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Standard Specification for Borated Stainless Steel Plate, Sheet, and Strip for Nuclear Application[1]

This standard is issued under the fixed designation A 887; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers chromium-nickel stainless steel plate, sheet, and strip, modified by the addition of natural or enriched boron, for nuclear application.

1.2 Borated stainless steels covered by this specification, because of their particular alloy content and specialized properties, may require special care in their fabrication and welding. Specific procedures are of fundamental importance, and it is presupposed that all parameters will be in accordance with approved methods capable of producing the desired properties in the finished fabrication.

1.3 The values stated in inch-pound units are to be regarded as the standard. SI units are provided for information only.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *plate*—material 3⁄16 in. (4.8 mm) and over in thickness and over 10 in. (250 mm) in width.

3.1.2 *sheet*—material under 3⁄16 in. (5.0 mm) in thickness and 24 in. (600 mm) and over in width.

3.1.3 *strip*—material under 3⁄16 in. (5.0 mm) in thickness and under 24 in. (600 mm) in width.

4. Ordering Information

4.1 Orders for material under this specification shall include the information specified in the Ordering Information section of Specification A 480/A 480M.

5. Process

5.1 If a specific type of melting is required by the purchaser, it shall be stated on the purchase order.

5.2 When specified on the purchase order, or when a specific type of melting has been specified on the purchase order, the material manufacturer shall indicate on the test report the type of melting used to produce the material.

6. Heat Treatment

6.1 The austenitic chromium-nickel steels shall be solution-annealed to meet the mechanical property requirements of this specification. Solution-annealing shall consist of heating the material to a temperature of 1900°F (1040°C) minimum for an appropriate time followed by water quenching or rapidly cooling by other means.

7. Material Test Report

7.1 A report of the results of all tests required by this specification and the type of melting used shall be supplied to the purchaser.

8. Chemical Composition

8.1 The chemical analysis of representative material shall be performed, as agreed upon between the purchaser and supplier, to determine the percentages of the elements identified in Table 1. The chemical composition thus determined shall be reported to the purchaser, or his representative, and shall conform to the requirements specified in Table 1.

8.2 When a product (check or verification) analysis is performed, the chemical composition thus determined may vary from the specified limits by the amounts shown in Table 1, Product Analysis Tolerances, of Specification A 480/A 480M.

8.3 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods, Practices, and Terminology A 751.

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[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel, and Related Alloys, and is the direct responsibility of Subcommittee A01.17 on Flat-Rolled and Wrought Stainless Steel.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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TABLE 1 Chemical Requirements Composition[A]

UNS Designation	Type	Carbon	Manganese	Phosphorous	Sulfur	Silicon	Chromium	Nickel	Boron	Other Elements[B]
S30460	304B	0.08	2.00	0.045	0.030	0.75	18.00–20.00	12.00–15.00	0.20–0.29	N 0.10 max
S30461	304B1	0.08	2.00	0.045	0.030	0.75	18.00–20.00	12.00–15.00	0.30–0.49	N 0.10 max
S30462	304B2	0.08	2.00	0.045	0.030	0.75	18.00–20.00	12.00–15.00	0.50–0.74	N 0.10 max
S30463	304B3	0.08	2.00	0.045	0.030	0.75	18.00–20.00	12.00–15.00	0.75–0.99	N 0.10 max
S30464	304B4	0.08	2.00	0.045	0.030	0.75	18.00–20.00	12.00–15.00	1.00–1.24	N 0.10 max
S30465	304B5	0.08	2.00	0.045	0.030	0.75	18.00–20.00	12.00–15.00	1.25–1.49	N 0.10 max
S30466	304B6	0.08	2.00	0.045	0.030	0.75	18.00–20.00	12.00–15.00	1.50–1.74	N 0.10 max
S30467	304B7	0.08	2.00	0.045	0.030	0.75	18.00–20.00	12.00–15.00	1.75–2.25	N 0.10 max

[A] Maximum, unless range or minimum is indicated.
[B] Cobalt concentration shall be limited to 0.2 max, unless a lower concentration is agreed upon between the purchaser and the supplier.

