



# AEROSPACE STANDARD

**AS7478™****REV. E**

Issued 1991-01  
Reaffirmed 2006-05  
Revised 2021-04

Superseding AS7478D

(R) Bolts and Screws, Steel, UNS S66286  
Classification: 130 ksi/1200 °F  
1800 °F Solution Heat Treated, Aged After Roll Threaded  
Procurement Specification for

FSC 5306

## RATIONALE

AS6416 added, many paragraphs updated or deleted, specs updated, figures redrawn, notes updated.

### 1. SCOPE

This procurement specification covers bolts and screws made from a corrosion and heat resistant, age hardenable iron base alloy of the type identified under the Unified Numbering System as UNS S66286.

#### 1.1 Type

The following specification designations and their properties are covered:

AS7478: 130 ksi minimum ultimate tensile strength at room temperature  
65 ksi stress-rupture strength at 1200 °F

AS7478-2: 130 ksi minimum ultimate tensile strength at room temperature  
78 ksi minimum ultimate shear strength at room temperature

##### 1.1.1 Classification

130 ksi minimum tensile strength at room temperature  
1200 °F maximum test temperature of parts

#### 1.2 Application

Primarily for aerospace propulsion system applications where stress-rupture strength and creep resistance are required at elevated temperature.

#### 1.3 Safety - Hazardous Materials

While the materials, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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Full document details: SAE AS7478E

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Documents

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## 2. REFERENCES

### 2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

#### 2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

|           |                                                                                                                                                                                                   |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AMS2759/3 | Heat Treatment, Precipitation-Hardening Corrosion-Resistant, Maraging, and Secondary Hardening Steel Parts                                                                                        |
| AMS5731   | Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing, and Rings, 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V, Consumable Electrode Melted, 1800 °F (982 °C) Solution Heat Treated |
| AS1132    | Bolts, Screws, and Nuts - External Wrenching UNJ Thread, Inch - Design Standard                                                                                                                   |
| AS3062    | Bolts, Screws, and Studs, Screw Thread Requirements                                                                                                                                               |
| AS3063    | Bolts, Screws, and Studs, Geometric Control Requirements                                                                                                                                          |
| AS6416    | Bolts, Screws, Studs and Nuts, Definitions for Design, Testing and Procurement                                                                                                                    |
| AS8879    | Screw Threads - UNJ Profile, Inch, Controlled Radius Root with Increased Minor Diameter                                                                                                           |

#### 2.1.2 AIA/NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, [www.aia-aerospace.org](http://www.aia-aerospace.org).

|             |                                                     |
|-------------|-----------------------------------------------------|
| NASM1312-6  | Fastener Test Methods, Method 6, Hardness           |
| NASM1312-8  | Fastener Test Methods, Method 8, Tensile Strength   |
| NASM1312-10 | Fastener Test Methods, Method 10, Stress-Rupture    |
| NASM1312-13 | Fastener Test Methods, Method 13, Double Shear Test |

#### 2.1.3 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), [www.asme.org](http://www.asme.org).

|            |                                                        |
|------------|--------------------------------------------------------|
| ASME B46.1 | Surface Texture (Surface Roughness, Waviness, and Lay) |
|------------|--------------------------------------------------------|

## 2.1.4 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

|                   |                                                                                |
|-------------------|--------------------------------------------------------------------------------|
| ASTM D3951        | Standard Practice for Commercial Packaging                                     |
| ASTM E8/E8M       | Standard Test Methods for Tension Testing of Metallic Materials                |
| ASTM E112         | Determining Average Grain Size                                                 |
| ASTM E139         | Conducting Creep, Creep-Rupture, and Stress-Rupture Test of Metallic Materials |
| ASTM E140         | Standard Hardness Conversion Tables for Metals                                 |
| ASTM E1417/E1417M | Standard Practice for Liquid Penetrant Inspection                              |

## 2.2 Definitions

Refer to AS6416.

## 2.3 Unit Symbols

|       |                                    |
|-------|------------------------------------|
| °     | degree, angle                      |
| °C    | degree Celsius                     |
| °F    | degree Fahrenheit                  |
| %     | percent (1% = 1/100)               |
| lbf   | pound-force                        |
| ksi   | kips (1000 pounds) per square inch |
| sp gr | specific gravity                   |
| HRC   | hardness, Rockwell C scale         |

## 3. TECHNICAL REQUIREMENTS

### 3.1 Material

Shall be AMS5731 steel heading stock, unless otherwise specified on part drawing.

