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ALLOY STEEL BARS AND SHAPES (ASME SA-479 WITH ADDITIONAL REQUIREMENTS)

APRIL 1976

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FOREWORD

This standard supersedes the November 1974 issue of RDT M 7-3T and incorporates those changes to that issue of the standard that were approved in April 1976 for publication in this revision. These changes are identified by the following marginal notations:

C	Change
D	Deletion
*E	Editorial
N	Addition

Systeme International (SI) metric equivalents have been added following standard American units.

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*With the exception of the change made on page 3 to add information that was inadvertently omitted from the November 1974 issue, the editorial changes that were made during preparation of this revision are not identified.

ALLOY STEEL BARS AND SHAPES (ASME SA-479 WITH ADDITIONAL REQUIREMENTS)

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ALLOY STEEL BARS AND SHAPES (ASME SA-479 WITH ADDITIONAL REQUIREMENTS)

1. SCOPE

This standard covers alloy steel bars and shapes for nuclear and associated applications.

2. GENERAL REQUIREMENTS

Material shall conform to the requirements of ASME SA-479; to the requirements of the ASME Boiler and Pressure Vessel Code (ASME Code), Section III, Article NB-2000; and to the additional requirements of this standard.

Note: The provisions of NB-2510 for the exemption of certain materials from requirements for nondestructive examination because of size or application do not apply. | N

3. BASIS OF PURCHASE

In addition to the requirements of Section 4 of ASME SA-479 the purchaser will specify the following as applicable:

1. Intended applications; e.g., vessels, piping, pumps, or valves.

2. For ferritic materials, the fracture toughness requirements (see NB-2300 and 4.8).

3. Heat treatment temperature, time, and heating and cooling rates for test specimen materials for ferritic materials which will be heat treated during fabrication or installation (see NB-2211).

4. Liquid penetrant or magnetic particle examination option (see 4.10).

5. Application Supplements and Optional Provisions invoked (see Sections 5 and 6). The purchaser will invoke Application Supplements when the end use is as described in Section 5.

4. ADDITIONAL REQUIREMENTS

The following requirements are mandatory.

4.1 Heat Treatment. Austenitic grades shall be furnished in the solution treated condition. Except as provided in 9.2 and 9.3 of ASME SA-479, the solution treatment procedure shall consist of heating

the materials to a minimum temperature of 1900°F (1038°C) and quenching in water or rapidly cooling by other means. Rapid cooling by other means is acceptable only when the cooling rate attained is sufficient to prevent reprecipitation of chromium carbides as demonstrated by freedom from intergranular attack when tested in accordance with ASTM A 262, Practice E. Specimens for the intergranular corrosion test shall be taken from the same locations as specified for mechanical test specimens. The number of intergranular corrosion tests shall not be less than the number of tensile tests required.

4.2 Product Analysis. Analyses shall be made on samples taken from broken tension test specimens or material samples taken from tension test specimen locations. The number of analyses shall not be less than the number of tensile tests specified. The chemical composition thus determined shall satisfy the requirements specified in ASME SA-479, Section 5.

4.3 Mechanical Properties. Yield strength shall be determined by the offset (0.2 percent) method. (The alternate method permitted by 11.2 of ASME SA-479 based on total extension under load is not permitted.) A minimum of one tension test shall be made for each lot of material procured. A lot is defined as all material of a single size and heat, annealed or treated in a single charge in a batch type furnace, or annealed or tested under the same conditions in a continuous furnace.

4.4 Retests. If in the course of preparation a test specimen is made defective due to such things as machining errors, the specimen may be replaced with another which shall be selected on the same basis as the one discarded. If, however, a specimen develops flaws upon testing or otherwise fails to meet test requirements, the material represented by the specimen shall be rejected except that, at the material manufacturer's option, the material may be reprocessed and retested, or each item may be individually tested for acceptance. All required mechanical property and corrosion tests shall be repeated after any re-heat treatment. In the event materials are re-heat treated, the certifications submitted as required in 4.11 shall include initial test data, re-heat treat data if other than treatment normally used by the manufacturer for the particular grade of material, and the final test data indicating acceptability.

4.5 Repair by Welding. Repair welding shall be in accordance with NB-2500 and the following additional requirements.

a. Where thermal cutting or gouging is performed, at least 1/8 in. (3 mm) of material shall be mechanically removed from the cut surface of austenitic materials before making weld repairs.

b. Repair welding of ferritic materials is not permitted.

c. The reporting requirements of NB-2539.6 shall apply to all repair welds regardless of size.

4.6 Marking.

4.6.1 Unless otherwise specified, each bar 1/2 in. (13 mm) or more in diameter, width, or thickness shall be marked in constantly recurring symbols at intervals not greater than 3 ft (900 mm) throughout its length. Marking shall be accomplished by an electrochemical etch or with marking ink. Supplementary marking by metal die or electric arc is permitted on the ends of bar.

