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30 May 1983
SUPERSEDING
MIL-S-5059C
20 June 1967

MILITARY SPECIFICATION
STEEL, CORROSION-RESISTANT (18-8), PLATE, SHEET AND STRIP

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for four types and five conditions of aircraft quality corrosion-resistant (18-8) steel plate, sheet and strip.

1.2 Classification. Material shall be furnished in the following types and conditions, as specified (see 6.2 and table I):

Types

301 (UNS S30100)
302 (UNS S30200)
304 (UNS S30400)
316 (UNS S31500)

Conditions

Annealed
1/4 Hard
1/2 Hard
3/4 Hard
Full Hard

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Engineering Specifications and Standards Department (Code 93), Naval Air Engineering Center, Lakehurst, NJ 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 9515

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

STANDARDS

FEDERAL

FED-STD-48	-	Tolerances for Steel Wrought Products, and for Centrifugally Cast Steel.
FED-STD-151	-	Metals; Test Methods.
FED-STD-183	-	Continuous Identification Marking of Iron and Steel Products.

MILITARY

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

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 8	-	Tension Testing of Metallic Materials.
ASTM E 10	-	Brinell Hardness of Metallic Materials.
ASTM E 18	-	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials.
ASTM E 290	-	Semi-Guided Bend Tests for Ductility of Metallic Materials.
ASTM A 262	-	Detecting Susceptilibility to Intergranular Attack in Stainless Steels

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)

AMS 2242 - Tolerances - Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium and Titanium Alloy Sheet, Strip and Plate.

(Application for copies should be addressed to SAE, 400 Commonwealth Drive, Warrendale, PA 15096.)

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Chemical composition. The chemical composition shall comply with the limits specified in table II.

3.2 Mechanical properties. The material shall comply with the mechanical properties specified in table IIIa and with the bend properties in table IIIb or c as applicable.

3.2.1 Cold bending. Materials shall withstand, without cracking, cold bending about an axis parallel to the direction of rolling, by either the free-bend method or the controlled-bend (V-block) method at the conditions specified by table IIIb and IIIc, respectively. The choice of method of test shall be at the option of the vendor.

3.3 Production methods. The steel shall be aircraft quality produced by the electric-furnace process. Sufficient discard shall be taken to ensure freedom from injurious piping and undue segregation.

3.4 Surface finish. Material shall be supplied with one of the following surface finishes, as specified (see 6.2.1):

Sheet materials

No. 1 Finish - Hot rolled, annealed, and descaled.
No. 2D Dull finish - Cold rolled, annealed, descaled. Cold rolling after solution heat treatment for any purpose (flattening, finidhing, polishing, etc.) is not permitted.
No. 2B Bright finish - Similar to 2D, except final cold pass on polished rolls.
No. 4 Standard polish - Final polish 120-150 grit, one or both sides.
No. 7 High luster finish - One or both sides.
No. 8 Mirror finish - One or both sides.

Strip materials

No. 1 Strip - Cold rolled, annealed and descaled.
No. 2 Strip - Cold rolled, annealed, descaled and rerolled on polished rolls.
No. 3 Strip - Cold rolled, highly reflective finish, final annealing in a controlled atmosphere furnace.

Unless otherwise specified, annealed sheet shall be furnished with a number 2D finish and annealed strip with a number 1 finish. Sheet and strip in the 1/4 hard condition or of higher hardness shall be furnished with a number 2B finish.

Plate materials

Hot rolled, annealed, or heat treated and blast cleaned or descaled. Standard polish - Final polish 120-150 grit abrasive.

Unless otherwise specified, plate shall be furnished with an unpolished finish.

3.5 Dimensional tolerances. The variation between measured and ordered dimensions shall not exceed the respective tolerance limits of AMS 2242, except that width tolerances for sheared and gas-cut plate shall comply with the tables titled "Alloy Steel Plates, Width and Length of Sheared Plates, One Inch and Under in Thickness, Shearing Tolerances" and "Alloy Steel Plates, Gas Cut Rectangular Plates, Width and Length Tolerances", respectively, of FED-STD-48.

3.6 Internal cleanliness. Assurance against a deleterious carbide network shall be made by examination of the microstructure. There shall be no evidence of a carbide network.

3.7 Identification of product. Plate, sheet and strip shall be legibly marked in accordance with FED-STD-183. The following marking items shall be included:

a. Type
b. Condition
c. Heat number
d. MIL-S-5059D

3.7.1 Coiled sheet and strip. The coiled sheet and strip shall be suitably tagged with the above information, using an oilproof tag, and shall also be marked near the outer end of the coil.

