



<b>AEROSPACE MATERIAL SPECIFICATION</b>	<b>AMS6559™</b>	<b>REV. A</b>
	Issued 2013-07 Revised 2018-06 Reaffirmed 2023-05	
Superseding AMS6559		
Steel, Bars, Wire, and Forgings 9.75V - 5.25Cr - 1.3Mo (2.40 - 2.55C) Powder Metallurgy Product Hot Isostatically Pressed (Composition similar to UNS T30111)		

### RATIONALE

AMS6559A results from a Five-Year Review and update that revises composition analytical methods (3.1), decarburization (3.4.3), and quality (3.5.2), adds no unauthorized exceptions (3.7), and revises reporting (4.4) and identification (5.2.1).

AMS6559A has been reaffirmed to comply with the SAE Five-Year Review policy.

#### 1. SCOPE

##### 1.1 Form

This specification covers a premium aircraft-quality, high-alloy tool steel gas-atomized and HIP-consolidated in the form of bars, wire, forgings, and forging stock.

##### 1.2 Application

These products have been used typically for critical parts, such as bearings operating under heavy loads and high speeds at moderate temperatures and subject to very rigid inspection standards, but usage is not limited to such applications.

#### 2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

##### 2.1 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).

AMS2248 Chemical Check Analysis Limits Corrosion and Heat-Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys

AMS2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock

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For more information on this standard, visit  
<https://www.sae.org/standards/content/AMS6559A/>

AMS2372	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Forgings
AMS2806	Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys
AMS2808	Identification, Forgings
ARP1917	Clarification of Terms Used in Aerospace Metals Specifications
AS1182	Standard Stock Removal Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical Tubing

## 2.2 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 E45	Determining the Inclusion Content of Steel
ASTM E140	Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
ASTM A370	Mechanical Testing of Steel Products
ASTM A751	Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
ASTM E384	Microindentation Hardness of Materials
ASTM E1077	Standard Test Methods for Estimating the Depth of Decarburization of Steel Specimens

## 2.3 European Committee for Standardization

Available from British Standards Institution Group, 389 Chiswick High Road, London, W4 4AL, United Kingdom, Tel: +44 (0) 20 8996 9001, [www.bsigroup.com](http://www.bsigroup.com).

Or:

National Standards Authority of Ireland, 1 Swift Square, Northwood, Santry, Dublin 9, Ireland, Tel: +353 1 807 3800, [www.nsai.ie](http://www.nsai.ie).

EN 10228	Steel Cleanliness Non-Destructive testing of Steel Forgings – Part 3: Ultrasonic Testing of Ferritic or Martensitic Steel
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## 3. TECHNICAL REQUIREMENTS

### 3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751 or by other analytical methods acceptable to purchaser.

**Table 1 - Composition**

Element	Min	Max
Carbon	2.40	2.55
Manganese	0.35	0.70
Silicon	0.70	1.10
Phosphorus	--	0.030
Sulfur	--	0.030
Chromium	4.75	5.75
Nickel	--	0.50
Cobalt	--	1.00
Molybdenum	1.00	1.50
Vanadium	9.25	10.00

### 3.1.1 Check Analysis

Composition variations shall meet the requirements of AMS2248, except that carbon shall be  $\pm 0.04\%$  and vanadium  $\pm 0.10\%$ .

### 3.2 Melting Practice

Steel shall be produced by inert gas atomization of pre-alloyed melts, with resulting powder consolidated via hot isostatic pressing (HIP). Sintering or the use of binders or fillers to consolidate powder is not permitted. Blending of elemental powders to achieve the required chemical composition is not permitted.

### 3.3 Condition

The product shall be supplied in the following condition; hardness shall be determined in accordance with ASTM A370.

#### 3.3.1 Bars

3.3.1.1 Annealed material shall have hardness not higher than 300BHN, or equivalent hardness (see 8.2).

3.3.1.2 Hot drawn material shall have hardness not higher than 320BHN, or equivalent hardness (see 8.2).

#### 3.3.2 Wire

Hot finished having tensile strength not higher than 177 ksi (1220 MPa), or equivalent hardness (see 8.3).

#### 3.3.3 Forgings

As ordered.

#### 3.3.4 Forging Stock

As ordered by the forging manufacturer.

### 3.4 Properties

#### 3.4.1 Response to Heat Treatment of Each Lot of Bars, Forgings, Wire and Forging Stock

Specimen or samples cut from larger products with section thickness not exceeding 0.375 inch (9.52 mm) shall have hardness not lower than 60 HRC, or equivalent (see 8.2), after being heat treated in accordance with the following heat treatment: Preheat in two steps at 842 to 932 °F (450 to 500 °C) and at (850 to 900 °C), hold for 1 minute at each temperature, austenitize at 2155 °F (1179 °C), quench down to 100 to 120 °F (38 to 49 °C) or lower in air, temper three times at 1040 °F (560 °C) at least 1 hour at temperature each time, air cool to room temperature 77 °F (25 °C) between tempers.

