SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS6454 REV. E

Issued 1984-01
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Superseding AMS6454D

Steel, Sheet, Strip, and Plate
1.8Ni - 0.80Cr - 0.25Mo (0.38 - 0.43C) (SAE 4340)
Vacuum Consumable Electrode Remelted

(Composition similar to UNS G43406)

RATIONALE

AMS6454E results from a Five-Year Review and update of this specification that includes revision of the decarburization requirement.

1. SCOPE

1.1 Form

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

1.2 Application

These products have been used typically for heat treated parts requiring good tensile and fatigue strengths in combination with good ductility, but usage is not limited to such applications. The product may be through-hardened to tensile strength ranges of 260 to 280 ksi (1793 to 1931 MPa) in nominal section thicknesses of 1.5 inches (38 mm) and under and 180 to 220 ksi (1241 to 1517 MPa) in nominal section thicknesses of 3 inches (76 mm) and under.

1.2.1 Certain design and processing procedures may cause these products to become susceptible to stress-corrosion cracking after heat treatment; ARP1110 recommends practices to minimize such conditions.

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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS6454E

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.

AMS2252 Tolerances, Low-Alloy Steel Sheet, Strip, and Plate

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

AMS2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat-Resistant Steels and Alloys Sheet, Strip, Plate, and Aircraft Tubing

ARP1110 Minimizing Stress Corrosion Cracking in Wrought Forms of Steels and Corrosion Resistant Steels and Alloys

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.

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 45 Determining the Inclusion Content of Steel

ASTM E 112 Determining Average Grain Size

ASTM E 290 Bend Testing of Material for Ductility

ASTM E 350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

ASTM E 384 Knoop and Vickers Hardness of Materials

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	0.38	0.43
Manganese	0.65	0.90
Silicon	0.15	0.35
Phosphorus	--	0.010
Sulfur	--	0.010
Chromium	0.70	0.90
Nickel	1.65	2.00
Molybdenum	0.20	0.30
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 vacuum consumable electrode process in the remelt cycle.

3.3 Condition

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

3.3.1 Sheet and Strip

Product shall be as specified by purchaser in one of the conditions below (See 8.6). Hardness shall not be higher than 98 HRB, or equivalent (See 8.2).

3.3.1.1 Cold finished, bright or atmosphere annealed, and descaled if necessary.

3.3.1.2 Hot rolled, annealed if necessary, and descaled.

3.3.2 Plate

Hot rolled, annealed if necessary, and descaled, having hardness not higher than 25 HRC, or equivalent (See 8.2).

3.3.2.1 If allowed by the purchaser, cold rolled, annealed if necessary and descaled as necessary, having hardness not higher than 25HRC, or equivalent (See 8.2).

3.3.3 If product is ordered spheroidize annealed, the degree of spheroidization shall be acceptable to purchaser.

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 of Each Heat

Visual examination of transverse full cross-sections from full transverse cross-sections of finished slab or billet or suitable rerolled product in accordance with ASTM A 604 in hot hydrochloric acid, 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

3.4.2 Micro-Inclusion Rating of Each Heat

No specimen shall exceed the limits shown in Table 3, determined in accordance with ASTM E 45, Method D, except that the length of any inclusion shall be not greater than 0.015 inch (0.38 mm):

TABLE 3 - MICRO-INCLUSION RATING LIMITS

	A Thin	A Heavy	B Thin	B Heavy	C Thin	C Heavy	D Thin	D Heavy
Worst Field Severity	1.5	1.0	1.0	1.0	1.0	1.0	1.5	1.0
Worst Field Frequency maximum	a	1	a	1	a	1	3	1
Total Rateable Fields, Frequency, maximum	b	1	b	1	b	1	8	1

a - Combined A+B+C, not more than three fields.
b - Combined A+B+C, not more than eight fields.

