SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS1177 | REV. A

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Superseding AS1177

Nondestructive Inspection Standards for Bolts and Screws

RATIONALE

AS1177A has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Purpose:

To establish the acceptance criteria of surface discontinuities of bolts and screws.

1.1.1 This acceptance criteria establishes the location, number, size, depth, and type of surface discontinuities that are permitted on bolts and screws as revealed by visual, magnetic particle, or fluorescent penetrant inspection.

1.2 Application:

Applicable to all types of bolts and screws made of low alloy steel (magnetic) or corrosion and heat resistant alloys (magnetic or nonmagnetic) that are primarily used in aerospace propulsion systems.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply; they are available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2640 Magnetic Particle Inspection
AMS 2645 Fluorescent Penetrant Inspection

2.2 Definitions:

2.2.1 DISCONTINUITY: An interruption in the normal physical structure or configuration of a part; such as a lap, seam, inclusion, crack, machining tear, or stringer.

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2.2.2 DEFECT: Any nonconformance of the unit of product with the specified requirements that is severe enough to cause the service of the product not to be fulfilled.

2.2.3 LAP: A surface imperfection appearing as a seam or crack, caused by folding of material during such operations as forming, rolling, or drawing.

2.2.4 SEAM: Open surface imperfection that is narrow and continuous, usually straight, running generally parallel to the bolt or screw axis. Seams are generally inherent in the bar from which the bolt or screw is made.

2.2.5 INCLUSION: Nonmetallic particles inherent in the material when it was made. These particles may be isolated or distributed in the form of longitudinal stringers.

2.2.6 CRACK: A fracture passing through or across grain boundaries. Cracks may occur during heat treatment or may be caused by over-stressing the metal during forging of forming.

2.2.7 MACHINING TEAR: A pattern of short, jagged individual cracks, generally at right angles to the direction of machining, frequently the result of improperly set cutting tools, or dull cutting tools.

2.2.8 STRINGER: A solid nonmetallic impurity in the metal bar, often the result of inclusions that have been extended during the rolling process.

3. TECHNICAL REQUIREMENTS:

3.1 Nonpermissible Discontinuities:

The following discontinuities shall be cause for rejection of parts inspected by either magnetic particle or fluorescent penetrant inspection procedures:

3.1.1 Discontinuities transverse to grainflow (i.e., at an angle of more than 10° to the axis of the shank), such as cracks, stringers, machining tears, and quench cracks.

3.1.2 Longitudinal discontinuities (i.e., at an angle of 10° or less to the axis of the shank) due to discontinuities other than seams, forming laps, and nonmetallic inclusions.

3.2 Magnetic Particle Inspection:

Parts inspected by magnetic particle inspection shall be considered acceptable if longitudinal discontinuities (i.e., at an angle of 10° or less to the axis of the shank) of seams, forming laps, and nonmetallic inclusions parallel to the grainflow are within the following limits, provided that the separation between discontinuities is not less than 0.06 inch (1.52 mm) in all directions:

3.2.1 Sides of Head: There shall be not more than six surface or subsurface discontinuities per head. The length of each discontinuity may be the full height of the surface but no discontinuity shall break over either edge to a depth greater than 0.03 inch (0.76 mm) or the equivalent of the basic thread height (see Table 1), whichever is less.

3.2.2 Shank or Stem: There shall be not more than 10 subsurface and hairline surface discontinuities. The length of any discontinuity may be the full length of the surface but the total length of all discontinuities shall not exceed twice the length of the surface. No discontinuity shall break into a fillet or over an edge.

3.2.3 Threads:

3.2.3.1 Root defects such as laps, seams, notches, slivers, folds, roughness, and oxide scale are not permissible (see Figure 1).

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 Figures 2 and 3).

3.2.3.3 There shall be no laps along the flank of the thread below the pitch diameter (see Figure 4). A single lap is permissible along the flank of the thread above the pitch diameter on either the pressure or nonpressure flank (one lap at any cross-section through the thread) provided it extends toward the crest and generally parallel to the flank (see Figure 4).

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 1) as measured from the thread crest when the thread major diameter is at minimum size (see Figure 5). 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 1 may be increased by one-half of the difference between the minimum major diameter and actual major diameter as measured on the part.

3.2.4 Top of Head and End of Stem: The number of discontinuities is not restricted but the depth of any individual discontinuity shall not exceed 0.01 inch (0.25 mm). No discontinuity, except those of 3.2.1, shall break over an edge.

3.2.5 Sectioned Specimens: Depth of discontinuities shall be determined by microscopic examination on representative samples of sectioned specimens, polished and etched, of the part discontinuity.