8.4 Boron determination not covered in Test Methods, Practices, and Terminology A 751 shall be made as agreed upon between the purchaser and the supplier.

9. Mechanical Properties

9.1 *Tensile Properties*—The material shall conform to the tensile property requirements specified in Table 2.

9.2 *Hardness*—The material shall conform to the hardness requirements as specified in Table 2.

9.3 *Grade*—The grade of the material is defined by the uniformity of the dispersion of the boron within the melt. Grade A corresponds to the near-optimal dispersion, while Grade B corresponds to a less-than-optimal dispersion of the boron. Conventional wrought metallurgical practice conforms to Grade B properties. The quality of the boron dispersion is measured indirectly through the ductility requirements, as specified in Table 2.

TABLE 3 Impact Test Requirements

Type	Grade	Charpy V-Notch Energy, ft-lb (J), min
304B	A	65 (88)
	B	40 (54)
304B1	A	60 (81)
	B	35 (47)
304B2	A	48 (65)
	B	16 (22)
304B3	A	38 (52)
	B	10 (14)
304B4	A	30 (41)
	B	. . .
304B5	A	23 (31)
	B	. . .
304B6	A	16 (22)
	B	. . .
304B7	A	10 (14)
	B	. . .

10. Special Tests

10.1 If any special tests are required that are pertinent to the intended application of the material ordered, they shall be agreed upon between the supplier and the purchaser.

10.2 Charpy V-notch impact testing is not required unless it is specified on the purchase order. If so specified, impact testing shall be performed in accordance with Test Methods and Definitions A 370. The impact test results thus determined shall be reported to the purchaser, or his representative, and shall conform to the requirements specified in Table 3. If subsize impact test specimens are used, the applicable requirements shall be agreed upon between the purchaser and the supplier.

11. Dimensions and Permissible Variations

11.1 Unless otherwise specified in the purchase order, material shall conform to the permissible tolerances shown in Specification A 480/A 480M.

11.2 *Sheet, Strip, and Plate*—Material with No. 1 finish may be ground to remove surface imperfections, provided such

TABLE 2 Mechanical Test Requirements

UNS Designation	Type	Grade	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %	Hardness, max	
			ksi	MPa	ksi	MPa		Brinell	Rockwell B
S30460	304B	A	75	515	30	205	40.0	201	92
		B	75	515	30	205	40.0	201	92
S30461	304B1	A	75	515	30	205	40.0	201	92
		B	75	515	30	205	35.0	201	92
S30462	304B2	A	75	515	30	205	35.0	201	92
		B	75	515	30	205	27.0	201	92
S30463	304B3	A	75	515	30	205	31.0	201	92
		B	75	515	30	205	19.0	201	92
S30464	304B4	A	75	515	30	205	27.0	217	95
		B	75	515	30	205	16.0	217	95
S30465	304B5	A	75	515	30	205	24.0	217	95
		B	75	515	30	205	13.0	217	95
S30466	304B6	A	75	515	30	205	20.0	241	100
		B	75	515	30	205	9.0	241	100
S30467	304B7	A	75	515	30	205	17.0	241	100
		B	75	515	30	205	6.0	241	100

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grinding does not reduce the thickness or width at any point beyond the permissible variations in dimensions.

12. Workmanship, Finish, and Appearance

12.1 The material shall be uniform quality consistent with good manufacturing and inspection practices. The steel shall have no imperfections of a nature or degree, for the type and quality ordered, that will adversely affect the stamping, forming, machining, or fabrication of finished parts.

13. General Requirements for Delivery

13.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 480/A 480M. In case of conflict, the requirements of this specification shall prevail.

14. Number of Tests

14.1 In the case of sheet or strip produced in coil form, two or more hardness tests (one from each end of the coil); one impact test, when required; and one or more tension tests shall be made on specimens taken from each coil. If the hardness difference between the two ends of the coil exceeds 5 HRB, or equivalent, tensile properties must be determined on both ends.

