The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS-S-18732

Issued OCT 1998

Submitted for recognition as an American National Standard

STEEL BARS, WIRE, FORGING STOCK, FORGINGS, TUBING (431), SPECIAL QUALITY

NOTICE

This document has been taken directly from U.S. Military Specification MIL-S-18732D, Notice 1 and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-S-18732D, Notice 1. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualifications requirements and associated qualified products lists are mandatory to DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this technical report.

1. SCOPE:

1.1 Scope:

This specification presents requirements for a special quality of type 431 corrosion-resistant steel.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2303 Aircraft Quality Steel Cleanliness

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

FED-STD-48	Tolerances for Steel and Iron Wrought Products
FED-STD-151	Metals; Test Methods
FED-STD-183	Continuous Identification Marking of Iron and Steel Products
MIL-H-6875	Heat Treatment of Steels (Aircraft Practice, Process for)
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-753	Corrosion - Resistant Steel Parts, Sampling, Inspection and Testing for Surface Passivation
MIL-STD-163	Steel Mill Products, Preparation for Shipment and Storage

2.3 Uniform Classification Committee:

Available from Uniform Classification Committee, 202 Chicago Union Station, Chicago, IL 60606.

Uniform Freight Classification Rules

3. REQUIREMENTS:

3.1 Chemical composition:

The chemical composition shall be as specified in table I.

TABLE I. Chemical Composition

Element	Percent	Check analysis tolerance (percent)[1]
Carbon	-0.13-0.17	0.01
Manganese	-0.30-0.80	.08
Silicon	-0.20-0.60	.05
Phosphorus	-0.040 (max.)	.005
Sulfur	-0.030 (max.)	.005
Chromium	15.50-16.50	.20
Nickel	-2.00- 3.00	.07
Molybdenum	-0.25 (max.)	.03
Nitrogen	-0.10 (max.)	.01
Carbon	Balance	-

[1] Individual determinations may vary above or below the specified range to the extent shown in the check analysis column, except that elements in any heat shall not vary both above and below the specified range.

3.2 Quality:

All material supplied under this specification shall be magnetic particle inspected in accordance with the requirements of AMS 2303 and shall comply with the frequency and severity limits specified therein.

3.2.1 Microstructure: After heat treatment to the HT-125 condition, materials shall not exhibit banding or segregation in excess of the limits of 3.2.1.1 or 3.2.1.2, respectively. The limits apply to all fields of longitudinal sections of specimens shown in figures 1 and 2 and when examined at 250 diameters magnification.

3.2.1.1 Free ferrite: Material shall not contain banded free ferrite in excess of that indicated by figure 3. Blocky ferrite, not banded, shall not exceed 4 percent. Unacceptable microstructure containing excessive banded free ferrite is shown on figure 4.

3.2.1.2 Retained austenite: Material shall not contain banded retained austenite in excess of amount shown in figure 5. Figures 6 and 7 represent unacceptable microstructures. Blocky austenite, not banded, is permitted.

3.3 Condition (as supplied):

The material shall be furnished annealed, or otherwise heat treated to a hardness range of Brinell 229-302 (excluding forging stock).

3.3.1 Surface condition:

3.3.1.1 Bar and forging stock, round: Surfaces shall be ground or rough turned.

3.3.1.2 Bar and forging stock, rectangular: Surfaces shall be hot-rolled and free from scale. Slight surface imperfections which are removable within half the specified tolerances will not be cause for rejection.

3.3.1.3 Tubing: Surface imperfections such as handling marks, straightening marks, light mandrel and die or roll marks, shallow pits, and scale pattern will not be cause for rejection, provided the imperfections are removable without reducing the diameter or wall thickness of the tubing below the permissible tolerance limits. Imperfections shall be removed by grinding or buffing, except when the imperfections are open so that the root areas are visible to the unaided eye and the surfaces blend smoothly into the normal surfaces of the tubing.

3.3.1.4 Wire: Surfaces shall be cold drawn, ground, polished or pickled.

3.3.2 Grain size: Grain size shall be No. 3 or finer, as indicated in supplement A, FED-STD-151, when tested in the HT-125 condition (excluding reforging stock).