4.6.2 RDT M 7-3 shall be included in the identification required by ASME SA-479 and NB-2150.

Note: Any Application Supplement or Optional Provision invoked shall be added in parentheses. Example: RDT M 7-3(A)(1).

Marking materials containing chlorine or other halides and low melting point elements, such as sulfur, lead, zinc, copper, and mercury in other than trace amounts, shall not be used for identification of austenitic stainless steel.

4.7 Ultrasonic Examination.

4.7.1 All material, regardless of size or intended application, shall be ultrasonically examined in accordance with NB-2500, subject to the limitations of NB-2541. To ensure complete coverage of the volume, the index of the search unit shall be such that the overlap shall not be less than that required to produce response amplitude from the calibration holes or notches of at least 20 percent of reject amplitude. The amount of overlap required shall be demonstrated using the transducer to be employed in examination of the material. All indications producing signal amplitudes 20 percent or greater of the reject amplitude shall be maximized and evaluated in terms of the acceptance standards. E

4.7.2 Ultrasonic examination of bars by the straight beam method shall also be performed using flat bottom hole calibration with the following requirements.

a. The diameter of the calibration hole shall be as follows:

Section Thickness*, in. (mm)	Hole Diameter, in. (mm)
1/2 (13) through 2 (50)	3/16 (5)
Over 2 through 3 (75)	1/4 (6)
Over 3 (75)	1/2 (13)

*Section thickness is the thickness of the material in the direction of propagation of the ultrasonic wave.

b. The depth of the calibration hole shall be 25 percent of the section thickness for 2 in. (50 mm) thickness and less; and the greater

of 1/2 in. (13 mm) or 10 percent of the section thickness for thicknesses greater than 2 in. (50 mm).

c. Amplitude compensation for test metal distance is permitted provided a distance-amplitude correction curve is established using reference blocks with flat bottom holes providing test distance of 10, 50, and 90 percent of the section thickness.

4.7.3 The following indications or conditions are unacceptable:

1. For thicknesses 1/2 in. (13 mm) and over, any indication with an amplitude equal to or greater than the amplitude of the signal from the reference hole or distance-amplitude curve.

2. For all material thicknesses, any condition which causes 90 percent loss of back reflection.

4.8 Fracture Toughness Tests. Ferritic materials which are 1/2 in. (13 mm) or greater in nominal section thickness and are excluded from the impact testing requirements of NB-2300 because of size shall be impact tested in accordance with the Charpy V-notch (C_V) method of ASME SA-370 and the following.

a. The requirements of NB-2321.2, NB-2322, NB-2340, NB-2350, and NB-2360 shall apply.

b. For thicknesses 5/8 in. (16 mm) or less, each specimen shall exhibit at least 20 mils (0.5 mm) lateral expansion.

c. The lowest service temperature shall be as specified by the purchaser.

4.9 Halide Contamination. Care shall be taken during all operations to minimize contact of austenitic stainless steels with halide or halide bearing compounds, including die lubricants, masking tape, and marking compounds. All processing compounds, degreasing agents, cleaning solutions, and foreign material shall be completely removed at any stage of processing prior to any elevated temperature treatment, and in any event immediately prior to packaging for shipment. Any pickling or descaling operation in a bath containing chlorides shall be followed immediately by a nitric acid pickle and rinsing with hot potable water which meets the requirements of Public Health Service Publication No. 956. Drinking water furnished by cities, counties, states, or other political subdivisions shall be assumed to meet these requirements.

4.10 Liquid Penetrant and Magnetic Particle Examination. All material, regardless of size or intended application, shall be liquid penetrant or magnetic particle examined as required by NB-2540. The purchaser may accept responsibility for performing the required examination if the material will be used in applications that require fabrication processes which will result in the creation of significant new C

surface areas, added heat treatment, or other changes which will materially affect the meaningfulness of such examinations if performed by the materials manufacturer. If the purchaser specifies that such examination is not to be performed by the materials manufacturer, the Certified Materials Test Report shall bear the notation: "Liquid penetrant (or magnetic particle, as applicable) examination was not performed" (see 3.4).

4.11 Certification. A Certified Materials Test Report shall be furnished. In addition to requirements of NB-2130, the report shall include certification of the material to the requirements of RDT M 7-3.

4.12 Quality Assurance. Material manufacturers and suppliers shall have a Quality System Program or Identification and Verification Program, as applicable, which meets the requiremets of NA-3700. Alternatively, for materials which NB-2610(b) exempts from these requirements a quality verification program which meets the requirements of RDT F 2-4 is acceptable. N

5. APPLICATION SUPPLEMENTS

The following requirements shall apply only when specified by the purchaser.