### 3.2 Design

Finished (completely manufactured) parts shall conform to the following requirements:

#### 3.2.1 Dimensions

The dimensions shall conform to the requirements as specified on the part drawing unless otherwise stated. Dimensions apply after plating but before lubrication or coating with dry film lubricants.

#### 3.2.2 Surface Texture

Surface texture of finished parts, prior to plating or coating, shall conform to the part drawing, determined in accordance with ASME B46.1.

### 3.2.3 Threads

Threads shall be in accordance with AS8879, unless otherwise specified on the part drawing.

#### 3.2.3.1 Incomplete Lead and Runout Threads

Incomplete threads and runouts are permissible as specified in AS3062.

#### 3.2.3.2 Chamfer

Bolts shall be chamfered as specified on the part drawing.

### 3.2.4 Geometric Tolerances

Part features shall be within the geometric tolerances specified on the part drawing and, where applicable, controlled in accordance with AS3063.

## 3.3 Fabrication

### 3.3.1 Blanks

Heads shall be formed by hot forging, cold forging, or machining. Heading stock to be hot forged shall be heated to a temperature not higher than 2100 °F. Lightening holes may be produced by any suitable method. Wrenching recesses may be forged or machined. Flash or chip clearance in machined recesses shall not cause dimensions to exceed the specified limits.

### 3.3.2 Heat Treatment

Shall conform to the technical requirements and other provisions specified in AMS2759/3 for A-286, 1800 °F solution heat treatment and 1325 °F aging treatment.

#### 3.3.2.1 Solution Heat Treatment

Headed and machined blanks of AMS5731, unless machined from solution heat treated stock, shall, before finishing the shank and the bearing surface of the head, cold rolling the head-to-shank fillet radius when specified, and rolling the threads, be solution heat treated as in 3.3.2. Blanks of other materials shall be solution heat treated in accordance with the applicable material specification. If blanks are machined from solution heat treated stock, only the aging treatment as in 3.3.2.2 is necessary.

#### 3.3.2.2 Aging Treatment

After cold rolling the fillet radius as in 3.3.4 when specified and rolling the threads as in 3.3.5, parts of AMS5731 shall be heat treated by aging as in 3.3.2. Parts of other materials shall be heat treated by aging after cold rolling the fillet radius as in 3.3.4 when specified and rolling the threads as in 3.3.5, in accordance with the applicable material specification.

### 3.3.3 Oxide Removal

Surface oxide resulting from prior heat treatment shall be removed from the full body diameter, thread roll diameter and bearing surface of the head of the solution heat treated blanks prior to cold rolling the fillet radius when specified and rolling the threads by a method such as (e.g., centerless grinding). The oxide 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.

### 3.3.4 Cold Rolling of Fillet Radius

After removal of oxide as in 3.3.3, the head-to-shank fillet radius of headed parts having the radius complete throughout the circumference of the part when specified shall be cold rolled sufficiently to remove all visual evidence of grinding or tool marks. If there is no visual evidence of grinding or tool marks prior to cold working, the fillet shall still be cold worked. Distortion due to cold rolling shall conform to Figure 1, unless otherwise specified on the part drawing. It shall not raise metal more than 0.002 inch above the contour at "A" or depress metal more than 0.002 inch below the contour at "B" as shown in Figure 1; distorted areas shall not extend beyond "C" as shown in Figure 1. In configurations having an undercut connected with the fillet radius, the cold rolling will be required only for 90 degrees of fillet arc, starting at the point of tangency of the fillet radius and the bearing surface of the head. For shouldered bolts having an unthreaded shank diameter larger than the thread major diameter and having an undercut connected with a fillet between the threaded shank and the shoulder of the unthreaded shank, the cold working will be required only for 90 degrees of fillet arc, starting at the point of tangency of the fillet radius and the shouldered surface of the unthreaded shank.

#### 3.3.4.1 Undercut Bolt Heads

In configurations having an undercut connected with the fillet radius, the cold working will be required only for 90 degrees of fillet arc, starting at the point of tangency of the fillet radius and the bearing surface of the head.

