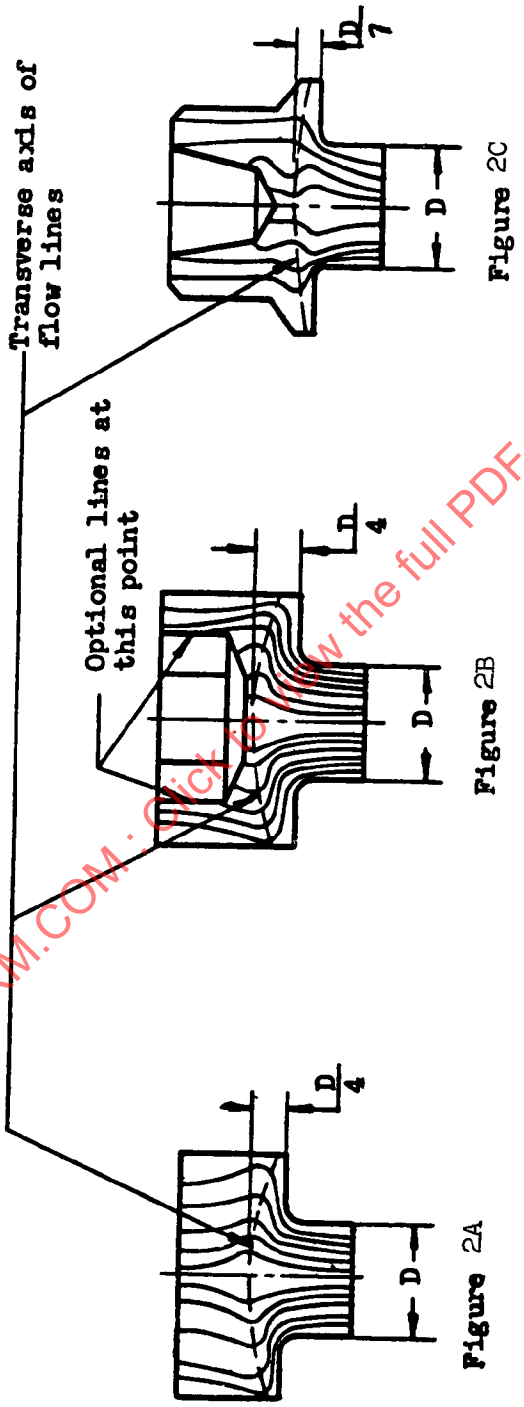


Figure 2C

Figure 2B

Figure 2A

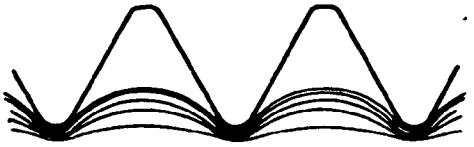


Figure 3
Flow Lines - Rolled Thread

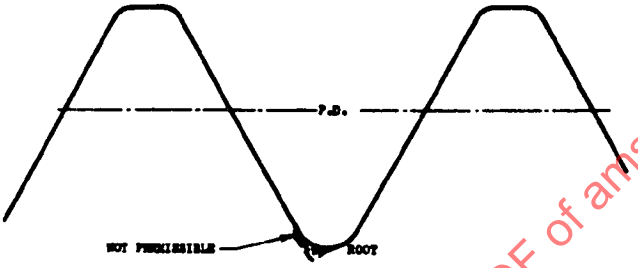


Figure 4
Rolled Thread

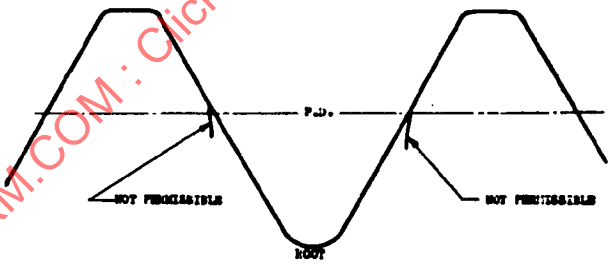


Figure 5
Rolled Thread

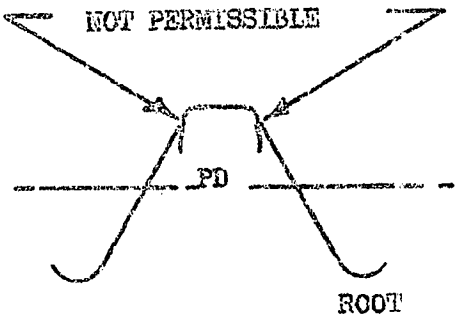


Figure 6
Rolled Thread