3.8 Workmanship. The plate, sheet and strip shall be free from seams, laminations, blisters, scale and other injurious defects.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. The inspection requirements specified herein are classified as quality conformance inspection (see 4.3 through 4.9).

4.3 Quality conformance inspection.

4.3.1 Inspection of product. Sheet, strip and plate shall be visually inspected to determine conformance to this specification with respect to surface finish (3.4), dimensions (3.5), identification of product (3.7) and workmanship (3.8). Sample units shall be randomly selected to represent each respective thickness, of a number not less than indicated by table IV. Inspection of coils for thickness and crown shall consist of measurements at the center and 1/2 inch in from the edge at each end of the coil and 1/2 inch in from the edge at three other locations along the coil. Inspection for thickness and crown of cut lengths of sheet and strip and of plate, shall consist of measurements at five locations distributed along and 1/2 inch in from the edge, and at the center of the cut ends. Nonconforming material shall be rejected. Reworking of rejected material is permitted provided reinspection is carefully conducted so that all of the nonconforming product is removed.

4.3.2 Packaging, packing and marking. Packaging, packing and marking shall be inspected for conformance to section 5.

4.4 Chemical analysis.

4.4.1 Sampling. Samples for check chemical analysis shall be selected in accordance with method 111 or 112 of FED-STD-151 to represent each heat in the shipment. The sample shall consist of not less than 2 ounces of material.

4.4.1.1 Samples for check chemical analysis may be waived provided that all of the material under inspection can be identified as being made from a heat previously analyzed and found to be in accordance with the chemical composition specified herein.

4.4.2 Method. Chemical analysis shall be performed as specified in method 111 or 112 of FED-STD-151. In the event of dispute, analysis shall be by wet chemical analysis.

4.5 Sampling for mechanical tests.

4.5.1 When sheet or strip is furnished in coil form, at least two (2) samples for mechanical tests shall be cut from each end. When material is furnished in cut sheet, strip or plate form, at least four (4) samples shall be selected from each 100 or less sheets, strips or plates of the same heat and conditioning, of the same thickness, and submitted for inspection at one time. However, no more than one (1) sample may be taken from a sheet, strip or plate.

4.5.2 When material cannot be identified as to heat, at least four (4) samples shall be selected from each 500 pounds of material of one condition and thickness and presented for inspection at one time.

4.5.3 A tension test specimen, a bend test specimen and a hardness test specimen shall be taken from each sample. Hardness tests may be made on the grip end of the tension test specimens before they are subjected to the tension test.

4.6 Tension tests.

4.6.1 Specimens. Tension test specimens shall be obtained in accordance with 4.5, except that not less than four (4) specimens of the same heat and condition and of the same thickness shall be submitted for inspection at one time.

4.6.2 Preparation of specimen. Tension test specimens shall be cut from each sample and shall conform to ASTM E 8, section 6. When the width of the material permits, test specimens shall be prepared with the longitudinal axis transverse to the direction of rolling.

4.6.3 Method. Tension tests shall be conducted in accordance with ASTM E 8. Yield strength shall be determined by the offset or extension-under-load method.

4.7 Bend tests.

4.7.1 Specimens. Bend test specimens shall be obtained in accordance with 4.5. A minimum of three (3) specimens shall be submitted for testing at one time.

4.7.2 Preparation of specimens. Where possible, strip specimens shall be cut from each sample with the longitudinal axis transverse to the direction of rolling. Specimens shall conform with ASTM E 290, section 7.

4.7.3 Method. Specimens shall be tested in accordance with ASTM E 290, as applicable. For controlled-bend (V-block) test specimens shall be bent cold by means of V-blocks or mating punch-and-die having an included angle of 45 degrees and with proper curvature of surfaces at the bend areas to impart the desired shape and diameter of the bend specimen.

4.8 Hardness tests.

4.8.1 Specimens. Hardness test specimens shall be obtained in accordance wtih 4.5. At least three (3) specimens shall be submitted for testing at one time.

4.8.2 Preparation of specimens. Hardness specimens shall conform to either ASTM E 10, section 4 or ASTM E 18, section 4, depending upon which method is used.

