AEROSPACE
MATERIAL SPECIFICATIONS

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York, N.Y. 10017

AMS 6540A
Superseding AMS 6540
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STEEL BARS, FORGINGS, TUBING, AND RINGS
0.48Cr - 8.0Ni - 4.0Co - 0.48Mo - 0.09V (0.24 - 0.30C)
Annealed

1. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

2. FORM: Bars, forgings, mechanical tubing, flash welded rings, and stock for forgings or flash welded Ø rings.

3. APPLICATION: Primarily for heat treated parts, such as pressure vessels, requiring through-hardening to high strength levels, and where such parts may require welding.

4. COMPOSITION:

Ø

	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

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

5. CONDITION: Unless otherwise ordered, the product shall be supplied in the following condition:

5.1 Bars, Forgings, Mechanical Tubing, and Flash Welded Rings: Annealed and descaled, having hardness Ø not higher than Brinell 341 or equivalent, except products ordered cold finished may have hardness as high as Brinell 352 or equivalent.

5.1.1 Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. Ø When supplied, they shall be manufactured in accordance with the latest issue of AMS 7496, unless otherwise specified.

Ø 5.2 Stock for Forgings or Flash Welded Rings: As ordered by the forging or flash welded ring manufacturer.

6. TECHNICAL REQUIREMENTS: When ASTM methods are specified for determining conformance to the following requirements, tests shall be conducted in accordance with the issue of the ASTM method listed in the latest issue of AMS 2350.

6.1 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined, unless otherwise specified, in accordance with ASTM E112, McQuaid-Ehn test.

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6.2 Decarburization:

6.2.1 Bars ordered ground, turned, or polished shall be free from decarburization on such ground, turned, or polished surfaces.

6.2.2 Allowable decarburization of bars and billets ordered for redrawing or forging or to specified microstructural requirements shall be as agreed upon by purchaser and vendor.

6.2.3 Decarburization of bars to which 6.2.1 or 6.2.2 is not applicable shall be not greater than the following:

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

6.2.3.1 Limits for depth of decarburization of bars over 5.000 in. in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor.

6.2.4 Unless otherwise agreed upon by purchaser and vendor, decarburization shall be measured by Rockwell Superficial 30-N scale hardness method, or equivalent hardness testing method, on hardened but untempered specimens protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization, when measured by a hardness method, is defined as the perpendicular distance from the surface to the nondecarburized depth under that surface below which there is no further increase in hardness. Such measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization or lack of decarburization thereon.

6.2.4.1 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 in. and the width is 0.065 in. or less.

6.3 Micro-Inclusion Rating: Unless otherwise specified, the inclusion rating, determined in accordance with ASTM E45, Method A, using not less than 9 specimens per heat or lot selected parallel to the direction of rolling and representing the worst area of inclusions in the inspection sample, shall be as specified below. The method of selection of specimens shall be such that suitable rating of the heat or lot of steel being qualified is assured. Two-thirds of all specimens as well as the average of all specimens shall not exceed the following limits, except that the length of any inclusion shall be not greater than 0.025 inch.

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

6.4 Properties After Heat Treatment: Material heat treated as in 6.4.1, except that annealing (6.4.1.1) is optional, shall conform to the requirements of 6.4.2 and 6.4.3.

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6.4.1 Heat Treatment:

6.4.1.1 Annealing: Heat to 1140 ± 25 (615.6 C ± 14), hold at heat for 8 - 24 hr, and cool in air to room temperature.

6.4.1.2 Normalizing: Heat to 1600 F ± 50 (871.1 C ± 28), hold at heat for 1 hr per inch of section thickness, and cool in air to room temperature.

6.4.1.3 Hardening: Heat to 1550 F ± 25 (843.3 C ± 14), hold at heat for 1 hr per inch of section thickness but at least 1 hr, and then quench sections up to 4 in., incl, in thickness into room-temperature oil or water, and sections over 4 in. in thickness into room-temperature oil only.

6.4.1.4 Tempering: Heat to required temperature not higher than 1050 F (565 C), hold at heat for 4 hr, and cool in air to room temperature.

6.4.2 Tensile Properties:

Tensile Strength, psi	185,000 min
Yield Strength at 0.2% Offset or at 0.0159 in. in 2 in. Extension Under Load (E = 29,500,000), psi	175,000 min
Elongation, % in 2 in. or 4D	13 min
Reduction of Area (round specimens), %	50 min

6.4.3 Fracture Toughness: When specified, shall be determined by a suitable method. Standards shall be as agreed upon by purchaser and vendor.

7. QUALITY: Steel shall be aircraft quality and shall conform to the requirements of the latest issue of AMS 2301. The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

8. TOLERANCES: Unless otherwise specified, tolerances shall conform to all applicable requirements of the following:

8.1 Bars: AMS 2251; for all hexagons, tolerances for cold finished shall apply.

8.2 Mechanical Tubing: AMS 2253.

9. REPORTS:

9.1 Unless otherwise specified, the vendor of the product shall furnish with each shipment three copies of a report of the results of tests for chemical composition, tensile properties, grain size, inclusion rating, and AMS 2301 frequency-severity rating for each heat in the shipment. This report shall include the purchase order number, heat number, material specification number, size, and quantity from each heat. If forgings are supplied, the part number and the source and size of stock used to make the forgings shall also be included.

9.2 Unless otherwise specified, the vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

10. IDENTIFICATION: Unless otherwise specified, the product shall be identified as follows:

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