#### 3.3.4.2 Shouldered Bolts

For shouldered bolts, having an unthreaded shank diameter larger than the thread major diameter and having an undercut connected with a fillet between the threaded shank and the shoulder of the unthreaded shank, the cold working will be required only for 90 degrees of the fillet arc, starting at the point of tangency of the fillet radius and the shouldered surface of the unthreaded shank.

#### 3.3.4.3 Close Tolerance Bolts

The shank diameter on full shank close tolerance bolts shall not exceed its maximum diameter limit after cold rolling the head to shank fillet radius.

### 3.3.5 Thread Rolling

Threads shall be formed on the finished blanks by a single cold rolling process after removal of oxide as in 3.3.3.

### 3.3.6 Cleaning

Bolts, after finishing, shall be cleaned in one of the following solutions for the time and temperature shown and then thoroughly rinsed:

- a. One volume of nitric acid (sp gr 1.42) and nine volumes of water for not less than 20 minutes at room temperature.
- b. One volume of nitric acid (sp gr 1.42) and four volumes of water for 30 to 40 minutes at room temperature.
- c. One volume of nitric acid (sp gr 1.42) and four volumes of water for 10 to 15 minutes at 140 to 160 °F.
- d. ASTM A967, ASTM A380, or AMS2700 for cleaning parts only, excluding any additional verification requirements (such as salt spray).

### 3.4 Plating or Coating

Where required, bolts shall be plated or dry film lubricated as specified by the part drawing.

### 3.5 Mechanical Properties

Bolts for tensile and stress-rupture tests shall be of sufficient size to develop the full strength of the bolt without stripping the thread. The loaded portion of the shank shall have a minimum of two to three full threads from the thread runout exposed between the loading fixtures during tensile test.

AS7478 finished parts shall be tested in accordance with the following test methods:

- a. Hardness: MIL-STD-1312-6 in accordance with NASM1312-6.
- b. Room temperature ultimate tensile strength: MIL-STD-1312-8 in accordance with NASM1312-8.
- c. Stress-rupture strength at 1200 °F: MIL-STD-1312-10 in accordance with NASM1312-10.

AS7478-2 finished parts shall be tested in accordance with the following test methods:

- a. Hardness: MIL-STD-1312-6 in accordance with NASM1312-6.
- b. Room temperature ultimate tensile strength: MIL-STD-1312-8 in accordance with NASM1312-8.
- c. Ultimate double shear at room temperature: MIL-STD-1312-13 in accordance with NASM1312-13.

### 3.5.1 Ultimate Tensile Strength at Room Temperature

#### 3.5.1.1 Finished Parts

Tension fasteners with either standard double hexagon or spline drive heads having a minimum metal condition in the head equal to the design parameters specified in AS1132, shall not fracture in the head-to-shank fillet radius except when this radius is connected with an undercut or with a shank diameter less than the minimum pitch diameter of the thread. The loaded portion of the shank shall have a minimum of two to three full threads from the thread runout exposed between the loading fixtures during tensile test. Tension bolts, such as hexagon, double hexagon, and spline drive head, shall have an ultimate tensile load not lower than that specified in Table 2A and shall be tested to failure in order to observe fracture location, first measuring and recording the maximum tensile load achieved. Screws, such as 100 degree flush head, pan head, and fillister head, shall have an ultimate tensile load not lower than that specified in Table 2B.

#### 3.5.1.2 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 E8/E8M on specimens as in 4.2.7. Specimens may be required by purchaser to perform confirmatory tests. Such specimens shall meet the following requirements:

- a. Ultimate tensile strength, minimum: 130 ksi.
- b. Yield strength at 0.2% Offset, minimum: 85 ksi.
- c. Elongation in 2 inches or 4D, minimum: 15%.
- d. Reduction of area, minimum: 20%.

### 3.5.2 Hardness

Shall be within the range 24 to 35 HRC (see 8.1), but hardness of the threaded section and of the head-to-shank fillet area when cold rolling of this area is specified, may be higher as a result of the cold rolling operations. Bolts shall not be rejected on the basis of hardness if the tensile strength properties of the part, specified in 3.6.1 are met.

### 3.5.3 Ultimate Shear Strength

Finished bolts having a close toleranced full shank as in AS1132 shall have an ultimate double shear load not lower than that specified in Table 2. The double shear test may be discontinued without a complete shear failure after the ultimate double shear load has been reached, recording the load achieved. Shear bolts having special diameters shall have the double shear load based on 78 ksi minimum shear strength. Shear test is not required for the following conditions: