



Designation: ~~B639-97~~ Designation: **B 639 – 02 (Reapproved 2008)**

Standard Specification for Precipitation Hardening Cobalt-Containing Alloys (UNS R30155 and UNS R30816) Rod, Bar, Forgings, and Forging Stock for High-Temperature Service¹

This standard is issued under the fixed designation B 639; 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 hot- and cold-worked precipitation hardenable cobalt-containing alloys (UNS R30155 and UNS R30816) rod, bar, forgings, and forging stock for high-temperature service.

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.

1.3 *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 become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer, 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

B 880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

E 8 Test Methods for Tension Testing of Metallic Materials

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications E38 Methods for

Chemical Analysis
of Nickel-
Chromium and
Nickel-Chromium-
Iron Alloys

E 139 Practice Test Methods for Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

E 1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys

<https://standards.iteh.ai/catalog/standards/sist/771f12c7-0510-47a4-87bd-2ae5a4363736/astm-b639-022008>

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bar*, *n*—material of rectangular (flats), hexagonal, octagonal, or square solid section in straight lengths.

3.1.2 *rod*, *n*—material of round solid section furnished in straight lengths.

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for ~~the safe and satisfactory performance of~~ material ordered under this specification. Examples of such requirements include, but are not limited to, the following:

4.1.1 *Alloy Name or UNS Number* (see Table 1).

4.1.2 *ASTM Designation, including year of issue.* Table 2 Table 3, including year of issue.

4.1.3 *Condition* (temper) (Table 4).

¹ This specification is under the jurisdiction of ASTM Committee B-2B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt and Their Alloys.

* New designation established in accordance with Practices E 527 and SAE J1086. Practice for Numbering Metals and Alloys (UNS).

Current edition approved Apr. 10, 1997. Published February 1998. Originally published as A639-70. Redesignated B639 in 1980. Last previous edition B639-92.

Current edition approved March 1, 2008. Published March 2008. Originally approved in 1970. Last previous edition approved in 2002 as B 639 – 02.

² Annual Book of ASTM Standards, Vol 03.01.

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.

TABLE 1 Chemical Requirements

| Element | Composition Limits, % | Product (Check) Analysis Variations, under min or over max, of the Specified Limit of Element |
|----------------------|---------------------------------|---|
| | UNS R30155 (Formerly Grade 661) | UNS R30816 (Formerly Grade 671) |
| Carbon | 0.08 to 0.16 | 0.04 |
| Manganese | 1.00 to 2.00 | 0.03 under min—0.04 over max |
| Manganese | 1.00 to 2.00 | 0.03 under min—0.04 over max |
| Silicon | 1.00 max | 0.05 |
| Silicon | 1.00 max | 0.05 |
| Phosphorus | 0.040 max | 0.005 |
| Phosphorus | 0.040 max | 0.005 |
| Sulfur | 0.030 max | 0.005 |
| Sulfur | 0.030 max | 0.005 |
| Chromium | 20.00 to 22.50 | 0.25 |
| Chromium | 20.00 to 22.50 | 0.25 |
| Nickel | 19.00 to 21.00 | 0.20 under min—0.25 over max |
| Nickel | 19.00 to 21.00 | 0.20 under min—0.25 over max |
| Molybdenum | 2.50 to 3.50 | 0.05 under min—0.10 over max |
| Tungsten | 2.00 to 3.00 | 0.10 |
| Tungsten | 2.00 to 3.00 | 0.10 |
| Columbium + tantalum | 0.75 to 1.25 | 0.05 |
| Columbium + tantalum | 0.75 to 1.25 | 0.05 |
| Iron | remainder ^A | 5.00 max |
| Iron | remainder ^A | 5.00 max |
| Cobalt | 18.50 to 21.00 | 0.20 under min—0.25 over max |
| Cobalt | 18.50 to 21.00 | 0.20 under min—0.25 over max |
| Nitrogen | 0.20 max | 0.04 |

^A Element shall be determined arithmetically by difference.

TABLE 2 Tensile and Hardness Requirements^A

| Alloy | Heat Treatment | Tensile Strength, min, psi (MPa) | Yield Strength (0.2 % offset), min, psi (MPa) | Elongation in 2 in. or 50.8 mm or 4D, min, % | Reduction of Area, min, % | Brinell Hardness, min |
|--------|---------------------------------|----------------------------------|---|--|---------------------------|-----------------------|
| R30155 | solution + precipitation harden | 110 000 (760) | 50 000 (345) | 30 | 30 | 192 |
| R30816 | solution + precipitation harden | 130 000 (895) | 60 000 (415) | 20 | 20 | 248 |

^A The supplier shall demonstrate that the material will meet fully heat-treated properties after full heat treatment in accordance with Table 4.

TABLE 3 Stress-Rupture Requirements^A

| Alloy | Heat Treatment | Test Temperature, °F (°C) | Stress, psi (MPa) ^B | Minimum, h | Elongation in 2 in. or 50.8 mm, or 4D, min, % |
|--------|---------------------------------|---------------------------|--------------------------------|------------|---|
| R30155 | solution + precipitation harden | 1350 (732) | 24 000 (165) | 100 | 10 |
| R30816 | solution + precipitation harden | 1350 (732) | 38 000 (260) | 100 | 8 |

^A The supplier shall demonstrate that material will meet fully heat-treated properties after full heat treatment in accordance with Table 4.

^B Test specimens meeting minimum requirements may be overloaded to produce rupture in a reasonable and practical time period.

TABLE 4 Heat Treatment^A

| Alloy | Recommended Solution Treatment | Precipitation Hardening Treatment |
|--------|--|---|
| R30155 | 2125 to 2175°F (1162 to 1190°C) hold 30 min, minimum, water quench | 1475 to 1525°F (801 to 829°C) hold 4 h, air cool or furnace cool |
| R30816 | 2130 to 2170°F (1165 to 1187°C), hold 1 h, water quench | 1390 to 1410°F (754 to 765°C) hold 12 h, air cool or furnace cool |

^A The purchaser shall designate on the purchase order or inquiry any partial stage of heat treatment required on the material to be shipped.

4.1.4 *Section*—Rod or bar (round, rectangle, square, hexagon, octagon).

4.1.4.1 *Forging* (sketch or drawing).

4.1.5 *Dimensions*, including length.