AEROSPACE MATERIAL SPECIFICATION

AMS6345™	REV. F

Issued 1996-11
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Superseding AMS6345E

(R) Steel, Sheet, Strip, and Plate 0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130) Aircraft Quality, Normalized or Otherwise Heat Treated (Composition similar to UNS G41300)

RATIONALE

AMS6345F is the result of a Five-Year Review and update of the specification. The revision adds thickness limits (see 1.1), clarifies composition reporting (see 3.1.2), adds a note on tensile properties (see 3.3.1) and moves the source note on properties to the table itself, revises decarburization methods (see 3.3.3), updates bend test information (see 3.3.4), adds pyrometry (see 3.3.5.1), and addresses changes to AMS2301 (see 4.2.1 and 4.4.3).

1. SCOPE

1.1 Form

This specification covers an aircraft-quality, low-alloy steel in the form of sheet, strip, and plate up to and including 1.500 inches (38.10 mm) in thickness.

1.2 Application

These products have been used typically where welding and moderate tensile properties are required, but usage is not limited to such applications. Sheet and strip are extensively used where a minimum tensile strength of 180 ksi (1241 MPa) is required in sections up to 0.125 inch (3.18 mm) in nominal thickness and proportionately lower strength is required in heavier thicknesses.

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.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

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

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

For more information on this standard, visit
https://www.sae.org/standards/content/AMS6345F/

AMS2259 Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels

AMS2301 Steel Cleanliness, Aircraft Quality, Magnetic Particle Inspection Procedure

AMS2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock

AMS2750 Pyrometry

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

AS7766 Terms Used in Aerospace Metals Specifications

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 A370 Mechanical Testing of Steel Products

ASTM A751 Chemical Analysis of Steel Products

ASTM E112 Determining Average Grain Size

ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

ASTM E290 Bend Testing of Material for Ductility

ASTM E1077 Estimating the Depth of Decarburization of Steel Specimens

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Composition shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751 or by other analytical methods acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.28	0.33
Manganese	0.40	0.60
Silicon	0.15	0.35
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	0.80	1.10
Molybdenum	0.15	0.25
Nickel	--	0.25
Copper	--	0.35

3.1.1 Aluminum, vanadium, and columbium (niobium) are optional grain refining elements and need not be determined or reported unless used to satisfy the average grain size requirements of 3.3.2.

3.1.2 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection unless limits of acceptability are specified by the purchaser.

3.1.3 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Condition

The product shall be supplied in the following condition:

3.2.1 Sheet and Strip

Sheet and strip shall be cold rolled, normalized or otherwise heat treated, and descaled if necessary; or hot rolled, normalized or otherwise heat treated, and descaled.

3.2.2 Plate

Hot rolled and normalized or otherwise heat treated.

3.2.2.1 If allowed by the purchaser, cold rolled and normalized or otherwise heat treated.

3.3 Properties

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

3.3.1 Tensile Properties

The long-transverse tensile properties of the as-supplied product shall be as shown in Table 2 (see 8.2). Alternatively, longitudinal tensile testing may be performed as permitted in AMS2370.

Table 2A - Minimum tensile properties[(1)], inch/pound units

Thickness Inches	Tensile Strength ksi	Yield Strength 0.2% Offset ksi	Elongation in 2 Inches or 4D Percent
Up to 0.062, excl	95	75	8
0.062 to 0.125, incl	95	75	10
Over 0.125 to 0.1874, incl	95	75	12
Over 0.1874 to 0.250, incl	90	70	15
Over 0.250 to 0.750, incl	90	70	16
Over 0.750 to 1.500, incl	90	70	18

(1) Properties have been taken from MIL-S-18729, Condition N, and have not been substantiated by AMS statistical methods.

Table 2B - Minimum tensile properties[(1)], SI units

Thickness Millimeters	Tensile Strength MPa	Yield Strength 0.2% Offset MPa	Elongation in 50.8 mm or 4D Percent
Up to 1.57, excl	655	517	8
1.57 to 3.18, incl	655	517	10
Over 3.18 to 4.760, incl	655	517	12
Over 4.760 to 6.35, incl	621	483	15
Over 6.35 to 19.05, incl	621	483	16
Over 19.05 to 38.10, incl	621	483	18

(1) Properties have been taken from MIL-S-18729, Condition N, and have not been substantiated by AMS statistical methods.

3.3.1.1 Mechanical property requirements for product outside the size range covered by Table 2 shall be agreed upon between the purchaser and producer and reported per 4.4.2.

3.3.2 Average Austenitic Grain Size

Average austenitic grain size shall be determined by either 3.3.2.1 or 3.3.2.2.