3.4 Response to thermal treatment:

When heat treated as specified herein, the material shall develop the properties specified in table II.

3.4.1 HT-200 condition: HT-200 is achieved by (1) quenching in oil at 52° ±6°C (125° ±10°F) from 1,020° ±14°C (1,875° ± 25°F); (2) cooling to room temperature in water; (3) soaking at -73° ±11°C (-100 ±20°F) in a suitable refrigerant for 2 hours; (4) tempering at 288° ±14°C (550° ±25°F) for 2 hours; and (5) retempering at 288° ±14°C (550° ±25°F) for 2 hours.

3.4.2 HT-125 condition: HT-125 is achieved by quenching in vigorously agitated oil (Houghton #2 or oil of equivalent H value) at 52° ±6°C (125° ±10°F) from 1,024° ±8°C (1,875° ±15°F), cooling to room temperature in water, tempering at 635° ±14°C (1,175° ±25°F) for 3 hours, and air cooling to room temperature. This heat treatment is used to provide maximum contrast for microstructure evaluation (see 3.2.1 and 4.5.2).

TABLE II. Mechanical properties

Direction of testing and condition[1]	Ultimate tensile strength minimum (psi)	Yield strength at 0.2 percent offset or at extension indicated (E 28,000,000) minimum 2-inch gage		Elongation in 4 diameters (minimum percent)	Reduction of area (minimum percent)
		(psi)	Length (in.)		
Longitudinal HT-200	200,000	150,000	0.0150	10	40

[1]Specimens shall have a minimum diameter of 0.250 inch.

3.5 DImensions and tolerances:

3.5.1 Diameter or Thickness: Variations of measured dimensions from ordered dimensions shall be within the tolerance limits specified in FED-STD-48.

3.5.2 Exact lengths: Bars of all sizes may be ordered to exact lengths or in lengths expressed as a multiple of a definite unit, with tolerances as specified in table titled "Stainless and Heat Resisting Steels, Hot Rolled Bars, Length Tolerances" of FED-STD-48.

3.5.3 Mill lengths: When exact or multiple lengths are not ordered, bars will be be accepted in mill lengths of 8 to 20 feet, but not more than 10 percent of any order shall be furnished in lengths shorter than 10 feet.

3.6 Identification of product:

Bars shall be marked in accordance with FED-STD-183. The following marking items shall be included in the legend:

MIL-S-18732
Heat number
Manufacturer's name or identifying trademark.

3.6.1 Bars and wire smaller than 1/2 inch in diameter or 3/8 inch in width of flat shall be tagged with the above information at each bundle end and with an extra tag included in the bundle.

3.7 Workmanship:

Material shall be sound and of uniform condition, smooth, clean, and free from scale and injurious defects such as cracks, seams, tears, grooves, laminations, pits, and blisters. Slight surface imperfections which are removable within half the specified tolerance will not be considered injurious defects.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to 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 inspections:

All the inspections required herein for the testing of steel are classified as quality conformance inspections, for which necessary sampling techniques and methods of testing are specified in this section.

4.3 Sampling and inspection for dimensions, finish, workmanship, packaging, and identification-marking requirements. Units of product shall be randomly selected to represent each lot of material of one heat, nominal dimensions, and offered for acceptance at one time, in accordance with table III.

TABLE III. Sampling for examination of product

Lot size	Sample size	Acceptance number
1 to 7	All	0
8 to 40	7	0
41 to 110	15	1
111 to 180	25	2
181 to 301	35	3
Over 301	50	4

4.3.1 Method: Samples shall be visually inspected.

4.4 Chemical analysis:

4.4.1 Sampling: Samples for check chemical analysis shall be selected in accordance with Method III of FED-STD-151, to represent each heat in the shipment.

4.4.1.1 Sample location: Samples for check chemical analysis shall be taken parallel to the axis of the material selected at a point midway between the center and the surface, except that material less than 1 1/4 inches thick shall be sampled through the entire cross section. The sample shall consist of not less than 2 ounces.

4.4.1.2 Waiver: 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 conformance with the chemical composition specified herein.

