

# AEROSPACE MATERIAL SPECIFICATION

**SAE** AMS6277

REV. G

Issued 1963-07  
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Superseding AMS6277F

Steel, Bars, Forgings, and Tubing  
0.50Cr - 0.55Ni - 0.20Mo (0.18 - 0.23C) (SAE 8620)  
Vacuum Arc or Electroslag Remelted

(Composition similar to UNS G86200)

## RATIONALE

AMS6277G results from a Five Year Review and update of this specification.

### 1. SCOPE

#### 1.1 Form

This specification covers a premium aircraft-quality, low-alloy steel in the form of bars, forgings, mechanical tubing, and forging stock.

#### 1.2 Application

These products have been used typically for carburized parts requiring high minimum core hardness in sections 0.375 inch (9.52 mm) and under in nominal thickness, and that are subject to rigid magnetic particle standards, but usage is not limited to such applications. The core may or may not be machinable after hardening.

#### 1.3 Classification

Steel covered by this specification is classified by melting practice as follows:

Type 1 Multiple melted using electroslag (ESR) remelting in the final melt cycle.

Type 2 Multiple melted using consumable electrode vacuum arc (VAR) remelting in the final melt cycle.

1.3.1 Unless a specific type is ordered, either type may be supplied.

### 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.

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## 2.1 SAE Publications

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

|         |   |
|---------|---|
| AMS2251 | Tolerances, Low-Alloy Steel Bars  |
| AMS2253 | Tolerances, Carbon and Alloy Steel Tubing   |
| AMS2259 | Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels   |
| AMS2300 | Steel Cleanliness, Premium Aircraft-Quality, Magnetic Particle Inspection Procedure   |
| 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   |
| 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, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

|            |  |
|------------|--|
| ASTM A 255 | Determining Hardenability of Steel   |
| ASTM A 370 | Mechanical Testing of Steel Products   |
| ASTM A 604 | Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets                                  |
| ASTM E 112 | Determining Average Grain Size   |
| ASTM E 350 | Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron |

## 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     | 0.18 | 0.23  |
| Manganese  | 0.70 | 1.00  |
| Silicon    | 0.15 | 0.35  |
| Phosphorus | --   | 0.012 |
| Sulfur     | --   | 0.010 |
| Chromium   | 0.40 | 0.60  |
| Nickel     | 0.40 | 0.70  |
| Molybdenum | 0.15 | 0.25  |
| Copper     | --   | 0.35  |

### 3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

### 3.2 Melting Practice

Steel shall be multiple melted using either electroslag or consumable electrode vacuum arc practice for the remelt cycle (See 1.3).

### 3.3 Condition

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A 370:

#### 3.3.1 Bars

Bar shall not be cut from plate.

##### 3.3.1.1 Bars 0.500 Inch (12.70 mm) and Under in Nominal Diameter or Least Distance Between Parallel Sides

Cold finished having tensile strength not higher than 125 ksi (862 MPa), or equivalent hardness (See 8.2).

##### 3.3.1.2 Bars Over 0.500 Inch (12.70 mm) in Nominal Diameter or Least Distance Between Parallel Sides

Hot finished and annealed having hardness not higher than 229 HB, or equivalent (See 8.3). Bars ordered cold finished may have hardness as high as 248 HB, or equivalent (See 8.3).

#### 3.3.2 Forgings

As ordered.

#### 3.3.3 Mechanical Tubing

Cold finished, unless otherwise ordered, having hardness not higher than 25 HRC, or equivalent (See 8.3). Tubing ordered hot finished and annealed shall have hardness not higher than 99 HRB, or equivalent (See 8.3).

#### 3.3.4 Forging Stock

As ordered by the forging manufacturer.

### 3.4 Properties

The product shall conform to the following requirements; hardness testing shall be performed in accordance with ASTM A 370:

#### 3.4.1 Macrostructure

Visual examination of transverse full cross-sections from bars, billets, tube rounds, and forging stock, etched in hot hydrochloric acid in accordance with ASTM A 604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM A 604 shown in Table 2.

TABLE 2 - MACROSTRUCTURE LIMITS

| Class | Condition          | Severity |
|-------|--------------------|----------|
| 1     | Freckles           | A        |
| 2     | White spots        | A        |
| 3     | Radial segregation | B        |
| 4     | Ring pattern       | B        |

3.4.1.1 If tubes are produced directly from ingots or large blooms, transverse sections may be taken from tubes rather than tube rounds. Macrostructure standards for such tubes shall be as agreed upon by purchaser and vendor.

#### 3.4.2 Average Grain Size of Bar, Forgings and Tubing

Shall be ASTM No. 5 or finer, determined in accordance with ASTM E 112.

#### 3.4.3 Hardenability of Each Heat

Shall be J 1/16 inch (1.6 mm) = 48 HRC maximum and J 3/16 inch (4.8 mm) = 32 HRC minimum, determined on the standard end-quench test specimen in accordance with ASTM A 255 except that the steel shall be normalized at 1700 °F ± 10 (927 °C ± 6) and the test specimen austenitized 1700 °F ± 10 (927 °C ± 6).

### 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 aircraft-quality conforming to AMS2300.

3.5.2 Bars and mechanical tubing 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 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

#### 3.6.1 Bars

In accordance with AMS2251.

#### 3.6.2 Mechanical Tubing

In accordance with AMS2253.

#### 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) macrostructure (3.4.1), average grain size (3.4.2), hardenability (3.4.3), and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable

###### 4.2.2 Periodic Tests

Frequency-severity cleanliness rating (3.5.1) 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, Mechanical Tubing, and Forging Stock

In accordance with AMS2370.

###### 4.3.2 Forgings

In accordance with AMS2372.

##### 4.4 Reports

4.4.1 The vendor of bars, forgings and tubing shall furnish with each shipment a report showing the results of tests for composition, macrostructure, and hardenability of each heat, and for condition and average grain size 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, AMS6277G, 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 If the ship size/shape is cut from a larger cross section, report the nominal metallurgically worked size (See 3.3.1).

4.4.3 The vendor of forging stock shall furnish with each shipment a report showing the results of tests for composition, macrostructure, and hardenability of each heat and the results of any additional property requirements imposed by 8.6. This report shall include the purchase order number, heat number, AMS6277G, size and quantity.

##### 4.5 Resampling and Retesting

###### 4.5.1 Bars, Mechanical Tubing, and Forging Stock

In accordance with AMS2370.

###### 4.5.2 Forgings

In accordance with AMS2372.