A. Ferritic materials which will be used in ASME Code, Section III, reactor vessel applications where neutron fluence will be greater than 10^{18} nvt (E_n or 1 Mev or above) shall satisfy the following provisions.

(1) Charpy V-Notch Impact Transition Curve. Optional Provision 1 shall be mandatory

(2) Steel Manufacturing Process. Steel shall be made by the basic electric furnace process. Molten steel shall be vacuum treated prior to or during the pouring of the ingot to remove objectionable gases, particularly hydrogen.

(3) Phosphorus, Sulfur, and Copper Limitations. For ladle analysis, the phosphorus content shall be 0.012 percent maximum, the sulfur content shall be 0.015 percent maximum, and the copper content shall be 0.10 percent maximum. For check analysis, phosphorus and sulfur content shall not exceed 0.015 and 0.018 percent, respectively, and copper content shall not exceed 0.10 percent.

(4) Grain Size. The McQuaid Ehn grain size of the material determined in accordance with ASTM E 112 shall be Number 5 or finer.

B. Austenitic stainless steel material intended for use at temperatures over 800°F (425°C) in ASME Code applications shall have a minimum carbon content of 0.04 percent or greater, as specified by the purchaser.

6. OPTIONAL PROVISIONS

The following provisions shall apply only when specified and to the extent specified by the purchaser.

1. Grain Size. Grain size determinations in accordance with ASTM E 112 shall be made on specimens taken from tension test specimen locations or from other locations specified by the purchaser. One such test shall be made for each tensile test required. Acceptable grain sizes shall be as specified by the purchaser.

Note: This Optional Provision is intended for use in exceptional situations only where grain size might be specifically important with respect to such things as high or low temperature creep, ductility, corrosion resistance, or nondestructive examination requirements such as ultrasonic examination.

2. Charpy V-Notch Transition Curve (Ferritic Steels).

(a) Sufficient C_V specimens shall be taken from the material to establish a temperature-impact energy transition curve. Test specimen location and orientation shall be as specified in NB-2322.

(b) The test temperature range shall be sufficiently wide to establish the upper and lower shelf ft-lb energies, with sufficient testing at intermediate temperatures to permit plotting a reasonably smooth curve.

(c) The test temperature, lateral expansion, absorbed energy, percent shear fracture, and location and orientation of specimens shall be reported.

3. Cobalt Content Limitations. When specified, the cobalt content as determined by check analysis performed on each heat of material shall not exceed 0.10 percent.

4. Extra Low Carbon Grades (Austenitic Steel).

(a) Carbon Content. When specified, the carbon content as determined by ladle and check analyses for the applicable type or grade of austenitic stainless steel covered by the referencing standard shall be 0.030 percent maximum. In all other respects, the requirements of the referencing standard shall apply for the type or grade whose carbon content is to be limited.

(b) Boiling Nitric Acid Test. The following shall apply where the boiling nitric acid test of Practice C, ASTM A 262, is specified. Duplicate specimens shall be taken from the material on the same frequency basis required for check analysis in the referencing standard, unless another frequency is specified by the purchaser. Specimens shall be prepared as required, sensitized by heating to 1250°F (675°C)

with one hour hold at temperature, and water quenched. The average corrosion rate for each specimen shall not exceed 0.0020 in. (0.050 mm) per month for the full five periods. Corrosion rates shall be reported for each period, together with the average rate for five periods for both specimens.

5. Intergranular Corrosion Test for Solution Heat-Treated and Water-Quenched Materials (Austenitic Steels). An intergranular corrosion test shall be performed in accordance with ASTM A 262, Practice E. Material up to 2 in. (50 mm) thick shall be capable of passing the test in the as-quenched condition. For materials greater than 2 in. (50 mm) thick, the applicability of these tests shall be a matter of negotiation between the materials manufacturer and purchaser.

6. Liquid Penetrant Examination (Ferritic Steels). Liquid penetrant examination shall be performed on all external surfaces and on all accessible internal surfaces in accordance with NB-2546.

7. Dropweight Tests (Ferritic Steels). Dropweight tests shall be performed in accordance with NB-2321.1.

7. REFERENCED DOCUMENTS

RDT F 2-4T	Quality Verification Program Requirements	N
ASME SA-370	Mechanical Testing of Steel Products	N
ASME SA-479 and ASTM A 479-75	Specification for Stainless and Heat-Resisting Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels	

ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components

ASTM A 262	Recommended Practices for Detecting Susceptibility to Intergranular Attack in Stainless Steels
ASTM E 112	Estimating Average Size of Metals

Public Health Service Publication No. 956, Drinking Water Standard