METRIC
DOD-F-24669/7
7 July 1986
SUPERSEDING
MIL-S-861A(SHIPS)
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MILITARY SPECIFICATION

FORGINGS AND FORGING STOCK, STEEL BARS AND BILLETS, CORROSION RESISTING; NAVAL STEAM TURBINE PARTS USE (METRIC)

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

1. SCOPE

1.1 Scope. This specification covers corrosion-resisting steel bars for naval steam turbine parts and quality assurance provisions for finished turbine blades.

1.2 Classification. Bars shall be of the following classes and conditions, as specified (see 6.2).

Class 403
- Condition AN - Annealed
- Condition HT - Heat-treated

Class 405
- Condition AN - Annealed

Class 410
- Condition AN - Annealed
- Condition HT - Heat-treated

Class 422
- Condition AN - Annealed (forging stock only)
- Condition HT - Heat-treated

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A AREA FORG

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specification and standards. The following specification and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATION

MILITARY

DOD-F-24669 - Forgings and Forging Stock, Steel Bars, Billets and Blooms, General Specification for. (Metric)

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection By Attributes.

MIL-STD-271 - Nondestructive Testing Requirements for Metals.

(Copies of specification and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 370 - Standard Methods and Definitions for Mechanical Testing of Steel Products. (DoD adopted)

E 10 - Standard Test Method for Brinell Hardness of Metallic Materials. (DoD adopted)

E 18 - Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials. (DoD adopted)

E 110 - Standard Test Method for Indentation Hardness of Metallic Materials by Portable Hardware Testers.

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

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. The material furnished under this specification shall be in accordance with the requirements of DOD-F-24669 and as specified herein.

3.2 Material processing. The material shall be processed in accordance with DOD-F-24669 except that it shall be melted by the electric furnace or vacuum induction process only.

3.3 Heat treatment. The material shall be uniformly annealed or heat treated as required by the condition specified to produce material meeting the required mechanical properties.

3.4 Chemical composition. The chemical composition shall be in accordance with tables I and II. Heat analysis shall be as specified in table I. Product analysis shall be in accordance with table I with the tolerances shown in table II.

TABLE I. Chemical composition.

Classes	Carbon (max)	Manganese (max)	Phosphorus (max)	Sulfur (max)	Silicon (max)	Chromium	Aluminum	Vanadium	Molybdenum	Tungsten	Nickel
	Percent	Percent	Percent	Percent	Percent	Percent	Percent				
Class 403	0.15	1.00	0.040	0.030	0.50	11.5 to 13.0	——	——	1/	-----	0.50 max
Class 410	.15	1.00	.040	.030	1.00	11.5 to 13.5	——	——	——	-----	-----
Class 405	.08	1.00	.040	.030	1.00	11.5 to 14.5	0.10 to 0.30	——	——	-----	-----
Class 422	.20-.25	1.00	.040	.030	0.75	11.5 to 13.5	——	0.15 to 0.30	0.75 to 1.25	0.75 to 1.25	0.50 to 1.00

1/ When material conforming to class 403 is specified for the manufacture of forged blades requiring resistance to corrosion as described in 3.6, 0.40 - 0.60 percent molybdenum will be permitted.

TABLE II. Product analysis.

Element	Tolerance, (max) percent
Carbon	0.01
Manganese	.03
Phosphorus	.005
Sulfur	.005
Silicon	.05
Chromium	.15
Aluminum	.05
Molybdenum 403	.03
Molybdenum 422	.05
Nickel	.03

3.5 Mechanical properties.

3.5.1 Heat treated material (condition HT). The heat treated material shall be in accordance with table III.

TABLE III. Mechanical properties.

Class	Condition	Tensile strength (min)		Yield strength 1/ (min)		Elongation in 2 inches, (min)	Reduction of area (min)	Charpy V-notch impact at room temperature (min)		Hardness 2/	
		MPa	lb/in^2	MPa	lb/in^2	Percent	Percent	Jouls	ft/lb	Brinell 3/	Rockwell
403	AN	---	---	---	---	---	--	--	--	241 max	B100 max
	HT	690	100,000	480	70,000	20	60	40	30	201-241	B94-B100
410	AN	---	---	---	---	---	--	--	--	241 max	B100 max
	HT	690	100,000	480	70,000	20	45	40	30	201-241	B94-B100
422	AN	---	---	---	---	---	--	--	--	262 max	C26 max
	HT	965	140,000	760	110,000	13	30	18	13	302-352	C33-C38

1/ Yield strength at an offset of 0.01 percent of the gauge length.
2/ The use of either the Brinell or Rockwell test is permitted.
3/ Brinell hardness taken with 10 millimeter ball, 3000 kilogram load.

3.5.2 Annealed material. Material furnished in condition AN shall meet the mechanical properties specified in table III when subjected to the appropriate harden and temper heat treatment. Annealed material shall not exceed the hardnesses specified in table III.

3.5.3 Hardenability. Class 405 bar shall not exceed a hardness of HB 250 or HRC 24 when tested as specified in 4.3.1.

3.6 Acid resistance. When specified (see 6.2) class 403 bars shall show no evidence of intergranular corrosion, disintegration, or pitting when subjected to the test specified in 4.3.2. This test is intended for class 403 bars which is to be used for the manufacture of forged blades which are to be subjected to acid cleaning or pickling at any stage of processing.

