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

AEROSPACE MATERIAL SPECIFICATION

AMS 2303A
Superseding AMS 2303

Issued 11-1-67
Revised 10-16-78

AIRCRAFT QUALITY STEEL CLEANLINESS
Martensitic Corrosion Resistant Steels
Magnetic Particle Inspection Procedure

1. SCOPE: This specification covers steel cleanliness requirements for aircraft-quality hardenable corrosion resistant steels by magnetic particle inspection methods. Applicable primarily to blooms, billets, tube rounds, stock for forging or flashwelded rings, slabs, bars, sheet, strip, plate, tubing, and extrusions used in fabricating parts subject to magnetic particle inspection, but may be used for qualification of a heat, melt, or lot of steel.

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 2350 - Standards and Test Methods
AMS 2640 - Magnetic Particle Inspection

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

ASTM E10 - Brinell Hardness of Metallic Materials

2.3 ANSI Publications: Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI B46.1 - Surface Texture

3. TECHNICAL REQUIREMENTS:

3.1 Specimen Preparation:

3.1.1 Heat Qualification: Sampling shall be in accordance with 4.3.1. Samples shall be converted into test specimens in accordance with 3.1.3.

3.1.2 Product Qualification: Product from a heat not qualified based on sampling as in 4.3.1 shall be sampled in accordance with 4.3.2. Samples shall be converted into test specimens in accordance with 3.1.3.

3.1.3 Working and Rough Machining:

3.1.3.1 Solid Product Over 36 Sq In. (232 cm^2) Cross-Sectional Area Except Flat Bars, Slabs, and Plates: A quarter-section shall be cut from the sample sufficiently oversize that the center of the original specimen will be approximately on the surface of the specimen after generating to test size. The specimen shall be converted into test size by machining, or forging and machining, to a diameter not larger than 6 in. (150 mm) consistent with the machining allowance specified in 3.1.4.1. As an alternate method when agreed upon by purchaser and vendor, the full section may be rolled or forged to a 6 in. (150 mm) round or square and an oversize quarter obtained as in 3.1.3.2. The identity for specimen surface representing center of original stock shall be maintained throughout machining and testing.

3.1.3.2 Solid Product 16 - 36 Sq In. (103 - 232 cm^2), Incl, in Cross-Sectional Area Except Flat Bars, Slabs, and Plates: A quarter-section shall be cut sufficiently oversize that the center of the original specimen will be approximately on the surface of the sample after generating to test

ø size. The specimen shall be converted to test size by machining, or forging and machining, to the largest possible round consistent with the machining allowance specified in 3.1.4.1. The identity for specimen surface representing center of original stock shall be maintained throughout machining and testing.

3.1.3.3 Solid Product Less Than 16 Sq In. (103 cm^2) in Cross-Sectional Area Except Flat Bars, Slabs, and Plates: The specimens shall be machined, consistent with the machining allowance specified

ø in 3.1.4.1, to straight cylindrical samples. As an alternate method when agreed upon by purchaser and vendor, a stepdown specimen shall be generated in equal length circumferential steps as in Table I, consistent with the machining allowance specified in 3.1.4.1.

TABLE I

Nominal Diameter or Distance Between Parallel Sides Inches	Step Length Inches	Step Diameter 1	2	3	4	5
0.250 to 0.500, incl	5.000	D	--	--	--	--
Over 0.500 to 0.750, incl	2.500	D	2/3D	--	--	--
Over 0.750 to 1.000, incl	1.665	D	3/4D	1/2D	--	--
Over 1.000 to 1.500, incl	1.250	D	4/5D	3/5D	2/5D	--
Over 1.500 to 4.000, incl	1.000	D	4/5D	3/5D	2/5D	1/5D

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Step Length Millimetres	Step Diameter 1	2	3	4	5
6.35 to 12.70, incl	127.00	D	--	--	--	--
Over 12.70 to 19.05, incl	63.50	D	2/3D	--	--	--
Over 19.05 to 25.40, incl	42.29	D	3/4D	1/2D	--	--
Over 25.40 to 38.10, incl	31.75	D	4/5D	3/5D	2/5D	--
Over 38.10 to 101.60, incl	25.40	D	4/5D	3/5D	2/5D	1/5D

D = Original diameter or distance between parallel sides minus machining stock removed.

