



Designation: B 655/B 655M – 96 (Reapproved 1999)

## Standard Specification for Niobium-Hafnium Alloy Bar, Rod, and Wire<sup>1</sup>

This standard is issued under the fixed designation B 655/B 655M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers hafnium alloyed niobium bar, rod, and wire.

1.2 The material covered by this specification is R04295, niobium-base alloy containing approximately 10 % hafnium and 1 % titanium.

1.3 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.4 The following safety hazards caveat pertains only to the test methods portion, Section 14, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

B 652 Specification for Niobium-Hafnium Alloy Ingots<sup>2</sup>

E 8 Test Methods for Tension Testing of Metallic Materials<sup>3</sup>

E 21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials<sup>3</sup>

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>4</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *bar*—material less than 6 in. [150 mm] in width and 0.187 in. [4.75 mm] or greater in thickness, with a rectangular or square cross section, supplied in straight lengths.

3.1.2 *rod*—material 0.125 to 2½ in. [3.21 to 64 mm] in diameter in round, hexagonal, or octagonal cross section supplied in straight lengths.

3.1.3 *wire*—material 0.020 to 0.124 in. [0.50 to 3.20 mm] in diameter furnished in coils, spools, or on reels. Material less than 0.020 in. [0.50 mm] in diameter is not covered in this specification.

### 4. Ordering Information

4.1 Orders for material under this specification should include the following information as applicable:

4.1.1 General alloy description (see 1.2),

4.1.2 Quantity in weight or pieces,

4.1.3 Size, diameter, and length,

4.1.4 Method of manufacture (Section 5),

4.1.5 Chemistry (Section 6),

4.1.6 Temper (Section 7),

4.1.7 Quality and finish (Section 10),

4.1.8 Sampling (Section 13),

4.1.9 Marking (Section 19),

4.1.10 Packaging (Section 20),

4.1.11 Required Reports (Section 18), and

4.1.12 Disposition of rejected material (Section 16).

### 5. Materials and Manufacture

5.1 Materials covered by this specification shall be made from ingots in accordance with Specification B 652.

5.2 The various niobium-hafnium alloy products covered by this specification are formed with the conventional extrusion, forging, swaging, rolling, and drawing equipment normally available in metal working plants.

### 6. Chemical Composition

6.1 The niobium-hafnium alloy ingots and billets for conversion to finished products covered by this specification shall conform to the requirements as to chemical composition prescribed in Table 1. Analysis for elements, not listed in Table 1 and not normally expected in niobium-hafnium alloy, shall not be required unless specified at time of purchase.

6.2 The manufacturer's ingot analysis shall be considered the chemical analysis for products supplied under this specification.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B-10 on Reactive and Refractory Metals and Alloys and is the direct responsibility of Subcommittee B10.03 on Niobium and Tantalum.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 02.04.

<sup>3</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 14.02.

**TABLE 1 Chemical Requirements (Ingot)**

Niobium-Hafnium Alloy Grade R04295	
Element	Content, Maximum Weight %, (Except Where Otherwise Specified)
Carbon	0.015
Oxygen	0.025
Nitrogen	0.010
Hydrogen	0.0015
Hafnium	9–11
Titanium	0.7–1.3
Zirconium	0.700
Tungsten	0.500
Tantalum	0.500
Niobium by difference	

6.3 Upon request of the purchaser at the time of purchase, the manufacturer shall furnish a report certifying the values of the interstitial elements, (C, O, N, H) as specified in Table 2 for each lot of material supplied. A lot is defined as that material produced from one ingot and heat treated at the same time.

6.4 In the event of dispute over conformity of the material to this specification, upon agreement between the purchaser and the seller as to procedure, representative samples of the material may be submitted to a referee for analysis.

## 7. Temper Designations

7.1 Unless otherwise stated, the materials supplied under this specification shall be in the annealed condition, defined as at least 90 % recrystallized.

7.2 Other temper designations, such as cold-worked temper or a stress-relieved temper can be specified as agreed upon between purchaser and the manufacturer at the time of purchase.

## 8. Mechanical Requirements

8.1 Materials in the annealed condition supplied under this specification shall conform to the requirements for mechanical properties as prescribed in Table 3.

8.2 The materials shall conform to the requirements for room temperature mechanical properties prescribed in Table 3 when tested within a room temperature range from 65 to 85°F [18 to 30°C].

8.3 *Elevated Temperature Mechanical Properties*—The purchaser may specify elevated temperature mechanical properties at the time of purchase. The materials shall meet the requirements specified in Table 3 when tested within a temperature range from 1975 to 2025°F [1080 to 1110°C].

**TABLE 2 Additional Chemical Requirements for Finished Product (When Specified by Purchaser)**

Niobium-Hafnium Alloy Grade R04295	
Element	Content, Maximum Weight %
Oxygen	0.035
Carbon	0.015
Nitrogen	0.010
Hydrogen	0.0015

## 9. Permissible Variations

9.1 *Tolerances on Rounds*—Tolerances on niobium-hafnium alloy round products covered by this specification shall be as prescribed in Table 4.

9.2 *Tolerances for Square, Rectangular, or Other Shapes*—Tolerances for forged or rolled square, rectangular, or other shapes shall be as agreed upon between the purchaser and manufacturer at the time of purchase.

### 9.3 Other Tolerances and Limitations:

9.3.1 The permissible variation in cut lengths shall not exceed a total of ¼ in. [6.5 mm].

9.3.2 The permissible variation in straightness of rounds shall not exceed 0.050 in. [1.26 mm] per foot [300 mm] in any length.

9.4 *Quantity or Weight*—For orders up to 100 ft [30 m] the manufacturer may overship up to 20 %. For orders up to 1000 lb [450 kg] or 1000 ft [300 m], the manufacturer may overship up to 10 %. The permissible overshipment for orders larger than this quantity shall be negotiated at the time of purchase.

## 10. Quality and Finish

10.1 Niobium-hafnium alloy bar, rod, and wire shall be free of injurious external and internal imperfections of a nature that will interfere with the purpose for which it is intended. Material may be finished as forged, rolled, swaged, drawn; in a cleaned, machined, or ground condition. The manufacturer shall be permitted to remove minor surface imperfections provided such removal does not reduce the dimensions below the minimum permitted by the tolerances in accordance with Section 9.

10.2 Test methods for these defects and standards of acceptability shall be as agreed upon between the purchaser and the manufacturer at the time of purchase.

## 11. Retests

11.1 If any sample or specimen exhibits obvious surface contamination or improper preparation disqualifying it as a truly representative sample, it shall be discarded and a new sample or specimen substituted.

11.2 In case of a failure, two additional specimens shall be retested. If both retest specimens conform to this specification, the original values shall be discarded and the material accepted.

11.3 If the results of the tests are not in conformance with the requirements of this specification, the lot may be reworked at the option of the manufacturer. The lot shall be acceptable if the results of all tests, after reworking, conform to this specification.

## 12. Significance of Numerical Limits

12.1 The following applies to all specified limits in this standard for purposes of determining conformance with this specification. The observed value or a calculated value shall be rounded off “to the nearest unit” in the last right-hand digit used in expressing the specification limit, in accordance with the rounding-off method of Practice E 29.