

Steel, Bars, Wire, and Forgings
10.5 Mo - 6 W - 3.75 Cr - 2 V (1.25 - 1.40 C)
Powder Metallurgy Product
Hot Isostatically Pressed
(Composition similar to UNS T11362)

RATIONALE

AMS6558 is a new specification to cover UNS T11362, a high speed steel, in the form of gas-atomized and HIP-consolidated solid bar products, forgings and forging stock.

1. SCOPE

1.1 Form

This specification covers a premium aircraft-quality, high-alloy steel 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, PA15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), 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

AMS2372 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Forgings

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on this Technical Report, please visit
<http://www.sae.org/technical/standards/AMS6558>**

- AMS2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys
- AMS2808 Identification, Forgings
- 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, PA19428-2959, Tel: 610-832-9585, www.astm.org.

- ASTM E 45 Determining the Inclusion Content of Steel
- ASTM A 370 Mechanical Testing of Steel Products
- ASTM E 350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
- ASTM E 384 Knoop and Vickers Hardness of Materials

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

Or: National Standards Authority of Ireland, 1 Swift Square, Northwood, Santry, Dublin 9, Ireland, Tel: +353 1 807 3800, www.nsai.ie.

- EN 10228 Steel Cleanliness Non-destructive testing of Steel Forgings – Part 3: Ultrasonic Testing of Ferritic or Martensitic Steel

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Carbon	1.25	1.40
Manganese	0.20	0.40
Silicon	0.15	0.40
Phosphorus		0.030
Sulfur		0.030
Chromium	3.40	4.00
Nickel		0.50
Cobalt		1.00
Molybdenum	10.00	11.00
Tungsten	5.75	6.50
Vanadium	1.80	2.10
Nitrogen		0.10

3.1.1 Check Analysis

Composition variations shall meet the requirements of AMS2248, except that carbon shall be plus or minus 0.04% and vanadium plus or minus 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 A 370.

3.3.1 Bars

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

3.3.1.2 Hot-drawn material shall have hardness not higher than 360 BHN 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 65 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 1562 to 1652 °F (850 to 900 °C), hold for one minute at each temperature, austenitize at 2175 °F (1190 °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 E 45, 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 vendor.
- 3.4.3.3 Decarburization of bars and wire to which 3.4.3.1 or 3.4.3.2 is not applicable shall be not greater than shown in 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 measured by the metallographic method or by a traverse method using microhardness testing in accordance with ASTM E 384. The microhardness method shall be conducted on a hardened but untempered specimen protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization, when measured by the microhardness method, is defined as the perpendicular distance from the surface to the depth under that surface where there is no 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. In case of dispute, the depth of decarburization determined using the microhardness traverse method shall govern.
- 3.4.3.4.1 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.

3.5 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 and wire ordered hot rolled or cold drawn, or ground, turned, or polished shall, after removal of the standard stock removal allowance in accordance with AS1182, be free from seams, laps, tears, and cracks open to the machined, ground, turned, or polished surface.

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 vendor and purchaser.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of the product shall supply all samples for vendor'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 vendor 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

The vendor of the product shall furnish with each shipment a report showing the following results of tests and relevant information: