



Designation: ~~B493-01 (Reapproved 2003)~~ Designation: B 493/B 493M - 08

Standard Specification for Zirconium and Zirconium Alloy Forgings¹

This standard is issued under the fixed designation B 493/B 493M; 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 specification² covers three grades of zirconium and zirconium alloy forgings.

~~1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.~~

~~1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.~~

1.3 The following safety hazards caveat pertains only to the test method portion, Section 12, of this specification: *This standard does not purport to address all of the safety problems, 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*:³

E 8 Test Methods for Tension Testing of Metallic Materials

3. Terminology

3.1 *Lot Definitions*:

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

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

~~3.1.3 *rounds, flats, tubes, and wrought powder metallurgical products (single definition, common to nuclear and non-nuclear standards)*—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*—a lot shall consist of a single blend produced at one time.~~

~~3.1.5 *weld fittings*—definition is to be mutually agreed upon between manufacturer and the purchaser. Lot Definition:~~

~~3.1.1 *forgings, n*—parts, including semi-finished products, or complex shapes, produced by hot mechanical work using hammers, presses, or forging machines; 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.~~

4. Classification

4.1 The forgings are furnished in three grades as follows:

4.1.1 *Grade R60702*—Unalloyed zirconium.

4.1.2 *Grade R60704*—Zirconium-tin alloy.

4.1.3 *Grade R60705*—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 ASME Boiler and Pressure Vessel Code applications see related Specification SB-493 in Section II of that Code.

³ 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*, Vol 03.01, volume information, refer to the standard's Document Summary page on the ASTM website.

5. Ordering Information

5.1 Orders for material under this specification shall include the following information:

5.1.1 Quantity (weight and number of pieces),

5.1.2 Name of material (zirconium forgings),

5.1.3 Finish (Section 9),

5.1.4 Dimension (diameter, thickness, length, width, or as specified in appropriate drawings),

5.1.5 ASTM designation and year of issue,

5.1.6 Grade number (see 3.1), and

~~5.1.7 Additions to the specification and supplementary requirements, if required:~~

5.1.7 Additions to the specification and supplementary requirements, if required, including, but not limited to: product marking (see 17.1), check analysis (see 7.3), inspection (see 13.1), lot definition (see 3.1.1), internal soundness (see S1.1), and surface quality (see S2.1) requirements.

NOTE 1—A typical ordering description is as follows: 8000-lb zirconium forgings, mechanically descaled, 100 mm by 120 mm by ~~12-in.~~ 1.2 m, rectangular bar, ~~ASTM B493, dated —, B 493/ 493M - 08, Grade R60702.~~

6. Materials and Manufacture

6.1 The forgings shall be formed with conventional forging equipment normally found in primary ferrous and nonferrous metal plants.

6.2 Forgings shall be furnished in the annealed conditions.

7. Chemical Composition

7.1 The material shall conform to the requirements as to chemical composition prescribed in Table 1.

7.2 The manufacturer's ingot analysis shall be considered the chemical analysis for forgings, except for hydrogen and nitrogen, which shall be determined on the finished product.

7.3 When requested by the purchaser and stated in the purchase order, a check analysis for any elements listed in Table 1 shall be made on the finished product.

7.3.1 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 and Quality Level Requirements

8.1 The material shall be free of injurious imperfections. Minor surface imperfections may be removed by spot grinding if such grinding does not reduce the dimensions of the finished piece below the minimum permitted by the tolerance for the product.

9. Finish and Appearance

~~9.1 The forgings shall have one of the following surface conditions as specified:~~

9.1 The forgings shall have one of the following surface conditions as specified in the purchase order:

9.1.1 As forged,

9.1.2 Mechanically descaled, or

9.1.3 Mechanically descaled and pickled.

10. Tensile Requirements

10.1 The material, as represented by the test specimens, shall conform to the tensile properties prescribed in Table 3.

TABLE 1 Chemical Requirements^A

Element	Composition, %		
	UNS Grade Designation		
	R60702	R60704	R60705
Zirconium + hafnium, min	99.2	97.5	95.5
Zirconium + hafnium, min ^B	99.2	97.5	95.5
Hafnium, max	4.5	4.5	4.5
Iron + chromium	0.2 max	0.2 to 0.4	0.2 max
Tin	...	1.0 to 2.0	...
Hydrogen, max	0.005	0.005	0.005
Nitrogen, max	0.025	0.025	0.025
Carbon, max	0.05	0.05	0.05
Niobium	2.0 to 3.0
Oxygen	0.16	0.18	0.18

^A By agreement between the purchaser and the manufacturer, analysis may be required and limits established for elements and compounds not specified in the table of chemical composition.

^B Zirconium is determined by difference.