~~Designation:B495–05~~ Designation: B495 – 10

Standard Specification for Zirconium and Zirconium Alloy Ingots[1]

This standard is issued under the fixed designation B495; 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 six grades of zirconium ingots.

~~1.2The values stated in either inch-pound or SI units are to be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. SI values cannot be mixed with inch-pound values.~~

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The following precautionary caveat pertains only to the test method portion, Section 10, 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:*[2]

E114 ~~Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method~~ Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method

E2626 Guide for Spectrometric Analysis of Reactive and Refractory Metals

3. Terminology

3.1 *Lot Definitions:*

3.1.1 ~~*castings*, *n*—a lot shall consist of all castings produced from the same pour.~~

~~3.1.2*ingot*, *n*—no definition required.~~

~~3.1.3*rounds, flats, tubes, and wrought powder metallurgical products (single definition, common to nuclear and non-nuclear standards)*, *n*—a lot shall consist of a material of the same size, shape, condition, and finish produced from the same ingot or powder blend by the same reduction schedule and the same heat treatment parameters. Unless otherwise agreed between manufacturer and purchaser, a lot shall be limited to the product of an 8 h period for final continuous anneal, or to a single furnace load for final batch anneal.~~

~~3.1.4*sponge*, *n*—a lot shall consist of a single blend produced at one time.~~

~~3.1.5*weld fittings*, *n*—definition is to be mutually agreed upon between manufacturer and the purchaser.~~ —a quantity of metal cast into a shape suitable for subsequent processing to various mill products.

4. Classification

4.1 The ingots are furnished in six grades as follows:

4.1.1 *Grade R60700*—Low oxygen unalloyed zirconium.

4.1.2 *Grade R60702*—Unalloyed zirconium.

4.1.3 *Grade R60703*—Unalloyed zirconium, metallurgical grade.

4.1.4 *Grade R60704*—Zirconium-tin alloy.

4.1.5 *Grade R60705*—Zirconium-niobium alloy.

4.1.6 *Grade R60706*—Zirconium-niobium alloy.

[1] This specification is under the jurisdiction of ASTM Committee B10 on Reactive and Refractory Metals and Alloys and is the direct responsibility of Subcommittee B10.02 on Zirconium and Hafnium.

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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.

5. Ordering Information

5.1 Orders for materials under this specification shall include the following information:
5.1.1 Quantity (weight),
5.1.2 Name of material (zirconium ingot),
5.1.3 Grade number (Section 4),
5.1.4 ASTM designation and year of issue,
5.1.5 Finish (Section 8), and
5.1.6 Additions to the specification and supplementary requirements, if required.

NOTE 1—A typical ordering description is as follows: 10,000-lb zirconium ingot, machine conditioned, ASTM B495, dated __, Grade R60702.

6. Materials and Manufacture

6.1 The ingots covered by this specification shall be manufactured by electron beam, vacuum, or inert atmosphere melting in furnaces conventionally used for reactive metals.

7. Chemical Composition

7.1 The material shall conform to the requirements as to chemical composition prescribed in Table 1.
7.2 When requested by the purchaser, a check analysis shall be performed for any elements listed in Table 1.
7.2.1 The manufacturer's analysis shall be considered as verified if the check analysis confirms the manufacturer's reported values within the tolerances prescribed in Table 2.

8. Workmanship, ~~Finish,~~Finish and Appearance

8.1 Ingots shall be conditioned by machining, grinding, or surface fusion to remove gross surface and subsurface defects detrimental to subsequent fabrication.
8.2 After conditioning has been completed, no abrupt changes in diameter or local depressions that will impair subsequent fabrication shall be permitted. The difference between the maximum and minimum radii of the conditioned ingot shall not exceed 20 % of the maximum radius, except within 6 in. ~~[150 mm]~~(150 mm) of the ends of the ingot where rounding is permissible. Lands, grooves, and local depressions shall be blended to a maximum angle of 30° to the axis of the ingot. Each end of the ingot shall be chamfered or radiused. The minimum chamfer or radius shall be ½ in. ~~[12 mm].~~ (12 mm).

9. Number of Tests and Retests

9.1 At least one sample from the top, middle, and bottom of each ingot shall be analyzed chemically.
9.2 An ultrasonic test shall be conducted on each ingot.
9.3 *Retests*:
9.3.1 If any sample or specimen exhibits obvious contamination, improper preparation, or flaws disqualifying it as a representative sample, it should be discarded and a new sample or specimen substituted.
9.3.2 If the results of any test are not in conformance with the requirements of this specification, the ingot may be retested at the option of the manufacturer. The ingot shall be acceptable if results of all retests following the initial test conform to this specification.

10. Test Methods

10.1 *Ultrasonic Test*—Inspect the ingots ultrasonically by the methods described in 10.1.1 and 10.1.2 unless otherwise agreed upon between the manufacturer and the purchaser.

TABLE 1 Chemical Requirements[A]

Element	Composition, %					
	UNS Grade Designation					
	R60700	R60702	R60703	R60704	R60705	R60706
Zirconium + hafnium, min	99.2	99.2	98.0	97.5	95.5	95.5
Hafnium, max	4.5	4.5	4.5	4.5	4.5	4.5
Iron + chromium	0.2 max	0.2 max	...	0.2 to 0.4	0.2 max	0.2 max
Tin	...	...	...	1.00 to 2.00	...	...
Hydrogen, max	0.004	0.004	...	0.005	0.005	0.005
Nitrogen, max	0.020	0.020	...	0.025	0.025	0.025
Carbon, max	0.05	0.05	...	0.05	0.05	0.05
Niobium	...	...	...	...	2.0 to 3.0	2.0 to 3.0
Oxygen, max	0.10	0.16	...	0.18	0.18	0.16

[A] By agreement between the purchaser and the manufacturer, analysis may be acquired and limits established for elements and compounds not specified in the table of chemical compositions.