4.4.1.3 Additional samples: Where the material is not identifiable as to heat or where the identify of any portion of the shipment is obscure in any respect, samples shall be selected in accordance with table III.

4.4.1.4 Method: Analysis shall be in accordance with Method 111 or 112 of FED-STD-151, except that in the event of dispute, Method 111 shall be used.

4.5 Microstructure and grain size:

4.5.1 Sampling: A sample shall be selected to represent each 50 pieces of each size from each heat, except when the minimum cross sectional dimension exceeds 2 inches, a sample shall be selected to represent each 10 pieces. When materials are not identified or the identity is obscure in any respect, sampling shall be in accordance with table III. The steel manufacturer may use heat evaluation tests in lieu of finish testing (see 4.4.1.3).

4.5.2 Method: Specimens shall be heat treated to the HT-125 condition and sectioned parallel to the direction of rolling or drawing to expose surfaces as indicated by figure 8. Specimens shall be suitably polished, etched with Villella's etchant, and examined at 250 diameters magnification. Acceptance standards are as indicated by 3.2.1 and figures 1 through 7.

4.6 Response to heat treatment:

4.6.1 Sampling: One tension test sample shall be selected from each 500 pieces or less of each configuration, produced under the same processing conditions, from the same heat, of the same size, essentially uniform in all respects and submitted for inspection at the same time. When materials are not identified or the identity is obscure in any respect, sampling shall be in accordance with table III. The steel manufacturer may use heat evaluation tests in lieu of finish testing.

4.6.1.1 Heat lots: Heat lots may be certified tests of four samples from intermediate mill products of sufficient size to provide short-of-center transverse specimens for testing.

4.6.2 Preparation of specimens: All tension test samples shall be given final machining before heat treatment, except for finish machining of bearing and close-tolerance surfaces. Tension specimens of Method 211 of FED-STD-151 shall be used.

4.6.2.1 Specimens shall be heat treated in accordance with equipment and process requirements of MIL-H-6875.

4.6.3 Method: Tension tests and determination of yield strength shall be conducted in accordance with Method 211 of FED-STD-151.

4.7 Rejection:

When the failure of one or more specimens indicates that the test sample fails to meet a specified requirement, the entire lot shall be rejected.

4.7.1 Retest: At the discretion of the supplier, retest will be permitted. A retest sample of five specimens shall be tested to replace each failed specimen of the initial sample. If one or more of the retest specimens fail, the lot shall be rejected with no further testing permitted.

4.7.1.2 Resubmittal: If the defectives in a lot previously rejected can be identified and reprocessed or removed, resampling at frequency of the initial sampling will be permitted.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and packing:

5.1.1 Levels A and B: Material shall be prepared for shipment in accordance with MIL-STD-163.

5.1.2 Level C: Material shall be packed in boxes or crates so constructed as to insure acceptance by common or other carrier and safe delivery at destination. Shipping containers shall comply with the Uniform Freight Classification Rules, or regulations of other carriers as applicable to the mode of transportation.

5.2 Marking of shipment:

Interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129 and MIL-STD-163. The identification shall include the following information listed in the order shown:

(a) Stock No. or other identification number as specified in the purchase document.

(b) Steel (bars, wire, forging stock, forgings, or tubing, as appropriate) 431, special quality MIL-S-18732, size and shape (round, square, hexagon, or flat).

(c) Heat No.

(d) Quantity contained, feet or pounds (as defined in the contractor's order for each size and shape).

(e) Name of contractor (and name of manufacturer, if not the same).

(f) Contract or order No.

6. NOTES:

6.1 Intended use:

The steel covered by this specification is intended for use in the manufacture of highly stressed structural parts exposed to corrosive environments and operating temperatures to 500 °F for materials heat treated to the HT-200 condition. The material is useful for one component of threaded stainless steel fasteners because of a tendency to resist seizure when in contact with other types of corrosion resisting steel.