3.3 Fluorescent Penetrant Inspection:

Parts inspected by fluorescent penetrant inspection shall be considered acceptable if longitudinal discontinuities (i.e., at an angle of 10° or less to the axis of the shank) of seams and forming laps parallel to the grainflow are within the following limits, provided that the separation between discontinuities is not less than 0.06 inch (1.52 mm) in all directions:

3.3.1 Sides of Head: There shall be not more than three discontinuities per head. The length of each discontinuity may be the full height of the surface but no discontinuity shall break over either edge to a depth greater than 0.03 inch (0.76 mm) or the equivalent of the basic thread height (see Table 1), whichever is less.

3.3.2 Shank or Stem: There shall be not more than five discontinuities. The length of any discontinuity may be the full length of the surface but the total length of all discontinuities shall not exceed twice the length of the surface. No discontinuity shall break into a fillet or over an edge.

3.3.3 Threads:

3.3.3.1 Root defects such as laps, seams, notches, slivers, folds, roughness, and oxide scale are not permissible (see Figure 1).

3.3.3.2 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 Figures 2 and 3).

3.3.3.3 There shall be no laps along the flank of the thread below the pitch diameter (see Figure 4). A single lap is permissible along the flank of the thread above the pitch diameter on either the pressure or nonpressure flank (one lap at any cross-section through the thread) provided it extends toward the crest and generally parallel to the flank (see Figure 4).

3.3.3.4 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 1) as measured from the thread crest when the thread major diameter is at minimum size (see Figure 5). 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 1 may be increased by one-half of the difference between the minimum major diameter and actual major diameter as measured on the part.

3.3.4 Top of Head and End of Stem: The number of discontinuities is not restricted but the depth of any individual discontinuity shall not exceed 0.01 inch (0.25 mm). No discontinuity, except those of 3.3.1, shall break over an edge.

3.3.5 Sectioned Specimens: Depth of discontinuities shall be determined by microscopic examination on representative samples of sectioned specimens, polished and etched, of the part discontinuity.

4. INSPECTION PROCEDURES:

4.1 Magnetic Particle Inspection:

The inspection shall be conducted in accordance with AMS 2640; any method may be used but resolution of disputed rejections shall be based upon the wet, continuous, fluorescent suspension method using amperages shown in 4.1.1 and 4.1.2.

4.1.1 Circular Magnetization: 800 to 1000 amperes per square inch (1.24 to 1.55 amperes per square millimeter) of contact area, passed through the part longitudinally.

4.1.2 Longitudinal Magnetization: Sufficient to produce 5000 ampere-turns per inch (196.85 ampere-turns per mm) of shank diameter with the part placed in a standard solenoid of appropriate size.

4.2 Fluorescent Penetrant Inspection:

The inspection shall be conducted in accordance with AMS 2645.

5. NOTES:

5.1 Dimensions and amperages in U.S. customary units are primary; SI units are shown (in parentheses) as the approximate equivalents of the primary units and are presented only for information.

5.2 Marginal Indicia:

The change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document.

PREPARED BY SAE COMMITTEE E-25,
GENERAL STANDARDS FOR PROPULSION SYSTEMS

TABLE 1 - Thread Height

Thread Pitches Per Inch n	Basic Thread Height (See Note 1) (UN and UNJ) inch	20% Basic Thread Height inch
80	0.0081	0.0016
72	0.0090	0.0018
64	0.0102	0.0020
56	0.0116	0.0023
48	0.0135	0.0027
44	0.0148	0.0030
40	0.0163	0.0033
36	0.0181	0.0036
32	0.0203	0.0041
28	0.0232	0.0046
24	0.0271	0.0054
20	0.0325	0.0065
18	0.0361	0.0072
16	0.0406	0.0081
14	0.0464	0.0093
13	0.0500	0.0100
12	0.0542	0.0108
11	0.0591	0.0118
10	0.0650	0.0130
9	0.0722	0.0144
8	0.0813	0.0163

NOTE 1: Basic thread height is defined as being equivalent to 0.650 times the pitch, where pitch equals 1/n.

TABLE 1A - Thread Height, SI Units

Thread Pitches Per Inch n	Basic Thread Height (See Note 1) (UN and UNJ) mm	20% Basic Thread Height mm
80	0.206	0.041
72	0.229	0.046
64	0.251	0.051
56	0.259	0.058
48	0.343	0.069
44	0.376	0.076
40	0.414	0.084
36	0.460	0.091
32	0.516	0.104
28	0.589	0.117
24	0.688	0.137
20	0.826	0.165
18	0.917	0.183
16	1.031	0.206
14	1.179	0.236
13	1.270	0.254
12	1.377	0.274
11	1.501	0.300
10	1.651	0.330
9	1.834	0.366
8	2.065	0.414

NOTE 1: Basic thread height is defined as being equivalent to 0.650 times the pitch where pitch equals 25.4/n.