



Designation: B 658/B 658M – 02

## Standard Specification for Seamless and Welded Zirconium and Zirconium Alloy Pipe<sup>1</sup>

This standard is issued under the fixed designation B 658/B 658M; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope

1.1 This specification<sup>2</sup> covers three grades of seamless and welded zirconium pipe.

1.2 Unless a single unit is used, for example corrosion mass gain in  $\text{mg}/\text{dm}^2$ , the 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.

1.3 The following precautionary caveat pertains only to the test methods portions 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:*

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

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

2.2 *ANSI Standard:*

B36.19 Stainless Steel Pipe<sup>5</sup>

2.3 *ASME Standard:*

ASME Boiler and Pressure Vessel Code, Section VIII<sup>6</sup>

ASME Boiler and Pressure Vessel Code, Section IX<sup>6</sup>

### 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

<sup>1</sup> 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code Applications, see related Specification SB-658 in Section II of that Code.

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

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

<sup>5</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

<sup>6</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5900.

3.1.1 *annealed*—for purposes of this specification “annealed” denotes material that exhibits a recrystallized grain structure.

3.2 *Lot Definitions:*

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

3.2.2 *ingot*—no definition required.

3.2.3 *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.

3.2.4 *sponge*—a lot shall consist of a single blend produced at one time.

3.2.5 *weld fittings*—definition is to be mutually agreed upon between manufacturer and the purchaser.

### 4. Classification

4.1 The pipe is 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.

### 5. Ordering Information

5.1 Orders for materials under this specification should include the following information:

5.1.1 Quantity (weight or total length),

5.1.2 Name of material (zirconium pipe),

5.1.3 Grade number (see 4.1),

5.1.4 Nominal pipe size and schedule (Table X1.1),

5.1.5 Lengths (random or specified cut lengths),

5.1.6 Method of manufacture (Section 6),

5.1.7 Workmanship and quality level requirements (Section 10),

5.1.8 ASTM designation and year of issue, and

5.1.9 Additions to the specification and supplementary requirements, if required. See 7.3, 14.1, 15.1, and 18.1 for additional optional requirements for the purchase order.

NOTE 1—A typical ordering description is as follows: 240-ft (70 mm) zirconium pipe, seamless, descaled 3.0-in. (75 mm) Schedule 40 by 12-ft (3 m) lengths, ASTM B 658 - 01, Grade R60702.

**6. Materials and Manufacture**

6.1 Seamless pipe shall be made from any seamless method that will yield a product meeting this specification.

6.2 Pipe containing welded seams or other joints made by welding shall comply with the following provisions:

6.2.1 Welded by welders, welding operators, and welding procedures qualified under the provisions of Section IX of the ASME Boiler and Pressure Vessel Code.

6.2.2 Filler metal, when used, shall be the same grade as the base metal.

6.2.3 Welds in grade R60705 shall be stress relief annealed within 14 days after welding to prevent delayed hydride cracking.

6.3 The pipe shall be furnished in the annealed or stress-relieved condition.

**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 piping, 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 product 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. Tensile Requirements**

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

**9. Permissible Variations in Dimensions**

9.1 *Diameter*—At any point (cross section) along the length of the pipe, the variations in outside diameters shall not exceed those prescribed in Table 4.

9.2 *Thickness*—The variation in thickness at any point shall not be more than ±12.5 % of the nominal wall thickness specified.

**TABLE 2 Permissible Variation in Check Analysis Between Different Laboratories**

Element	Permissible Variation in Product Analysis, %
Hydrogen	0.002
Nitrogen	0.01
Carbon	0.01
Hafnium	0.1
Iron + chromium	0.025
Tin	0.05
Niobium	0.05
Oxygen	0.02

**TABLE 3 Tensile Requirements**

	UNS Grade Designations		
	R60702	R60704	R60705
Tensile strength, min, ksi (MPa)	55 (380)	60 (415)	80 (550)
Yield strength, min, ksi (MPa)	30 (205)	35 (240)	55 (380)
Elongation in 2 in. or 50 mm, min, % <sup>A</sup>	16	14	16

<sup>A</sup>When a sub-size specimen is used, the gage length shall be as specified in Test Methods E 8 for that specimen.

**TABLE 4 Permissible Variations in Diameter<sup>A</sup>**

Nominal Diameter, in. (mm)	Permissible Variations in Outside Diameter, in. (mm)	
	Over	Under
1/8 to 1 1/2 (3.2 to 40), incl	1/64 (.4)	1/32 (.8)
Over 1 1/2 to 4 (40 to 100), excl	1/32 (.8)	1/32 (.8)
Over 4 to 8 (100 to 200), incl	1/16 (1.6)	1/32 (.8)
Over 8 to 12 (200 to 305), excl	3/32 (2.4)	1/32 (.8)

<sup>A</sup>For seamless pipe only. Tolerances on welded pipe shall be as agreed upon between the manufacturer and the purchaser.

**TABLE 1 Chemical Requirements<sup>A</sup>**

Element	Composition, %		
	R60702	UNS Grade Designation R60704	R60705
Zirconium + hafnium, min	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, max	0.16	0.18	0.18

<sup>A</sup>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 compositions.