



Designation: ~~B550/B550M-07~~ Designation: B550/B550M – 07 (Reapproved 2012)

Standard Specification for Zirconium and Zirconium Alloy Bar and Wire¹

This standard is issued under the fixed designation B550/B550M; 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 bar and wire.

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

E8 [Test Methods for Tension Testing of Metallic Materials](#)

E29 [Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *annealed, n*—denotes material that exhibits a recrystallized grain structure.

3.2 *Lot Definitions:*

3.2.1 *bar and wire, 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.

3.2.2 *Forms:*

3.2.2.1 *bar, n*—a hot rolled, forged, or cold worked semifinished solid section product whose cross sectional area is equal to or less than 16 in.^2 ($10\,323 \text{ mm}^2$); rectangular bar must be less than or equal to 10 in. (254 mm) in width and greater than 0.1875 in. (4.8 mm) in thickness.

3.2.2.2 *wire, n*—rounds, flats, or special shapes less than or equal to 0.1875 in. (4.8 mm) in thickness or major dimension.

4. Classification

4.1 The bar or wire is to be furnished in three grades as follows:

4.1.1 *Grade R60702*—Unalloyed zirconium.

4.1.2 *Grade R60704*—Zirconium-tin.

4.1.3 *Grade R60705*—Zirconium-niobium.

5. Ordering Information

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

5.1.1 Quantity (weight or number of pieces),

5.1.2 Name of material (zirconium bar or wire) (Table 1),

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² For ASME Boiler and Pressure Vessel Code applications, see related Specification SB-550 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.

TABLE 1 Product Sections and Size

Product	Section	Size
<u>Bars:</u>	Hot-finished round, squares, octagons, and hexagons	¼ in. (6.4 mm) and over in diameter or size
	Hot-finished round, squares, octagons, and hexagons	¼ in. [6.4 mm] and over in diameter or size
	Hot-finished flats	¼ in. (6.4 mm) to 10 in. (250 mm), incl. in width, and ¼ in. (3.2 mm) and over in thickness
	Hot-finished flats	¼ in. [6.4 mm] to 10 in. [250 mm], incl. in width, and ¼ in. [3.2 mm] and over in thickness
	Gold-finished rounds, squares, octagons, hexagons, and shapes	Over ½ in. (13 mm) in diameter or size ^A
<u>Bars:</u>	Cold-finished rounds, squares, octagons, hexagons, and shapes	Over ½ in. [13 mm] in diameter or size ^A
	Gold-finished flats	⅜ in. (9.5 mm) and over in width, ^B and ⅜ in. (3.2 mm) and over in thickness ^C
	Cold-finished flats	⅜ in. [9.5 mm] and over in width, ^B and ⅜ in. [3.2 mm] and over in thickness ^C
	Gold-finished flats	⅜ in. (9.5 mm) and over in width, ^B and ⅜ in. (3.2 mm) and over in thickness ^C
<u>Wire:</u>	Gold-finished rounds, squares, octagons, hexagons, and shapes	½ in. (13 mm) and under in diameter or size
<u>Wire:</u>	Cold-finished rounds, squares, octagons, hexagons, and shapes	½ in. [13 mm] and under in diameter or size
	Gold-finished flats	⅛ in. (1.6 mm) to under ⅜ in. (9.5 mm) in width, and 0.010 in. (.25 mm) to under ⅜ in. (4.8 mm) in thickness
	Cold-finished flats	⅛ in. [1.6 mm] to under ⅜ in. [9.5 mm] in width, and 0.010 in. [.25 mm] to under ⅜ in. [4.8 mm] in thickness

^A Sizes ½ in. ([13 mm]) and under are wire when in coils, and cut wire when finished in straight lengths.

^B Widths less than ⅜ in. ([9.5 mm]) and thicknesses less than ⅜ in. ([4.8 mm]) are generally described as flat wire.

^C Thickness ⅜ in. ([3.2 mm]) to under ⅜ in. ([4.8 mm]) can be cold-rolled strip as well as bar.