3.1.3.4 Flat Bars: The type of test and the location in the section shall be as agreed upon by purchaser and vendor.

3.1.3.5 Slabs or Plates: A straight cylindrical or rectangular specimen shall be machined, or forged and machined, from each slab or plate tested. The specimen shall be taken essentially parallel to the direction of rolling, midway between edge and center of the slab or plate width, shall be nominally 5 in. (125 mm) in length, and not more than 4 in. (100 mm) in final diameter or thickness.

3.1.3.5.1 Product Up to 4 In. (102 mm), Incl., in Nominal Thickness: A straight cylindrical specimen shall respresent the full thickness consistent with the machining allowance specified in 3.1.4.3.

3.1.3.5.2 Product Over 4 to 8 In. (102 to 203 mm), Incl, in Nominal Thickness: A straight cylindrical specimen shall represent surface to mid-thickness consistent with the machining allowance specified in 3.1.4.3.

3.1.3.5.3 Product Over 8 In. (203 mm) in Nominal Thickness: A straight cylindrical specimen shall be taken so that the axis is approximately midway between the surface and mid-thickness, and shall have a diameter equal to one-third the nominal thickness of the section.

3.1.3.6 Tubing:

3.1.3.6.1 Up to 10 In. (254 mm), Incl, in Nominal OD: Specimens nominally 5 in. (125 mm) in length shall be machined to straight cylindrical sections in accordance with 3.1.4.2.1.

3.1.3.6.2 Over 10 In. (254 mm) in Nominal OD with Nominal Wall Thickness Up to 2 In. (50 mm), Incl: Specimens nominally 5 in. (125 mm) in length shall be machined to straight cylindrical sections in accordance with 3.1.4.2.2.

3.1.3.6.3 Over 10 In. (254 mm) in Nominal OD with Nominal Wall Thickness Over 2 to 4 In. (50 to 102 mm), Incl: Specimens nominally 5 in. (125 mm) in length representing the full cross section less the machining allowance specified in 3.1.4.2.2, shall be machined to straight cylindrical sections.

3.1.3.6.4 Over 10 In. (254 mm) in Nominal OD with Nominal Wall Thickness Over 4 In. (102 mm): Specimens nominally 5 in. (125 mm) in length, representing the inside surface to the mid-thickness of the wall, less the machining allowance specified in 3.1.4.2.2, shall be machined to straight cylindrical sections.

3.1.4 Machining:

3.1.4.1 Product Other Than Tubing, Flat Bars, Slab, and Plate: The converted sample shall be machined to conform to the allowance of Table II for surface removal, allowing 0.010 in. (0.25 mm) per side for finish machining after heat treatment.

TABLE II

Nominal Diameter or Distance Between Parallel Sides Inches	Minimum Stock Removal Inch per Side
0.250 to 0.500, incl	0.030
Over 0.500 to 0.750, incl	0.045
Over 0.750 to 1.000, incl	0.060
Over 1.000 to 1.500, incl	0.075
Over 1.500 to 2.000, incl	0.090
Over 2.000 to 2.500, incl	0.125
Over 2.500 to 3.500, incl	0.156
Over 3.500 to 4.500, incl	0.187
Over 4.500 to 6.000, incl	0.250

TABLE II (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Minimum Stock Removal Millimetres per Side
6.35 to 12.70, incl	0.76
Over 12.70 to 19.05, incl	1.14
Over 19.05 to 25.40, incl	1.52
Over 25.40 to 38.10, incl	1.91
Over 38.10 to 50.80, incl	2.28
Over 50.80 to 63.50, incl	3.18
Over 63.50 to 88.90, incl	3.96
Over 88.90 to 114.30, incl	4.75
Over 114.30 to 152.40, incl	6.35

3.1.4.2 Tubing:

3.1.4.2.1 Up to 10 In. (254 mm), Incl, in Nominal OD: Tubing with nominal wall thickness less than 0.250 in. (6.35 mm) shall have 10% of the wall thickness or 0.015 in. (0.38 mm), whichever is less, removed from the OD after heat treatment. Samples from tubing with nominal wall thickness of 0.250 in. (6.35 mm) and over shall be machined to conform to the stock removal requirement of Table III.

