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Standard Specification for Seamless and Welded Zirconium and Zirconium Alloy Pipe[1]

This standard is issued under the fixed designation B658/B658M; 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.

ε[1] NOTE—The Nominal Outside Diameter heading in Table 4 was corrected editorially in March 2012.

1. Scope

1.1 This specification[2] covers three grades of seamless and welded zirconium pipe.

1.2 Unless a single unit is used, for example corrosion mass gain in mg/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:*[3]

B614 Practice for Descaling and Cleaning Zirconium and Zirconium Alloy Surfaces

E8/E8M Test Methods for Tension Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E2626 Guide for Spectrometric Analysis of Reactive and Refractory Metals

2.2 *ANSI Standard:*

B36.19 Stainless Steel Pipe[4]

2.3 *ASME Standard:*

ASME Boiler and Pressure Vessel Code, Section VIII[5]

ASME Boiler and Pressure Vessel Code, Section IX[5]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *annealed*, *n*—for purposes of this specification "annealed" denotes material that exhibits a recrystallized grain structure.

3.2 *Lot Definitions:*

3.2.1 *pipe*, *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.

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.

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[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-658 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* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.

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

TABLE 1 Chemical Requirements[A]

Element	Composition, %		
	UNS Grade Designation		
	R60702	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

[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 compositions.

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, %[A]	16	14	16

[A] When a sub-size specimen is used, the gauge length shall be as specified in Test Methods E8/E8M for that specimen.

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 B658/B658M - 05, 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. The heat treatment shall be as follows:

6.2.3.1 The stress-relieving treatment shall consist of holding the pipe at a minimum temperature of 1100°F [600°C] for not less than 30 min per inch [25mm] of the maximum thickness in a nonreducing atmosphere. The minimum time at this temperature is 15 min. All stress-relieved parts shall be cleaned subsequently and shall be free of oxide scale contamination (see Practice B614).

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

9.1.1 The tolerances on the outside diameter include ovality except as provided for in 9.1.2.

9.1.2 Thin-wall pipe usually develops significant ovality (out-of-roundness) during final annealing, straightening, or both. Thin-wall pipe is defined as having a wall thickness of 3 % or less of the outside diameter. The diameter tolerances of Table 4 are