Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 6524A
Superseding AMS 6524

Issued 11-1-70
Revised 1-15-78

STEEL SHEET, STRIP, AND PLATE
1.0Cr - 7.5Ni - 4.5Co - 1.0Mo - 0.09V (0.29 - 0.34C)
Premium Quality, Consumable Electrode Melted, Annealed

1. SCOPE:

1.1 Form: This specification covers a premium-quality, low-alloy steel in the form of sheet, strip, and plate.

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) 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., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2252 - Tolerances, Alloy Steel Sheet, Strip, and Plate
AMS 2259 - Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS 2300 - Premium 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 and Forging Stock

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

ASTM A370 - Mechanical Testing of Steel Products
ASTM A604 - Macroetch Testing of Consumable Electrode Vacuum Arc Remelted Steel Bars and Billets
ASTM E45 - Determining the Inclusion Content of Steel
ASTM E112 - Estimating the Average Grain Size of Metals
ASTM E338 - Sharp-Notch Tension Testing of High-Strength Sheet Materials
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
ASTM E399 - Plane-Strain Fracture Toughness of Metallic Materials

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

2.3.1 Federal Standards:

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

2.3.2 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

Printed in U.S.A.

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E350, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

	min	max
Carbon	0.29	0.34
Manganese	0.10	0.35
Silicon	--	0.20
Phosphorus	--	0.01
ø Sulfur	--	0.01
Chromium	0.90	1.10
Nickel	7.00	8.00
Cobalt	4.25	4.75
Molybdenum	0.90	1.10
Vanadium	0.06	0.12
Copper	--	0.35

3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259.

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

3.2.1 Sheet and Strip: Cold finished, bright or atmosphere annealed, and descaled if necessary, or hot rolled, annealed, and descaled having hardness not higher than 36 HRC or equivalent.

3.2.2 Plate: Hot rolled, annealed, and descaled, having hardness not higher than 36 HRC or equivalent.

3.2.3 When normalized and tempered product is ordered, hardness shall be not higher than 40 HRC or equivalent.

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

3.3.1 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined in accordance with ASTM E112.

3.3.2 Macrostructure: Visual examination of specimens as in 4.3.1, etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 160° - 180° F (71° - 82° C) for sufficient time to develop a well-defined macrostructure, shall show no 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 standards agreed upon by purchaser and vendor.

3.3.3 Micro-inclusion Rating: Two-thirds of the total number of specimens, as well as the average of all specimens, shall not exceed the following limits, determined in accordance with ASTM E45, Method D, except that the length of any inclusion shall be not greater than 0.015 in. (0.38 mm):

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

3.3.4 Decarburization:

3.3.4.1 Product Under 0.045 In. (1.14 mm) in Nominal Thickness: The method of test and the allowance shall be as agreed upon by purchaser and vendor.

3.3.4.2 Product 0.045 to 0.375 In. (1.14 to 9.52 mm), Excl, in Nominal Thickness:

3.3.4.2.1 Specimens: Shall be the full thickness of the product except that specimens from plate over 0.249 in. (6.32 mm) thick shall be slices approximately 0.250 in. (6.35 mm) thick cut parallel to and preserving one original surface of the plate. Recommended specimen size is 1 x 4 in. (25 x 100 mm).

3.3.4.2.2 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 further decarburization. Protective plating, if used, shall then be removed from specimens of product 0.045 to 0.250 in. (1.14 to 6.35 mm), excl, in nominal thickness and a portion of the specimen shall be ground to a depth of 0.050 in. (1.27 mm) or one-half thickness, whichever is less. Specimens from product 0.250 to 0.375 in. (6.35 to 9.52 mm), excl, in nominal thickness shall be ground to remove 0.020 in. (0.51 mm) of metal from the original surface of the plate and a portion of the specimen shall be further ground to a depth of at least one-third 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.

3.3.4.2.3 Allowance:

3.3.4.2.3.1 Product 0.045 to 0.250 In. (1.14 to 6.35 mm), Excl, in Nominal Thickness: The product shall show no layer of complete decarburization, determined microscopically at a magnification not exceeding 100X. It shall also be free from partial decarburization to the extent that the difference in hardness between the original surface and the portion ground as in 3.3.4.2.2 shall be not greater than 2 units on the Rockwell "A" scale.

3.3.4.2.3.2 Product 0.250 to 0.375 In. (6.35 to 9.52 mm), Excl, in Nominal Thickness: Shall be free from decarburization to the extent that the difference in hardness between the two prepared steps shall be not greater than 3 units on the Rockwell "A" scale.