4.8.3 Method. Specimens shall be tested in accordance with ASTM E 10 or ASTM E 18.

4.9 Internal cleanliness tests.

4.9.1 Sampling. At least three (3) samples shall be taken from each heat.

4.9.2 Preparation of samples. Samples shall be prepared in accordance with ASTM A 262, Practice C.

4.9.3 Method. Samples shall be tested in accordance with ASTM A 262, Practice C.

4.10 Additional testing. The frequency of sampling specified above is based on the assumption that the material is produced from the same heat at one time and is essentially homogeneous in all respects. If the material is taken from stock and is not identifiable as to heat and method of manufacture, or if the identity of any portion of the shipment is obscure in any respect, additional samples and tests shall be required to determine conformance of all portions of the shipment to this specification.

4.11 Rejection and retest. Failure of a specimen to meet the test requirements shall be cause for rejection of the lot. At the discretion of the acquiring activity, retest will be permitted. A retest sample of five specimens to replace each failed specimen of the original samples shall be tested. If one of the retest specimens fails, the lot shall be rejected with no further retesting permitted.

4.12 Conformance test results. Results of the above conformance tests shall be retained for a period of six months by the contractor. The results shall be readily available to the Government quality assurance representative.

5. PACKAGING

5.1 Packaging and packing. Packaging and packing shall be level A or C, as specified (see 6.2.1).

5.1.1 Level A. Materials shall be properly separated by type, condition, and size when prepared for delivery. Material shall be packaged and packed in accordance with MIL-STD-163.

5.1.2 Level C. Materials shall be packaged and packed in accordance with the manufacturer's commercial practice.

5.2 Marking of shipments. Marking and labeling of shipments shall be in accordance with MIL-STD-163.

6. NOTES

6.1 Intended use. The steel is intended for use in the fabrication of the structural parts of aircraft where a corrosion-resistant steel is required but where gas or arc welding and elevated temperature are not involved.

6.1.1 The mechanical properties specified herein for other than annealed materials are obtained by cold working (strain hardening) and not by heat treatment. Therefore, the cold-worked material should not be heated to temperature which adversely affects the mechanical properties or corrosion-resistance before, during, or after fabrication. However, the resistance spot welding process may be used in the fabrication of parts from this material.

6.2 Ordering data. Acquisition documents should specify the following:

a. Title, number and date of this specification.

b. Type, condition, size and thickness, and surface finish (see 1.2 and 3.4).

c. Level of packaging and packing required (see 5.1).

6.3 Definitions.

6.3.1 Sheet. Sheet shall be interpreted as material which is less than 0.1875 inch in thickness and 24 inches or more in width.

6.3.2 Strip. Strip shall be interpreted as material which is 0.1875 inch or less in thickness and less than 24 inches in width.

6.3.3 Plate. Materials over 10 inches in width and 0.1875 inch or over in thickness.

6.4 Type designations. The use of 301, 302, 304 and 316 in this specification designates alloys having chemical compositions similar to, but not necessarily identical with, AISI type 301, 302, 304 and 316, respectively. The unified numbering system (UNS) designations are listed for information purposes only and similar alloys shall not be construed as an acceptable alternate, unless all requirements of this specification are met.

Custodians:
Navy - AS
Air Force - 20
Army - AR

Preparing activity:
Navy - AS

(Project No. 9515 - 0109)

Review activities:
Navy - OS
Air Force - 99
Army - EA, MI
DLA - CS, IS

User activities:
Army - ME

TABLE I. Type and condition matrix.

Type	Conditions				
	Annealed	1/4 hard	1/2 hard	3/4 hard	Hard
301	X	X	X	X	X
302	X	X	X	X	X
304	X	X	X	X	X
316	X	X			

TABLE II. Chemical composition.

Type	Percent								
	C (max)	Mn (max)	P (max)	S (max)	Cr	Ni	Si (max)	Cu (max)	Mo
301	0.15	2.00	0.045	0.03	16.0-18.0	6.0-8.0	1.00	0.50	0.50 (max)
302	0.15	2.00	0.045	0.030	17.0-19.0	8.0-10.0	1.00	0.50	0.50 (max)
304	0.08	2.00	0.045	0.030	18.0-20.0	8.0-12.0	1.00	0.50	0.50 (max)
316	0.08	2.00	0.045	0.030	16.0-18.0	10.0-14.0	1.00	0.50	2.00-3.00

TABLE IIIa. Minimum tension test and hardness requirements.

