



Designation: **B863—13a B863 – 14**

Standard Specification for Titanium and Titanium Alloy Wire¹

This standard is issued under the fixed designation B863; 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 titanium and titanium alloy wire as follows:

- 1.1.1 *Grade 1*—UNS R50250. Unalloyed titanium, ~~low oxygen~~,
- 1.1.2 *Grade 2*—UNS R50400. Unalloyed titanium, ~~standard oxygen~~,
- 1.1.2.1 *Grade 2H*—UNS R50400. Unalloyed titanium (Grade 2 with 58 ksi (400 MPa) minimum UTS),
- 1.1.3 *Grade 3*—UNS R50550. Unalloyed titanium, ~~medium oxygen~~,
- 1.1.4 *Grade 4*—UNS R50700. Unalloyed titanium, ~~high oxygen~~,
- 1.1.5 *Grade 5*—UNS R56400. Titanium alloy (6 % aluminum, 4 % vanadium),
- 1.1.6 *Grade 6*—UNS R54520. Titanium alloy (5 % aluminum, 2.5 % tin),
- 1.1.7 *Grade 7*—UNS R52400. Unalloyed titanium plus 0.12 to 0.25 % palladium, ~~standard oxygen~~,
- 1.1.7.1 *Grade 7H*—UNS R52400. Unalloyed titanium plus 0.12 to 0.25 % palladium (Grade 7 with 58 ksi (400 MPa) minimum UTS),
- 1.1.8 *Grade 9*—UNS R56320. Titanium alloy (3 % aluminum, 2.5 % vanadium),
- 1.1.9 *Grade 11*—UNS R52250. Unalloyed titanium plus 0.12 to 0.25 % palladium, ~~low oxygen~~,
- 1.1.10 *Grade 12*—UNS R53400. Titanium alloy (0.3 % molybdenum, 0.8 % nickel),
- 1.1.11 *Grade 13*—UNS R53413. Titanium alloy (0.5 % nickel, 0.05 % ruthenium),
- 1.1.12 *Grade 14*—UNS R53414. Titanium alloy (0.5 % nickel, 0.05 % ruthenium),
- 1.1.13 *Grade 15*—UNS R53415. Titanium alloy (0.5 % nickel, 0.05 % ruthenium),
- 1.1.14 *Grade 16*—UNS R52402. Unalloyed titanium plus 0.04 to 0.08 % palladium, ~~standard oxygen~~,
- 1.1.14.1 *Grade 16H*—UNS R52402. Unalloyed titanium plus 0.04 to 0.08 % palladium (Grade 16 with 58 ksi (400 MPa) minimum UTS),
- 1.1.15 *Grade 17*—UNS R52252. Unalloyed titanium plus 0.04 to 0.08 % palladium, ~~low oxygen~~,
- 1.1.16 *Grade 18*—UNS R56322. Titanium alloy (3 % aluminum, 2.5 % vanadium) plus 0.04 to 0.08 % palladium,
- 1.1.17 *Grade 19*—UNS R58640. Titanium alloy (3 % aluminum, 8 % vanadium, 6 % chromium, 4 % zirconium, 4 % molybdenum),
- 1.1.18 *Grade 20*—UNS R58645. Titanium alloy (3 % aluminum, 8 % vanadium, 6 % chromium, 4 % zirconium, 4 % molybdenum) plus 0.04 to 0.08 % palladium,
- 1.1.19 *Grade 21*—UNS R58210. Titanium alloy (15 % molybdenum, 3 % aluminum, 2.7 % niobium, 0.25 % silicon),
- 1.1.20 *Grade 23*—UNS R56407. Titanium alloy (6 % aluminum, 4 % vanadium with extra low interstitial elements, ELI),
- 1.1.21 *Grade 24*—UNS R56405. Titanium alloy (6 % aluminum, 4 % vanadium) plus 0.04 % to 0.08 % palladium,
- 1.1.22 *Grade 25*—UNS R56403. Titanium alloy (6 % aluminum, 4 % vanadium) plus 0.3 to 0.8 % nickel and 0.04 to 0.08 % palladium,
- 1.1.23 *Grade 26*—UNS R52404. Unalloyed titanium plus 0.08 to 0.14 % ruthenium,
- 1.1.23.1 *Grade 26H*—UNS R52404. Unalloyed titanium plus 0.08 to 0.14 % ruthenium (Grade 26 with 58 ksi (400 MPa) minimum UTS),
- 1.1.24 *Grade 27*—UNS R52254. Unalloyed titanium plus 0.08 to 0.14 % ruthenium,
- 1.1.25 *Grade 28*—UNS R56323. Titanium alloy (3 % aluminum, 2.5 % vanadium) plus 0.08 to 0.14 % ruthenium,
- 1.1.26 *Grade 29*—UNS R56404. Titanium alloy (6 % aluminum, 4 % vanadium with extra low interstitial elements, ELI) plus 0.08 to 0.14 % ruthenium,
- 1.1.27 *Grade 32*—UNS R55111. Titanium alloy (5 % aluminum, 1 % tin, 1 % vanadium, 1 % zirconium, 0.8 % molybdenum),

