Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE MATERIAL SPECIFICATION

AMS 6523

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Revised

STEEL SHEET, STRIP, AND PLATE
0.75Cr - 9.0Ni - 4.5Co - 1.0Mo - 0.09V (0.17 - 0.23C)
Premium Quality, Consumable Electrode Melted, Annealed

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

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

3. COMPOSITION:

	min	max
Carbon	0.17	0.23
Manganese	0.20	0.30
Silicon	--	0.10
Phosphorus	--	0.010
Sulfur	--	0.010
Chromium	0.65	0.85
Nickel	8.50	9.50
Cobalt	4.25	4.75
Molybdenum	0.90	1.10
Vanadium	0.06	0.12
Copper	--	0.35

3.1 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.

4. CONDITION: Unless otherwise ordered, the product shall be supplied hot rolled, annealed, and descaled having hardness not higher than Rockwell C 36 or equivalent.

4.1 When normalized and tempered material is specified, hardness shall be not higher than Rockwell C 40 or equivalent.

5. 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.

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

5.2 Decarburization:

5.2.1 Material Under 0.045 In. in Thickness: The method of test and the allowance shall be as agreed upon by purchaser and vendor.

5.2.2 Material 0.045 to 0.375 In., Excl, Thick:

5.2.2.1 Specimens: Shall be the full thickness of the material except that specimens from plate over 0.249 in. thick shall be slices approximately 0.250 in. thick cut parallel to and preserving one original surface of the plate. Recommended specimen size is 1 x 4 inches.

5.2.2.2 Procedure: Specimens shall be hardened by austenitizing and quenching; preferably they shall not be tempered but if tempered, the tempering temperature shall be not higher than 300 F (149 C). During heat treatment, specimens shall be protected by suitable atmosphere or medium or by suitable plating to prevent carburization or decarburization. Protective plating, if used, shall then be removed from specimens of material 0.045 to 0.250 in., excl, in thickness and a portion of the specimen shall be step ground to a depth of 0.050 in. or half thickness, whichever is less. Specimens from material 0.250 in. to 0.375 in., excl, in thickness shall be ground to remove 0.020 in. from the original surface of the plate and a portion of the specimen shall be ground to a depth of at least 1/3 the original thickness of the specimen. At least three Rockwell hardness readings shall be taken on each prepared step and each group of readings averaged.

5.2.2.3 Allowance:

5.2.2.3.1 Material 0.045 to 0.250 In., Excl, Thick: Unless otherwise specified, the product shall be free from complete decarburization. It shall also be free from partial decarburization to the extent that the difference in hardness between the surface and the nondecarburized depth below the surface shall be not greater than 2 points on the Rockwell A scale.

5.2.2.3.2 Material 0.250 to 0.375 In., Excl, Thick: Shall be free from decarburization to the extent that the difference in hardness between the two prepared steps shall be not greater than 3 points on the Rockwell A scale.

5.2.3 Material 0.375 In. and Over Thick: The total decarburization as determined microscopically on the plate as supplied shall be not greater than the following:

Nominal Thickness Inches	Depth of Decarburization Inch
0.375 to 0.500, incl	0.015
Over 0.500 to 1.000, incl	0.025
Over 1.000 to 2.000, incl	0.035

5.3 Inclusion Rating: Unless otherwise specified, the inclusion rating, determined in accordance with ASTM E45, Method D, using not less than 9 specimens per heat 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 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 0.015 inch.

	Inclusion Rating			
Type	A	B	C	D
Thin	1.5	1.5	1.5	2.0
Heavy	1.0	1.0	1.0	1.5

5.4 Properties After Normalizing, Hardening, and Tempering: Material, normalized by heating to 1650 F ± 25 (898.9 C ± 14), holding at heat for 1 hr per in. of maximum cross-section, and cooling in air to room temperature; hardened by heating to 1525 F ± 25 (829.4 C ± 14), holding at heat for 1 hr per in. of maximum section thickness but not less than 1 hr, and quenching in oil or water; and double tempered by heating to 1025 F ± 15 (537.8 C ± 8.3), holding at heat for 4 - 8 hr, suitably cooling to room temperature, reheating to 1025 F ± 15 (537.8 C ± 8.3), holding at heat for 4 - 8 hr, and suitably cooling to room temperature, shall conform to the following requirements:

5.4.1 Tensile Properties: Test specimens and testing procedures shall be in accordance with ASTM A370.

Tensile Strength, psi	190,000 min
Yield Strength at 0.2% Offset or at 0.016 in. in 2 in. Extension Under Load (E = 29,500,000), psi	180,000 min
Elongation, % in 2 in. or 4D	
Nominal Thickness, inch	
Up to 0.250, excl	5 min
0.250 and over	10 min
Reduction of Area (round specimens), %	45 min

5.4.1.1 For widths 9 in. and over, tensile test specimens shall be taken with the axis perpendicular to the direction of rolling. For widths less than 9 in., tensile test specimens shall be taken with the axis parallel to the direction of rolling.

5.4.2 Hardness: Product should have hardness not lower than Rockwell C 41 or equivalent but shall not be rejected on the basis of hardness if the tensile property requirements are met.

5.4.3 Fracture Toughness: When specified, product shall be subject to fracture toughness testing. The method of testing and standards for acceptance of product shall be as agreed upon by purchaser and vendor. (ASTM E338 is a recommended method of test for sheet. ASTM E399 is a suggested method of test for plate.)

5.5 Macrostructure: Full cross-sectional specimens, representing the top and bottom of the first, middle, and last usable ingots in a heat, shall be obtained from the finished billet or a suitable rerolled product and shall be etched in hot hydrochloric acid (1:1) at 160 - 180 F (71.1 - 82.2 C) for sufficient time to develop a well-defined macrostructure. The macro-etched specimen, when examined visually, shall show no injurious imperfections such as pipe, porosity, blow holes, segregation, and inclusions which would be detrimental to fabrication or to performance of parts. Macrostructure shall be equal to or better than standards agreed upon by purchaser and vendor.

5.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, acceptance of the product may be based on the testing of three additional specimens for each original nonconforming specimen, all of which additional specimens shall conform to specified requirements. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the material represented and no additional testing shall be permitted. Results of all tests shall be reported.

6. QUALITY: Steel shall be premium quality and shall conform to the requirements of the latest issue of AMS 2300. Unless otherwise permitted, material shall be multiple melted using consumable electrode practice in the remelt cycle; at least one of the melting cycles shall be under vacuum. 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.

7. SAMPLING: Shall be in accordance with all applicable requirements of the latest issue of AMS 2370 and as specified herein.

8. TOLERANCES: Unless otherwise specified, tolerances shall conform to all applicable requirements of the latest issue of AMS 2252.