5.1.3 Grade number (see 4.1),

5.1.4 Standard designation and year of issue, for example ASTM Specification B550/B550M-07, and

5.1.5 Additions to the specification as required.

NOTE 1—A typical ordering description is as follows: 1000 lb (500 kg) [500 kg] zirconium cold drawn bar, 0.35 in. (10 mm) [10 mm] in diameter by 10 ft (3 m) [3 m] in length, ASTM B550 - 01, Grade R60702.

6. Materials and Manufacture

6.1 Bar and wire covered by this specification shall be formed with conventional fabrication methods and equipment found in primary ferrous and nonferrous metal plants.

6.2 The products covered include the sections and sizes shown in Table 1.

6.3 Bar and wire will be supplied in the conditions prescribed in Table 2.

7. Chemical Composition

7.1 The material shall conform to the requirements as to chemical composition prescribed in Table 3.

7.2 The manufacturer's ingot analysis shall be considered the chemical analysis for bar and wire, 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 3 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 4.

8. Mechanical Properties

8.1 The annealed material shall conform to the requirements for mechanical properties, at room temperature, as prescribed in Table 5. Wire supplied for welding applications shall be furnished with a temper suitable for uniform feeding in semiautomatic or automatic welding equipment.

TABLE 2 Condition

Form	Condition
Bars	hot finished
	hot finished and annealed
	cold finished
	cold finished and annealed
Wire	cold finished
	cold finished and annealed

TABLE 3 Chemical Requirements^A

Element	Composition, %		
	Grades R60702	Grades R60704	Grades 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 composition.

TABLE 4 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 5 Tensile Requirements^A

	Grades		
	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, % ^B	16	14	16

^A For bar only.

^B When a sub-size specimen is used, the gage length shall be as specified in Test Methods E8 for the specimen.

9. Permissible Variations in Dimensions

9.1 Unless otherwise specified, all bar or wire shall conform to the permissible variations in dimensions prescribed in Tables 6-14, as follows:

9.1.1 Table 6, Dimensional Tolerances for Hot-Finished Rounds, Squares, Octagons, and Hexagons.

9.1.2 Table 7, Dimensional Tolerances in Hot-Rolled Flat Bars.

9.1.3 Table 8, Permissible Variations in Sectional Dimensions for Cold-Finished Bars in Rounds, Hexagons, Octagons, and Squares.

9.1.4 Table 9, Permissible Variations in Width and Thickness for Cold-Finished Bars in Flats.

9.1.5 Table 10, Permissible Variations in Sectional Dimensions for Wire.

9.1.6 Table 11, Permissible Variations in Thickness and Width for Cold-Finished Flat Wire.

9.1.7 Table 12, Permissible Variations in Length for Hot-Finished or Cold-Finished Bars.

TABLE 6 Dimensional Tolerances for Hot-Finished Rounds, Squares, Octagons, and Hexagons

Specified Size, in.-([mm])	Variation in Size, in.-([mm])	
	Out of Round,	Out of Square, in.-([mm])
Up-0.500 (13)	+0.030 -0 (+0.75)	0.025 (0.64)
Up-0.500 [13]	+0.030 -0 [+0.75]	0.025 [0.64]
Over 0.500-1.000 (13-25)	+0.050 -0 (+1.3)	0.040 (1)
Over 0.500-1.000 [13-25]	+0.050 -0 [+1.3]	0.040 [1]
Over 1.000-2.000 (25-50)	+0.070 -0 (+1.8)	0.060 (1.5)
Over 1.000-2.000 [25-50]	+0.070 -0 [+1.8]	0.060 [1.5]
Over 2.000-4.000 (50-100)	+0.150 -0 (+3.8)	0.080 (2)
Over 2.000-4.000 [50-100]	+0.150 -0 [+3.8]	0.080 [2]
Over 4.000-6.000 (100-150)	+0.250 -0 (+6.4)	0.100 (2.5)
Over 4.000-6.000 [100-150]	+0.250 -0 [+6.4]	0.100 [2.5]