3.7 Cold bend. When specified (see 6.2) class 410 material with a hardness over HB 200 shall not crack or break on the outside of the bent portion when tested in accordance with 4.3.3. This test applies to class 410 material intended for use as shrouding.

3.8 Magnetic particle inspection. Blades machined or forged from class 403 bars shall be inspected in accordance with 4.3.4. Blades shall be free of cracks, laps and seams. Inclusions shall be acceptable provided they comply with the following:

(a) They are parallel to the blade axis.
(b) They do not extend from the profile around a corner into the platform or tendon.
(c) They do not bleed dye penetrant when subject to a liquid penetrant inspection.

3.9 Hardness. Class 403 forged blades shall meet the Brinell or Rockwell hardness requirements of class 403, condition HT, when tested in accordance with 4.3.5.

4. QUALITY ASSURANCE PROVISIONS

4.1 The quality assurance provisions shall be in accordance with DOD-F-24669 and as specified herein.

4.2 Sampling.

4.2.1 Hardenability test. One sample shall be taken from each lot of class 405 bars for hardenability test.

4.2.2 Mechanical property tests. Classes 403, 410, and 422 (condition HT) shall have two bars selected from each lot tested for compliance with table III. For each bar selected one tensile and three Charpy impact tests shall be performed.

4.2.3 Acid resistance test. One bar from each lot of class 403 bars shall be subjected to the acid resistance test.

4.2.4 Cold bend test. One bar from each lot of class 410 having a hardness over HB 200 shall be subjected to the cold bend test.

4.2.5 Dimensional examination. A dimensional examination shall be performed on a sample selected in accordance with MIL-STD-105, general inspection level II, acceptance quality level 1.5.

4.2.6 Magnetic particle inspection. All class 403 blades shall be inspected.

4.3 Examination and test procedures.

4.3.1 Hardenability test. One test specimen 1-1/4 centimeter (cm) (1/2-inch) thick shall be prepared from class 405 material selected in accordance with 4.2.1. The specimen shall be heated to 955 ± 15 degrees Celsius (°C) (1750 ± 25 degrees Fahrenheit (°F)), held at temperature for 30 minutes, oil quenched and subjected to a hardness test. Failure of the test specimen to comply with the requirement of 3.5.3 shall result in rejection of the lot represented.

4.3.2 Acid resistance test. When specified (see 6.2), a test specimen 5 cm by 1-1/4 cm (2-inches by 1/2-inch) shall be cut from one end of the class 403 bar selected in accordance with 4.2.3. The specimen shall be heated in air to 1065 ± 15°C (1950 ± 25°F), held at temperature for 1 hour, air cooled, and then pickled in a 50 percent hydrochloric acid solution at 75 ± 3°C (170 ± 5°F) until all scale is removed. This cycle shall be repeated five times and the specimen examined at low magnification (20X-30X).

4.3.3 Cold bend test. Bend tests shall be conducted in accordance with ASTM A 370. Material up to and including 10 millimeters (mm) (3/8-inch) in thickness shall be bent cold through 180 degrees around a pin the diameter of which is equal to the thickness of the material. Material over 10 mm (3/8-inch) thickness shall be bent around a pin the diameter of which is equal to twice the thickness of the material. The axis of the bend shall be parallel to the direction of rolling.

4.3.4 Magnetic particle inspection. A magnetic particle inspection shall be performed in accordance with MIL-STD-271 and shall meet the requirements of 3.8.

4.3.5 Hardness (class 403 blades). Hardness tests shall be performed in accordance with either ASTM E 10, ASTM E 18 or ASTM E 110.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition.)

5.1 Preservation, packing, packaging, and marking shall be in accordance with DOD-F-24669.

6. NOTES

6.1 Intended use.

6.1.1 Class 403 HT material is intended for use in the manufacture of machined blades. Class 403 AN material is intended for use in the manufacture of forged blades. The material shall be ordered in the shortest lengths that will cut without excessive waste. This material is intended for use at service temperature not over 480°C (900°F).

6.1.2 Class 410 material is intended for use in the manufacture of such items as shrouding, packing pieces, wedges, spacer blocks, and locking pieces. This material is intended for use at temperatures not over 480°C (900°F).

6.1.3 Class 405 material is intended for use in the manufacture of such items as shrouding, diaphragm and partitions, when material of low hardenability is required for welding. This material is intended for use at temperatures not over 510°C (950°F).

6.1.4 Class 422 material is intended for use in the manufacture of such items as blades, locking pins, diaphragm and nozzle partitions, nozzle blocks or rings and shrouding. This material is intended for use at temperatures over 480 to 540°C (900 to 1000°F) maximum.

6.2 Ordering data. In addition to the ordering data of DOD-F-24669, acquisition documents should specify the following:

(a) Class and condition required (see 1.2).
(b) Whether the acid resistant test is required for class 403 bars (see 3.6 and 4.3.2).

(c) Whether the cold bend test is required for class 410 material with a hardness over HB 200 (see 3.7 and 4.3.3).
(d) Size, shape and quantity of bars and billets required.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER
DOD-F-24669/7

2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
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- ☐ OTHER *(Specify)*: _____

b. ADDRESS *(Street, City, State, ZIP Code)*

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional

b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional

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8. DATE OF SUBMISSION *(YYMMDD)*

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