14.2 In the case of sheet, strip, or plate produced in cut lengths, one tension test; one impact test, when required; and one or more hardness tests shall be made on each 100 or less pieces of the same heat and nominal thickness rolled separately or continuously and heat treated within the same operating period, either as a lot or continuously.

NOTE 1—The term "continuously," as applied to heat treatment, is meant to describe a heat-treating operation in which one cut length follows another through the furnace. Interspersement of different melts is permissible if they are of approximately the same nominal thickness and are heat treated in the same operating period and under the same conditions (time and temperature), provided that each heat is tested.

15. Specimen Preparation

15.1 Tension-test specimens shall be taken from finished material and shall be selected either in the longitudinal or transverse direction. The tension-test specimen shall conform to the appropriate Sections, (Plate-Type Specimen, Sheet-Type Specimen, and Round Specimens) of Test Methods and Definitions A 370.

NOTE 2—For plate material up to and including ¾ in. (19.05 mm) thick, the sheet-type tension specimen described in the Sheet-Type Specimen section (Figure relating to rectangular tension test specimens), of Test Methods and Definitions A 370 is also permitted.

15.2 Notched-bar impact test specimens shall be taken from finished material. Full-size (10 by 10 mm) Type A specimens shall be used when the material thickness permits. When the material thickness is insufficient to obtain full-size specimens, subsize specimens shall be used. The subsize specimens may have a width of full material thickness or may be reduced in thickness to provide the largest possible standard subsize specimen listed in Test Methods and Definitions A 370. Alternative specimens may be used, in place of the subsize specimens, as agreed upon between the purchaser and the supplier.

15.3 Hardness tests may be made on the grip ends of the tensions test specimens before they are subjected to the tension test.

16. Test Methods

16.1 The properties enumerated in this specification shall be determined in accordance with methods as specified in Specification A 480/A 480M.

16.2 Retests may be made in accordance with the provisions of the section on General Precautions of Test Methods and Definitions A 370.

17. Retreatment

17.1 If any specimens selected to represent any heat fail to meet any of the test requirements, the material represented by such specimens may be reheat-treated and resubmitted for test.

18. Inspection

18.1 In addition to inspection performed by the supplier, inspection of the material by the purchaser's representative at the producing plant shall be made as agreed upon between the purchaser and supplier as part of the purchase order.

19. Rejection and Rehearing

19.1 Samples tested by the purchaser in accordance with this specification that represent rejected material shall be retained for 3 weeks from the date of the notification to the seller of the rejection. In case of dissatisfaction with the results of the tests, the seller may make claim for a rehearing within that time.

20. Certification

20.1 The producer's certification that the material was manufactured and tested in accordance with this specification, together with the report of the test results, shall be furnished at the time of shipment.

21. Product Marking

21.1 Each sheet, strip, or plate shall be marked on one face, in the locations indicated below with the designation number and its suffix, type, test identification number, and the name or mark of the manufacturer. The characters shall be of such size as to be clearly legible. The marking shall be sufficiently stable to withstand normal handling. Unless otherwise specified by the purchaser, the marking, at the producer's option, may be done with: (*1*) marking fluid (if a specific maximum impurity limit of designated elements in the marking fluid is required by the purchaser, it shall be so stated on the purchase order), (*2*) low-stress blunt-nosed-continuous or low-stress blunt-nosed-interrupted-dot die stamp, (*3*), a vibratory tool with a minimum tip radius of 0.005 in. (0.1 mm), or (*4*) electrochemical etching.

21.1.1 Flat sheet, strip in cut lengths, and plate shall be marked in two places near the ends.

21.1.2 Sheet and strip in coils shall be marked near the outside end of the coil. The inside of the coil shall also be marked or shall have a tag or label attached and marked with the information of 21.1.

21.1.3 Material less than ¼ in. (6.4 mm) in thickness shall not be marked with die stamps.

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21.2 The manufacturer's test identification number shall be legibly stamped on each test specimen, if to be shipped to the customer.

21.3 Marking for identification for U.S. Government procurement shall be in accordance with Specification A 480/A 480M.

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