## 3.4.2 Micro-Inclusion Rating of Each Heat

No specimen shall exceed the limits of Table 2, determined in accordance with ASTM E45, Method A.

**Table 2 - Micro-inclusion rating**

Type	A	B	C	D
Thin	1.5	1.5	1.5	1.5
Heavy	1.0	1.0	1.0	1.0

## 3.4.3 Decarburization

3.4.3.1 Bars and wire ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces.

3.4.3.2 Allowable decarburization of bars, wire, and billets ordered for forging or to specified microstructural requirements shall be as agreed upon by purchaser and producer.

3.4.3.3 Where 3.4.3.1 or 3.4.3.2 are not applicable, decarburization of bars and wire shall be not greater than shown in Table 3.

**Table 3****Table 3A - Maximum depth of decarburization, inch/pound units**

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarburization Inch
Up to 0.500, incl	0.010
Over 0.500 to 1.000, incl	0.015
Over 1.000 to 1.500, incl	0.020
Over 1.500 to 2.000, incl	0.025
Over 2.000 to 2.500, incl	0.030
Over 2.500 to 3.000, incl	0.035
Over 3.000 to 4.000, incl	0.045

**Table 3B - Maximum depth of decarburization, SI units**

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 12.70, incl	0.25
Over 12.70 to 25.40, incl	0.38
Over 25.40 to 38.10, incl	0.51
Over 38.10 to 50.80, incl	0.64
Over 50.80 to 63.50, incl	0.76
Over 63.50 to 76.20, incl	0.89
Over 76.20 to 101.60, incl	1.14

3.4.3.4 Decarburization shall be evaluated by one of the two methods of 3.4.3.4.1 or 3.4.3.4.2.

### 3.4.3.5 Metallographic Method

A cross section of the surface shall be prepared in accordance with ASTM E1077 and examined metallographically at a magnification not to exceed 100X. Optical indications of decarburization shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

#### 3.4.3.5.1 Hardness Traverse Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E384 conducted on a hardened but untempered specimen protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization is defined as the perpendicular distance from the surface to the depth under that surface where there is not further increase in hardness. Such measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization on the adjacent surface. Acceptance shall be as listed in Table 3.

3.4.3.5.2 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the above limits by more than 0.005 inch (0.13 mm) and the width is 0.065 inch (1.65 mm) or less.

3.4.3.6 In case of dispute, the total depth of decarburization determined using the microindentation hardness traverse method shall govern.

## 3.5 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.5.1 Steel shall be premium quality conforming to EN 10228, Quality Class 4 (see 8.6).

3.5.2 Bars shall be free from seams, laps, tears, and cracks after removal of the standard stock removal allowance in accordance with AS1182.

3.5.3 Grain flow of die forgings, except in areas that contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

## 3.6 Tolerances

As agreed between producer and purchaser.

3.7 Any exceptions shall be authorized by purchaser and reported as in 4.4.3.

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

### 4.2 Classification of Tests

#### 4.2.1 Acceptance Tests

Composition (3.1), condition (3.3), hardness (3.3.1), response to heat treatment (3.4.1), micro-inclusion rating (3.4.2), freedom of internal defects (3.5.1) and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

#### 4.2.2 Periodic Tests

Decarburization (3.4.3) and grain flow of die forgings (3.5.3) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.

#### 4.3 Sampling and Testing

##### 4.3.1 Bars, Wire, and Forging Stock

In accordance with AMS2370.

##### 4.3.2 Forgings

In accordance with AMS2372.

#### 4.4 Reports

4.4.1 The producer of bars, forgings and wire shall furnish with each shipment a report showing the producer identity, country where the metal was produced, the results of tests for composition of each heat, condition, hardness and response to heat treatment of each lot and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS6559A, product form and size (and/or part number, if applicable), and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.

4.4.2 The producer of forging stock shall furnish with each shipment a report showing the producer identity and country where the metal was produced, the results of tests for composition, condition hardness and response to heat treatment. This report shall include the purchase order number, heat and lot numbers, AMS6559A, product form and size (and/or part number, if applicable), and quantity.

4.4.3 When material produced to this specification has exceptions authorized by purchaser taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS6559A(EXC) because of the following exceptions:" and the specific exceptions shall be listed (see 5.2.1).

#### 4.5 Resampling and Retesting

##### 4.5.1 Bars, Wire, and Forging Stock

In accordance with AMS2370.

##### 4.5.2 Forgings

In accordance with AMS2372.

### 5. PREPARATION FOR DELIVERY

#### 5.1 Sizes

Except when exact lengths or multiples of exact lengths are ordered, straight bars and wire will be acceptable in mill lengths of 6 to 20 feet (1.8 to 6.1 m), but not more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).

#### 5.2 Identification

##### 5.2.1 Bars and Wire

In accordance with AMS2806 for tagging. When technical exceptions authorized by purchaser are taken (see 4.4.3), the material shall be identified with AMS6559A(EXC).

Line marking is optional.