3.3.4.3 Product 0.375 In. (9.52 mm) and Over in Nominal Thickness: The total decarburization, determined microscopically at a magnification not exceeding 100X on the as-supplied plate, shall be not greater than shown in Table I.

TABLE I

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
Over 2.000	As agreed upon

TABLE I (SI)

Nominal Thickness Millimetres	Depth of Decarburization Millimetre
9.52 to 12.70, incl	0.38
Over 12.70 to 25.40, incl	0.64
Over 25.40 to 50.80, incl	0.89
Over 50.80	As agreed upon

3.3.5 Properties After Heat Treatment: The product shall have the following properties after being normalized by heating to 1650° F ± 25 (899° C ± 15), holding at heat for 1 hr per inch (25 mm) of maximum cross-section, and cooling in air to room temperature; hardened by heating to 1550° F ± 25 (843° C ± 15), holding at heat for 1 hr per inch (25 mm) of maximum cross-section but not less than 1 hr, and quenching in oil or water, cooling to -100° F ± 10 (-73° C ± 6), holding at -100° F ± 10 (-73° C ± 6) for not less than 2 hr, warming to room temperature, and double tempered by heating to 975° F ± 15 (524° C ± 8), holding at heat for 2 hr per inch (25 mm) of maximum cross-section but not less than 2 hr, cooling to approximately 125° F (52° C), reheating to 975° F ± 15 (524° C ± 8), holding at heat for 2 hr per inch (25 mm) of maximum cross-section but not less than 2 hr, and cooling in air to room temperature:

3.3.5.1 Tensile Properties: Shall be as specified in Table II.

TABLE II

Nominal Thickness Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min	Reduction of Area (round specimens) %, min
Up to 0.250, excl	220,000	185,000	6	--
0.250 and over	220,000	190,000	10	35

TABLE II (SI)

Nominal Thickness Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50 mm or 4D %, min	Reduction of Area (round specimens) %, min
Up to 6.35, excl	1517	1276	6	--
6.35 and over	1517	1310	10	35

3.3.5.2 Hardness: Should be not lower than 46 HRC or equivalent but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.3.5.1 are met.

3.3.5.3 Fracture Toughness: When specified, product shall be subjected to fracture toughness testing. Method of test 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. For plate, ASTM E399 is a recommended method of test.

3.4 Quality:

3.4.1 Steel shall be premium quality conforming to AMS 2300. It shall be multiple melted using consumable electrode practice in the remelt cycle, unless otherwise permitted; at least one of the melting cycles shall be under vacuum.

3.4.2 The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from internal and external imperfections detrimental to usage of the product.

3.5 Tolerances: Unless otherwise specified, tolerances shall conform to all applicable requirements of AMS 2252.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as ø required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to composition (3.1), condition (3.2), grain size ø (3.3.1), macrostructure (3.3.2), inclusion rating (3.3.3), decarburization (3.3.4), AMS 2300 frequency-severity rating (3.4), and tolerance (3.5) requirements are classified as acceptance tests.

4.2.2 Periodic Tests: Test to determine conformance to response to heat treatment (3.3.5), requirements ø are classified as periodic tests.

4.3 Sampling: Shall be in accordance with AMS 2370 and the following; a heat shall be the consumable ø electrode remelted ingots produced from steel originally melted as a single furnace charge. Frequency and extent of sampling for periodic tests shall be as agreed upon by purchaser and vendor.

4.3.1 Samples for macrostructure (3.3.2) testing shall be full cross-sectional specimens obtained from the ø finished slab or billet or a suitable rerolled product representing the top and bottom of at least the first, middle, and last usable ingots of each heat.

4.3.2 Samples for micro-inclusion rating (3.3.3) shall consist of specimens obtained from the finished billet or suitable rerolled product representing the top and bottom of the first and last ingots from a heat ø yielding 10 or fewer ingots or from the top and bottom of the first, middle, and last usable ingots from heats yielding more than 10 ingots.

4.3.3 Specimens for tensile tests (3.3.5.1) of widths 9 in. (229 mm) and over shall be taken with the axis of the specimen perpendicular to the direction of rolling; for widths less than 9 in. (229 mm), specimens shall be taken with the axis parallel to the direction of rolling.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment three copies of a report showing the results of tests on each heat for chemical composition, grain size, macrostructure, micro-inclusion rating, and AMS 2300 frequency-severity rating and stating that the product conforms to the other acceptance test requirements of this specification. This report shall include the purchase order number, heat number, material specification number and its revision letter, size, and quantity from each heat.

4.4.2 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 and its revision letter, 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.