TABLE III

Machined Diameter Inches	Minimum Stock Removal Inch per Side
Up to 2-1/2, incl.	0.044
Over 2-1/2 to 3-1/2, incl.	0.046
Over 3-1/2 to 4-1/2, incl.	0.052
Over 4-1/2 to 5-1/2, incl.	0.057
Over 5-1/2 to 6-1/2, incl.	0.064
Over 6-1/2 to 8, incl.	0.074
Over 8 to 10, incl.	0.087

TABLE III (SI)

Machined Diameter Millimetres	Minimum Stock Removal Millimetres per Side
Up to 63.5, incl	1.12
Over 63.5 to 88.9, incl	1.17
Over 88.9 to 114.3, incl	1.32
Over 114.3 to 139.7, incl	1.45
Over 139.7 to 165.1, incl	1.63
Over 165.1 to 203.2, incl	1.88
Over 203.2 to 254.0, incl	2.21

3.1.4.2.2 Tubing Over 10 In. (254 mm) in Nominal OD: Tubing with nominal wall thickness up to 4 in. (100 mm), incl, shall be turned to straight cylindrical sections representing the full cross section of the wall, less allowance of 0.150 in. (3.81 mm) stock removal on the OD and ID and allowing 0.010 in. (0.25 mm) per side for finish machining after heat treatment. Samples from tubing with nominal wall thickness over 4 in. (100 mm) shall be turned to cylindrical sections representing the cross section from the OD to mid-thickness of the wall less allowance of 0.150 in. (3.81 mm) stock removal on the OD, and allowing 0.010 in. (0.25 mm) per side for finish machining after heat treatment.

3.1.4.3 Flat Bars, Slabs, and Plates: Allowance of 20% of the nominal thickness or 0.100 in. (2.54 mm), whichever is less, shall be made for minimum stock removal, allowing 0.010 in. (0.25 mm) per side for finish machining after heat treatment.

3.1.5 Heat Treatment: Unless otherwise specified, rough machined specimens shall be hardened by suitably austenitizing, quenching, and tempering to produce hardness not lower than 200 HB, determined in accordance with ASTM E10.

3.1.6 Finish Machining: The heat treated specimens shall be finish machined to surface texture not rougher than 40 microinches (1.0 μm)AA, determined in accordance with ANSI B46.1. Rateable surface of specimens shall be nominally 5 in. (125 mm) in length. The ends of the specimen shall be finished to provide good electrical contact.

3.2 Inspection: Magnetic particle inspection shall be performed in accordance with AMS 2640 by the circular, wet, continuous method using 800 - 1200 amp per in. (32 - 48 A/mm) of diameter. If the stepdown bar (3.1.3.3) is used, the smallest step shall be magnetized and inspected first; the larger steps shall be magnetized and inspected individually in succession of increasing size until all steps have been evaluated. If a longitudinal slice from slab or plate as in 3.1.3.5 is used, only the longitudinal surfaces perpendicular to the two faces of the slab or plate shall be inspected.

3.2.1 Cleanliness standards presented herein govern nonmetallic inclusions only. Material which, during inspection, reveals indications representing actual ruptures, such as cracks, seams, laminations, and laps, will be subject to rejection except where these defects result from sample preparation.

3.2.2 The results of magnetic particle inspection shall be appropriately recorded. All recorded results shall be identified, filed, and made available to the purchaser upon request.

3.3 Evaluation of Steel Cleanliness: After inspection, each indication 1/16 in. and over in length shall be recorded. The frequency (number) and severity (size) of the indications shall be calculated as follows:

3.3.1 Frequency (F):

3.3.1.1 The number of indications per test specimen is totaled.

3.3.1.2 The frequency per specimen is determined by dividing the total number of indications from each specimen by the area of the test specimen in square inches.

3.3.1.3 The frequency ratings for all test specimens from a heat are totaled.

3.3.1.4 The average frequency (F) equals the total frequency rating for all test specimens from a heat divided by the number of test specimens.