3.3.2.1 The average austenitic grain size shall be ASTM No. 5 or finer, determined in accordance with ASTM E112.

3.3.2.2 The product of a heat shall be considered to have an ASTM No. 5 or finer austenitic grain size if one or more of the following are determined by heat analysis (see 8.5):

- A total aluminum content of 0.020 to 0.050%
- An acid soluble aluminum content of 0.015 to 0.050%
- A vanadium content of 0.02 to 0.08%
- A columbium (niobium) content of 0.02 to 0.05%

3.3.3 Decarburization of Each Lot

Decarburization shall be evaluated by one of the methods of 3.3.3.1 or 3.3.3.2.

3.3.3.1 Metallographic (Microscopic) Method

A cross section taken perpendicular to the surface shall be prepared in accordance with ASTM E1077 and examined metallographically at a magnification not to exceed 200X. The sample shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

3.3.3.2 Hardness Traverse (Microindentation) Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E1077. Samples shall be hardened in a protective atmosphere to prevent changes in surface carbon content. Samples may be tempered at the option of the producer. Measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization on the adjacent surface. Acceptance shall be as listed in Table 3.

Table 3A - Maximum total depth of decarburization, 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 3B - Maximum total depth of decarburization, 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

3.3.3.3 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.

3.3.3.4 In the case of dispute, the total depth of decarburization determined using the microindentation hardness traverse method shall govern.

3.3.4 Bending

Product 0.750 inch (19.05 mm) and under in nominal thickness shall be transverse bend tested in accordance with ASTM E290. Testing shall be performed at room temperature. Bend requirements shall be in accordance with Table 4. When visually examined, the specimen shall exhibit no cracking. In case of dispute, the results of tests using the guided bend test of ASTM E290 shall govern.

Table 4 - Bend requirements

Nominal Thickness Inch	Nominal Thickness Millimeters	Angle Deg	Bend Radius(1) Max
Up to 0.090, excl	Up to 2.29, excl	180	1.5 t
0.090 to 0.1874, incl	2.29 to 4.760, incl	135 min	1.5 t
Over 0.1874 to 0.250, incl	Over 4.760 to 6.35, incl	90 min	1.5 t
Over 0.250 to 0.750, incl	Over 6.35 to 19.05, incl	90 min	1.5 t

(1) Bend radius is defined as a bend factor multiplied by the nominal thickness (t).

3.3.5 Response to Heat Treatment

3.3.5.1 Tensile Strength

Product 0.249 inch (6.32 mm) and under in nominal thickness shall have tensile strength not lower than 125 ksi (862 MPa), or equivalent hardness (see 8.2), after being hardened by quenching in oil from 1600 °F ± 10 °F (871 °C ± 6 °C) and tempered for not less than 30 minutes at not lower than 900 °F (482 °C). Pyrometry shall be in accordance with AMS2750.

3.3.5.2 Hardness

Product shall develop the applicable minimum center hardness shown in Table 5, or equivalent (see 8.3), when hardened by quenching in oil from 1600 °F ± 10 °F (871 °C ± 6 °C).

Table 5 - Minimum hardness, as quenched

Nominal Thickness Inches	Nominal Thickness Millimeters	Hardness HRC
Over 0.249 to 0.375, incl	Over 6.32 to 9.52, incl	42
Over 0.375 to 0.500, incl	Over 9.52 to 12.70, incl	38
Over 0.500 to 0.625, incl	Over 12.70 to 15.88, incl	32
Over 0.625 to 0.750, incl	Over 15.88 to 19.05, incl	29
Over 0.750 to 0.875, incl	Over 19.05 to 22.22, incl	27
Over 0.875 to 1.500, incl	Over 22.22 to 38.10, incl	26

3.4 Quality

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

3.4.1 Steel shall be aircraft-quality conforming to AMS2301.

3.5 Tolerances

Steel tolerances shall conform to all applicable requirements of AMS2252.

3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (see 3.1), condition (see 3.2), tensile properties (see 3.3.1), average grain size (see 3.3.2), decarburization (see 3.3.3), bending (see 3.3.4), response to heat treatment (see 3.3.5), frequency-severity cleanliness rating (see 3.4.1), and tolerances (see 3.5) are classified as acceptance tests and shall be performed on each heat or lot as applicable. If grain refining elements (see 3.3.2.2) are not present, the ASTM E112 grain size test (see 3.3.2.1) shall be conducted on each lot. If process qualification in accordance with AMS2301 has been met, the frequency-severity cleanliness rating shall be conducted on a periodic basis as defined in AMS2301.

4.2.2 Periodic Tests

If grain refining elements (see 3.3.2.2) are present, the ASTM E112 grain size test (see 3.3.2.1) shall be conducted on a periodic basis and shall be performed at a frequency selected by the producer (not to exceed 1 year) unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

Sampling and testing shall be in accordance with AMS2370.