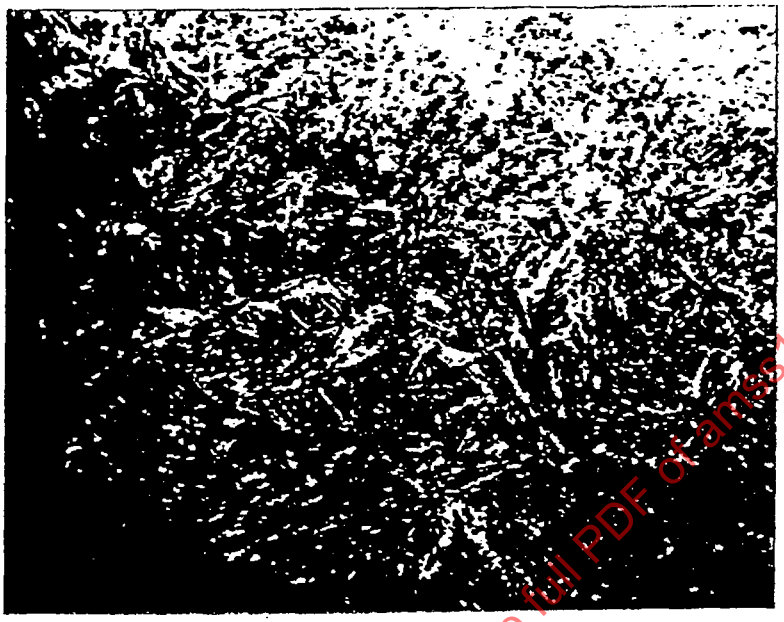

FIGURE 1 - Desired microstructure (100% Martensite)

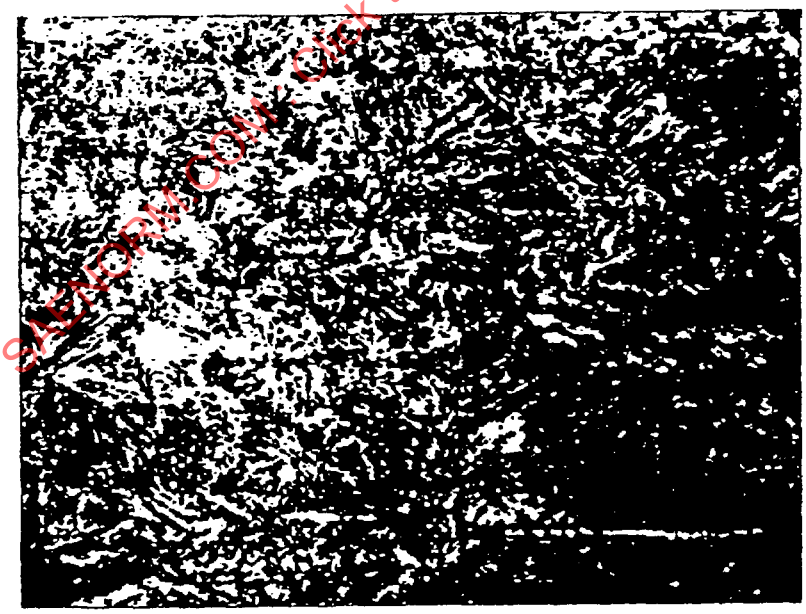

FIGURE 2 - Acceptable microstructure containing small amount of banded free ferrite

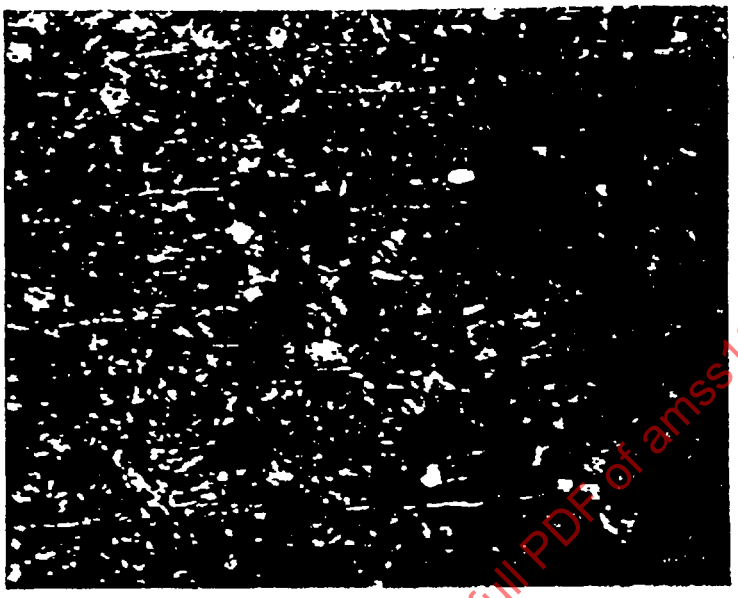

FIGURE 3 - Acceptable microstructure containing maximum amount of banded free ferrite permitted in any field

