



AEROSPACE MATERIAL

Society of Automotive Engineers, Inc. **SPECIFICATION**

TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AMS 6540B

Superseding AMS 6540A

Issued 2-15-65

Revised 5-15-73

STEEL BARS, FORGINGS, TUBING, AND RINGS
0.48Cr - 8.0Ni - 4.0Co - 0.48Mo - 0.09V (0.24 - 0.30C)
Annealed

1. SCOPE:

- 1.1 Form: This specification covers an aircraft-quality, low-alloy steel in the form of bars, forgings, mechanical tubing, flash welded rings, and stock for forging or flash welded rings.
- 1.2 Application: Primarily for heat treated parts, such as pressure vessels, requiring through-hardening to high strength levels and where such parts may require welding during fabrication.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) and Aerospace Standards (AS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

2.1.1 Aerospace Material Specifications:

AMS 2251 - Tolerances, Alloy Steel Bars
AMS 2253 - Tolerances, Carbon and Alloy Steel Tubing
AMS 2259 - Chemical Check Analysis Limits, Wrought Low-Alloy
and Carbon Steel
AMS 2301 - Aircraft Quality Steel Cleanliness, Magnetic Particle
Inspection Procedure
AMS 2350 - Standards and Test Methods
AMS 2370 - Quality Assurance Sampling of Carbon and Low-Alloy
Steels, Wrought Products Except Forgings
AMS 2372 - Quality Assurance Sampling of Carbon and Low-Alloy
Steels, Forgings and Forging Stock
AMS 2375 - Approval and Control of Critical Forgings
AMS 2808 - Identification, Forgings
AMS 7496 - Rings, Flash Welded, Carbon and Low Alloy Steel

2.1.2 Aerospace Standards:

AS 1182 - Standard Machining Allowance, Aircraft Quality and
Premium Quality Steel Products

- 2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM A370 - Mechanical Testing of Steel Products
ASTM E45 - Determining the Inclusion Content of Steel
ASTM E112 - Estimating Average Grain Size of Metals
ASTM E338 - Sharp-Notch Tension Testing of High Strength Sheet Materials
ASTM E353 - Chemical Analysis of Stainless, Heat Resisting, Maraging,
and Other Similar Chromium-Nickel-Iron Alloys
ASTM E381 - Rating Macroetched Steel
ASTM E399 - Plane-Strain Fracture Toughness of Metallic Materials

SAE Technical Board rules provide that: "All technical reports, including standards approved by the Board, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E353, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

	min	max
Carbon	0.24 - 0.30	
Manganese	0.10 - 0.35	
Silicon	--	0.35
Phosphorus	--	0.010
Sulfur	--	0.010
Chromium	0.35 - 0.60	
Nickel	7.00 - 9.00	
Cobalt	3.50 - 4.50	
Molybdenum	0.35 - 0.60	
Vanadium	0.06 - 0.12	
Copper	--	0.35

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2259, paragraph titled "Low Alloy Steels"; check analysis limits for cobalt shall be 0.05 under min or over maximum.

3.2 Condition: The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370:

3.2.1 Bars:

3.2.1.1 Bars 0.500 In. (12.70 mm) and Under in Diameter or Distance Between Parallel Sides: Annealed and cold finished having tensile strength not higher than 180,000 psi (1241 MPa) or equivalent hardness.

3.2.1.2 Bars Over 0.500 In. (12.70 mm) in Diameter or Distance Between Parallel Sides: Hot finished and annealed having hardness not higher than 341 HB or equivalent except that bars ordered annealed and cold finished may have hardness as high as 352 HB or equivalent.

3.2.2 Forgings and Flash Welded Rings: Annealed and descaled having hardness not higher than 341 HB or equivalent.

3.2.2.1 Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. When supplied, they shall be manufactured in accordance with AMS 7496.

3.2.3 Mechanical Tubing: Annealed and cold finished having hardness not higher than 38 HRC or equivalent except that tubing ordered hot finished and annealed shall have hardness not higher than 36 HRC or equivalent.

3.2.4 Stock for Forging or Flash Welded Rings: As ordered by the forging or flash welded ring manufacturer.

3.3 Heat Treatment: Bars, forgings, mechanical tubing, and flash welded rings shall be annealed by heating to 1140° F $\pm$ 25° (615.6° C $\pm$ 14°), holding at heat for 8 - 24 hr, and cooling in air to room temperature.

3.4 Properties: The product shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370:



3.4.1 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, ASTM E112, McQuaid-Ehn test.

3.4.2 Macrostructure: Visual examination of transverse sections from bars, billets, tube rounds, and stock for forging or flash welded rings, etched in accordance with ASTM E381 in hot hydrochloric acid (1:1) at 160 - 180° F (71.1 - 82.2° C) for sufficient time to develop a well-defined macrostructure, shall show no injurious imperfections such as pipe, cracks, porosity, segregation, and inclusions detrimental to fabrication or to performance of parts. Macrostructure shall be equal to or better than the following macrographs of ASTM E381:

Section Size		Macrographs
Square Inches	(Square Centimeters)	
Up to 36, incl	(Up to 232, incl)	S2 - R1 - C2
Over 36 to 100, incl	(Over 232 to 645, incl)	S2 - R2 - C3
Over 100	(Over 645)	As agreed upon

3.4.3 Inclusion Rating: Two-thirds of all specimens, as well as the average of all specimens, shall not exceed the following limits, determined in accordance with ASTM E45, Method A, except that the length of any inclusion shall be not greater than 0.025 in. (0.64 mm):

Type	Inclusion Rating			
	A	B	C	D
Thin	2.0	2.0	2.0	2.5
Heavy	1.5	1.5	1.5	1.5

3.4.4 Decarburization:

3.4.4.1 Bars, tubing, and flash welded rings ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces. Decarburization of tubing ID shall not exceed the maximum depth specified in Table II.

3.4.4.2 Allowable decarburization of bars, billets, and tube rounds ordered for redrawing, forging, or flash welding, or to specified microstructural requirements shall be as agreed upon by purchaser and vendor.

3.4.4.3 Decarburization of bars and flash welded rings to which 3.4.4.1 or 3.4.4.2 is not applicable shall be not greater than shown in Table I:

TABLE I

Nominal Diameter or Distance Between Parallel Sides Inches	Depth of Decarburization Inch
Up to 0.375, incl	0.010
Over 0.375 to 0.500, incl	0.012
Over 0.500 to 0.625, incl	0.014
Over 0.625 to 1.000, incl	0.017
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 5.000, incl	0.045