3.4.2.1 A rateable field is defined as one which has a type A, B, C, or D inclusion rating of at least No. 1.0 thin or heavy in accordance with the Jernkontoret chart, Plate I-r, ASTM E 45.

3.4.3 Average Grain Size of Each Lot

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

3.4.4 Hardenability of Each Heat

Shall be J 12/16 inch (J19 mm) = 53 HRC, minimum, and J 20/16 inch (J32 mm) = 50 HRC, minimum, determined on the standard end-quench test specimen in accordance with ASTM A 255 except that the steel shall be normalized at 1600 °F ± 10 (871 °C ± 6) and the specimen austenitized at 1550 °F ± 10 (843 °C ± 6).

3.4.5 Decarburization of Each Lot

Decarburization shall be evaluated by one of the methods of 3.4.5.1, 3.4.5.2, or 3.4.5.3.at the discretion of the producer.

3.4.5.1 Metallographic Method

A cross section of the surface shall be visually examined metallographically at a magnification not to exceed 100X. The product shall show no layer of complete or partial decarburization exceeding the limits of Table 4.

3.4.5.2 Step Method

Specimen shall be full thickness of the product up to 0.250 inch (6.35 mm) or reduced to 0.250 inch (6.35 mm) preserving one original surface for heavier product. Recommended size is 1 inch x 4 inches (25 mm x 102 mm). Specimens shall be hardened by austenitizing and quenching. They should 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. The protective plating, if used, shall be removed.

For product less than 0.250 inch (6.35 mm), a portion of the specimen shall be ground to a depth of 0.050 inch (1.27 mm) or one-half thickness, whichever is less using sufficient coolant to prevent thermal or mechanical effects. The product shall not show evidence of complete decarburization (ferrite) when examined metallographically at a magnification not exceeding 100X. It shall be free of partial decarburization to the extent that the difference in hardness between the original surface and the surface (depth) generated by grinding shall not be greater than two units on the HRA scale or equivalent (See 8.2)

For product 0.250 inch (6.35 mm) and thicker, the specimens shall be ground to remove 0.010 inch (0.25 mm) of metal and a portion of the specimen shall be further ground to a depth of at least one-third the original thickness of the specimen. The difference in the hardness between the two prepared steps shall be no greater than three units on the HRA scale or equivalent (See 8.2).

3.4.5.3 Hardness Traverse Method

The total depth of decarburization determined by a traverse method using microhardness testing in accordance with ASTM E 384 at a magnification not exceeding 100X, shall be defined as the perpendicular distance from the surface to the depth under the surface below which there is not further increase in hardness. The sample shall be hardened as listed in paragraph 3.3.3.2. Acceptance shall be as listed in Table 4.

TABLE 4A - MAXIMUM DECARBURIZATION LIMITS, INCH/POUND UNITS

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

TABLE 4B - MAXIMUM DECARBURIZATION LIMITS, SI UNITS

Nominal Thickness Millimeters	Total Depth of Decarburization Millimeter
Up to 12.70, incl	0.38
Over 12.70 to 25.40, incl	0.64
Over 25.40	0.89

3.4.5.4 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 inch (0.13 mm) and the width is 0.065 inch (1.65 mm) or less.

3.4.5.5 In the case of dispute, the microhardness traverse method shall govern.

3.4.6 Bending

Product 0.749 inch (19.02 mm) and under in nominal thickness shall be tested in accordance with ASTM E 290 using a sample prepared nominally 0.75 inch (19.0 mm) in width with its axis of bending parallel to the direction of rolling and shall withstand without cracking when bending at room temperature through the angle and bend radius shown in Table 5. In case of dispute, the results of tests using the guided bend test of ASTM E 290 shall govern.

TABLE 5 - BEND REQUIREMENTS

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Angle Degrees	Bend Radius t = nominal thickness
Up to 0.249, incl	Up to 6.32, incl	180	1.5t
Over 0.249 to 0.749, incl	Over 6.32 to 19.02, incl	90	1.5t