Type (UNS)	Condition	Tensile strength (psi) 1/	Yield Strength		Percent Elongation in 2 inches			Hardness 2/	
			0.2 percent offset (psi)	Extension under load (inch in 2 inches)	Thickness up to 0.015 inch	Thickness 0.016 to 0.030 inch	Thickness 0.031 inch and over	Rockwell	BHN
301 (S30100)	Annealed	110,000	40,000	-	60	60	55	B85 3/	165 3/
	1/4 hard	125,000	75,000	0.0098	25	25	25	C25	253
	1/2 hard	150,000	110,000	0.0125	15	15	15	C32	301
	3/4 hard	175,000	135,000	0.0144	12	12	12	C37	344
	Full hard	185,000	140,000	0.0148	8	8	8	C41	381
302 (S30200)	Annealed	90,000	37,000	-	50	50	60	B82 3/	155 3/
	1/4 hard	125,000	75,000	0.0098	12	12	12	C25	253
	1/2 hard	150,000	110,000	0.0125	10	10	10	C32	301
	3/4 hard	175,000	135,000	0.0144	5	5	5	C37	344
	Full hard	185,000	140,000	0.0148	2	2	2	C41	381
304 (S30400)	Annealed	85,000	35,000	-	55	55	60	B80 3/	150 3/
	1/4 hard	125,000	75,000	0.0098	10	12	12	C25	253
	1/2 hard	150,000	110,000	0.0125	6	7	7	C32	301
	3/4 hard	175,000	135,000	0.0144	3	5	5	C37	344
	Full hard	185,000	140,000	0.0148	3	5	5	C41	381
316 (S31600)	Annealed	85,000	35,000	-	50	50	55	B80 3/	150 3/
	1/4 hard	125,000	75,000	0.0098	10	10	10	C25	253

NOTES:

1/ Maximum tensile strength for any condition shall not exceed the specified mimimum by more than 15,000 psi.
2/ Material shall not be rejected for low hardness provided that tensile properties meet the mimimum requirements.
3/ Maximum.

TABLE IIIb. Free bend test requirements.

Type	Condition	Thickness 0.050 inch and under		Thickness over 0.050 through 0.187 inch		Thickness over 0.187 inch	
		Bend angle in degrees	Bend 1/ factor	Bend angle in degrees	Bend 1/ factor	Bend angle in degrees	Bend 1/ factor
301	Annealed	130	1	180	1	180	1
	1/4 hard	180	1	90	2	---	---
	1/2 hard	180	2	90	2	---	---
	3/4 hard	180	3	---	---	---	---
	Hard	180	4	---	---	---	---
302	Annealed	180	1	180	1	180	1
	1/4 hard	180	1	90	2	---	---
	1/2 hard	180	2	90	2	---	---
	3/4 hard	180	3	---	---	---	---
	Hard	180	4	---	---	---	---
304	Annealed	180	1	180	1	180	1
	1/4 hard	180	1	90	2	---	---
	1/2 hard	180	2	90	2	---	---
	3/4 hard	180	3	---	---	---	---
	Hard	180	4	---	---	---	---
316	Annealed	180	1	180	1	180	1
	1/4 hard	180	2	90	2	---	---

TABLE IIIc. Controlled bend (V-block) test requirements.

Type	Condition	Thichness 0.050 inch and under		Thickness over 0.050 through 0.187 inch		Thickness over 0.187 inch	
		Bend angle in degrees	Bend 1/ factor	Bend angle in degrees	Bend 1/ factor	Bend angle in degrees	Bend 1/ factor
301	Annealed	135	1	135	1	135	1
	1/4 hard	135	2	135	3	---	---
	1/2 hard	135	4	135	4	---	---
	3/4 hard	135	6	---	---	---	---
	Hard	135	6	---	---	---	---
302	Annealed	135	1	135	1	135	1
	1/4 hard	135	2	135	3	---	---
	1/2 hard	135	4	135	4	---	---
	3/4 hard	135	6	---	---	---	---
	Hard	135	6	---	---	---	---
304	Annealed	135	1	135	1	135	1
	1/4 hard	135	2	135	3	---	---
	1/2 hard	135	4	135	4	---	---
	3/4 hard	135	6	---	---	---	---
	Hard	135	6	---	---	---	---
316	Annealed	135	1	135	1	135	1
	1/4 hard	135	5	135	6	---	---

1/ Specimens shall be bent around a diameter equal to the product of the bend factor times the nominal thickness of the test specimen.

TABLE IV. Sampling.

Lot size	Sample size	Acceptance number
1 - 65	4	0
66 - 110	5	0
111 - 300	7	0
301 - 500	10	0
501 - 800	15	0
Over 800	25	0

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