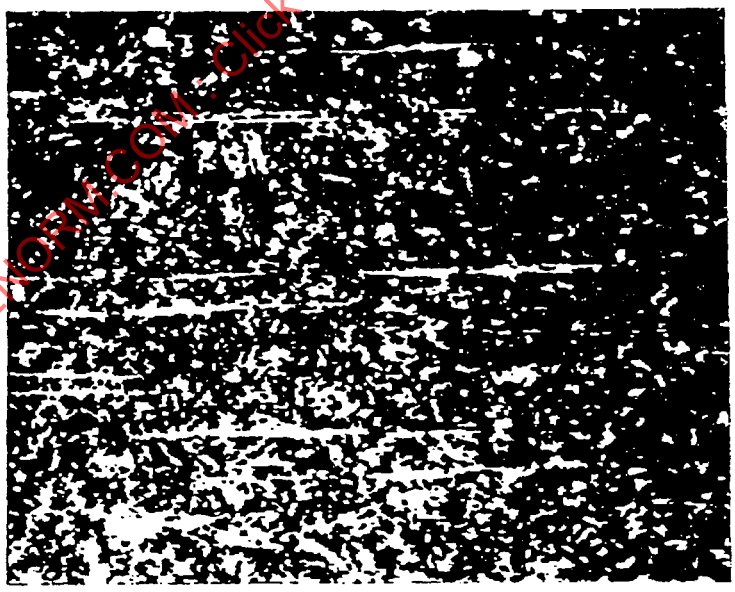

FIGURE 4 - Unacceptable microstructure containing excessive banded free ferrite

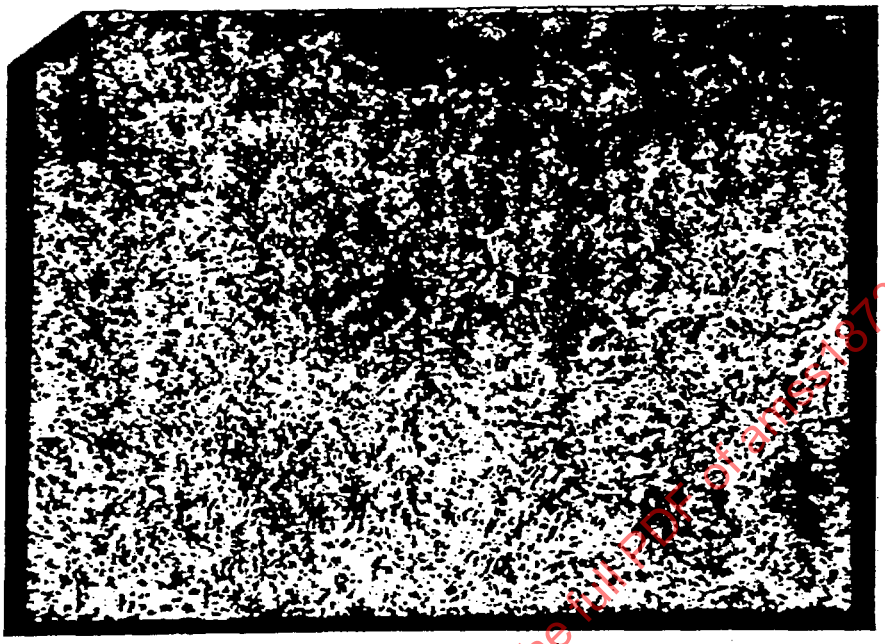

FIGURE 5 - Acceptable microstructure containing maximum amount of banded retained austenite permitted in any field of examination