3.3.2 Severity (S):

3.3.2.1 The length of each indication is recorded.

3.3.2.2 The product for each specimen is computed by totaling the product of the number of indications times the appropriate progression factor listed in the following table:

Length of Indication Inches	Progression Factor for Severity Rating
1/16 to 1/8, incl	0.5
Over 1/8 to 1/4, incl	1
Over 1/4 to 1/2, incl	2
Over 1/2 to 3/4, incl	4
Over 3/4 to 1, incl	8
Over 1 to 1-1/2, incl	16

3.3.2.2.1 Specimens which contain indications representing non-metallic inclusions over 1-1/2 in. in length shall be subject to rejection.

3.3.2.3 The severity per specimen is determined by dividing the product for each specimen by the area of the specimen in square inches.

3.3.2.4 The severity ratings for all test specimens from a heat are totaled.

3.3.2.5 The average severity (S) equals the total severity rating for all test specimens from a heat divided by the number of test specimens.

3.4 Disposition: Product inspected in accordance with this specification shall conform to the following maximum frequency and severity ratings:

3.4.1 Heat Qualification (Reference 4.3.1):

Ø 3.4.1.1 Product Other Than Slab, Sheet, Strip, and Plate:

3.4.1.1.1 Individual Test Bar:

Carbon Content Percent	Ratings	
	Frequency	Severity
Up to 0.25, excl	0.75	0.75
0.25 and over	0.67	0.55

3.4.1.1.2 Average of All Test Bars From A Heat:

Carbon Content Percent	Ratings	
	Frequency	Severity
Up to 0.25, excl	0.40	0.35
0.25 and over	0.37	0.32

3.4.1.2 Slab and Plate: Shall have maximum individual and average frequency and severity ratings as Ø agreed upon by purchaser and vendor.

3.4.2 Product Qualification (Reference 4.3.2):

3.4.2.1 Product Other Than Sheet, Strip, and Plate:

3.4.2.1.1 Individual Test Bar:

Product Nominal Diameter		Carbon Content	Ratings	
Inches	(Millimetres)	Percent	Frequency	Severity
Up to 2.500, excl	(Up to 63.50, excl)	Up to 0.25, excl	1.10	1.05
		0.25 and over	1.00	0.95
2.500 and over	(63.50 and over)	Up to 0.25, excl	0.80	0.80
		0.25 and over	0.80	0.67

3.4.2.1.2 Average of All Test Bars From a Heat:

Product Nominal Diameter		Carbon Content	Ratings	
Inches	(Millimetres)	Percent	Frequency	Severity
2.500 and over	(63.50 and over	Up to 0.25, excl	0.40	0.35
		0.25 and over	0.37	0.32

3.4.2.1.2.1 Product under 2.500 in. (63.50 mm) in nominal diameter or distance between parallel sides inspected using the straight cylindrical test bars or product less than 16 sq in. (102 cm^2) in cross-sectional area inspected by the alternate step-down specimen (3.1.3.3) shall have maximum average frequency and severity ratings as agreed upon by purchaser and vendor.

3.4.2.2 Sheet, Strip and Plate: Shall have maximum individual and average frequency and severity ratings Ø agreed upon by purchaser and vendor.

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 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: Tests to determine conformance to all applicable requirements of this specification are classified as acceptance tests.

4.2.1 Heat Qualification: Tests in accordance with 4.3.1 to determine conformance to "heat qualification" requirements, if acceptable, need be conducted only once per heat.

4.2.1.1 Heats which have been qualified as semi-finished product shall be considered qualified for finished product.

4.2.2 Product Qualification: Tests to determine conformance to the requirements of this specification on product not "heat qualified" shall be conducted on product of each size and shape of each lot made from each heat.

4.3 Sampling: The sampling procedure described in 4.3.1 shall be performed by the producer for heat qualification. No further sampling by the producer shall be required from a heat which meets the requirements of 3.4.1. Sampling procedure on the product shall be as described in 4.3.2.

4.3.1 Heat Qualification: Samples shall be taken from semi-finished or finished product representing the top and bottom of the first ingot and last usable ingot from heats having not more than 10 ingots or not over 30 tons or from portions of heats within these limits; and from the top and bottom of the first ingot, middle ingot, and last usable ingot of heats having more than 10 ingots or over 30 tons.