TABLE 7 Dimensional Tolerances in Hot-Rolled Flat Bars

Thickness, in. [mm]	Variation in Thickness, in. [mm]		Variation in Width, ^A in. [mm]
	+	-	
Up-0.150 [3.8]	+0.020	-0 [+0.5]	1/8 -0 [3.2]
Over 0.150-0.250 [3.8-6.3]	+0.030	-0 [+0.75]	5/32 -0 [4.0]
Over 0.250-0.350 [6.3-8.9]	+0.040	-0 [+1.0]	3/16 -0 [4.8]
Over 0.350-0.450 [8.9-11.4]	+0.050	-0 [+1.3]	7/32 -0 [5.6]
Over 0.450-0.550 [11.4-14]	+0.070	-0 [+1.8]	B
Over 0.550-1.500 [14-38]	+0.080	-0 [+2.0]	B
Over 1.500 [38]	B	-	B

^A For bars sheared from plate, width tolerances shall be as follows:
^B Depends on size and quantity ordered.

Specified Thickness, in. [mm]	Width Tolerances, in. [mm]	
	Over	Under
Over 0.100-0.150	1/16 [1.6]	1/16 [1.6]
Over 0.150-0.250	5/64 [2.0]	5/64 [2.0]
Over 0.250-0.350	3/32 [2.4]	3/32 [2.4]
Over 0.350-0.450	7/64 [2.8]	7/64 [2.8]
Over 0.450-0.550	1/8 [3.2]	1/8 [3.2]
Over 0.550-0.650	5/32 [4.0]	5/32 [4.0]

TABLE 8 Permissible Variations in Sectional Dimensions for Cold-Finished Bars in Rounds, Hexagons, Octagons, and Squares

Specified Size, in.-([mm])	Permissible Variation, in. ^A ([mm])	
	Over	Under
Rounds		
Over 1/2 -1, incl (13-25)	0.002 (0.05)	0.002 (0.05)
Over 1/2 -1, incl [13-25]	0.002 [0.05]	0.002 [0.05]
1-1 1/2, excl (25-38)	0.0025 (0.06)	0.0025 (0.06)
1-1 1/2, excl [25-38]	0.0025 [0.06]	0.0025 [0.06]
1 1/2 -4, incl ^B (38-100)	0.003 (0.08)	0.003 (0.08)
1 1/2 -4, incl ^B [38-100]	0.003 [0.08]	0.003 [0.08]
Hexagons, Octagons, and Squares		
Over 1/2 -1, incl (13-25)	0	0.004 (0.10)
Over 1/2 -1, incl [13-25]	0	0.004 [0.10]
Over 1-2, excl (25-50)	0	0.006 (0.15)
Over 1-2, excl [25-50]	0	0.006 [0.15]
Over 2-3, incl (50-75)	0	0.008 (0.20)
Over 2-3, incl [50-75]	0	0.008 [0.20]
Over 3 (75)	0	0.010 (0.25)
Over 3 [75]	0	0.010 [0.25]

^A When it is necessary to heat treat or heat treat and pickle after cold finishing, because of special hardness or mechanical property requirements, tolerances are double those shown in the table.

^B For permissible variations on sizes over 4 in.-([100 mm]) the manufacturer should be consulted.

9.1.8 Table 13, Permissible Variations in Length for Round and Shape, Straightened and Cut Wire, and Exact Length Resheared Wire.

9.1.9 Table 14, Permissible Variations in Straightness for Hot- or Cold-Finished Bars.

10. Workmanship, Finish and Appearance

10.1 Bars in the hot-finished condition which will conform to the tolerances prescribed in Tables 6 and 7, shall be furnished with one of the following finishes as designated on the purchase order:

- 10.1.1 Not descaled,
- 10.1.2 Mechanically descaled,
- 10.1.3 Mechanically descaled and pickled, and
- 10.1.4 Turned (round bars only).

10.2 Bars and wire in cold-finished condition that will conform to the tolerances prescribed in Tables 8-12, shall be furnished with one of the following finishes as designated on the purchase order.

- 10.2.1 Cold drawn or cold rolled, or swaged,
- 10.2.2 Turned (round bars only),
- 10.2.3 Centerless ground (round bars only), and
- 10.2.4 Polished (round bars only).

10.3 Bars or wire shall be free of cracks, seams, slivers, blisters, burrs, and other injurious imperfections in accordance with standards of acceptability agreed upon between the manufacturer and the purchaser.