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 B10.01 on Titanium.

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*A Summary of Changes section appears at the end of this standard

- 1.1.28 *Grade 33*—UNS R53442. Titanium alloy (0.4 % nickel, 0.015 % palladium, 0.025 % ruthenium, 0.15 % chromium),
- 1.1.29 *Grade 34*—UNS R53445. Titanium alloy (0.4 % nickel, 0.015 % palladium, 0.025 % ruthenium, 0.15 % chromium),
- 1.1.30 *Grade 35*—UNS R56340. Titanium alloy (4.5 % aluminum, 2 % molybdenum, 1.6 % vanadium, 0.5 % iron, 0.3 % silicon),
- 1.1.31 *Grade 36*—UNS R58450. Titanium alloy (45 % niobium),
- 1.1.32 *Grade 37*—UNS R52815. Titanium alloy (1.5 % aluminum),
- 1.1.33 *Grade 38*—UNS R54250. Titanium alloy (4 % aluminum, 2.5 % vanadium, 1.5 % iron), and
- 1.1.34 *Grade 39*—UNS R53390. Titanium alloy (0.25 % iron, 0.4 % silicon).

NOTE 1—H grade material is identical to the corresponding numeric grade (that is, Grade 2H = Grade 2) except for the higher guaranteed minimum UTS, and may always be certified as meeting the requirements of its corresponding numeric grade. Grades 2H, 7H, 16H, and 26H are intended primarily for pressure vessel use.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

2. Referenced Documents

2.1 *ASTM Standards*:²

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

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

[E539 Test Method for Analysis of Titanium Alloys by X-Ray Fluorescence Spectrometry](#)

[E1409 Test Method for Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by Inert Gas Fusion](#)

[E1447 Test Method for Determination of Hydrogen in Titanium and Titanium Alloys by Inert Gas Fusion Thermal Conductivity/Infrared Detection Method](#)

[E1941 Test Method for Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis](#)

[E2371 Test Method for Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry \(Performance-Based Test Methodology\)](#)

[E2626 Guide for Spectrometric Analysis of Reactive and Refractory Metals](#)

2.2 *AWS Standard*:³

[AWS A5.16/A5.16M-2007 Specification for Titanium and Titanium Alloy Welding Electrodes and Rods](#)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard*:

3.1.1 *coils, n*—wire in coil form with pitch and cast as described by purchaser.

3.1.2 *straight lengths, n*—wire in straight lengths, generally made by straightening wire from coils by the producer.

3.1.3 *weld wire, n*—round wire for welding.

3.1.4 *wire, n*—rounds, flats, or special shapes from 0.010 in. (0.25 mm) to 0.750 in. (19.05 mm) in thickness or major dimension.

4. Product Classification

4.1 *Wire*—See 3.1.4.

4.2 *Coils*—Coiled wire may be spooled on spools if required by the user.

4.3 *Straight Lengths*—After straightening, it may be necessary to perform cleaning or other finishing operations. Straight lengths are normally 10 to 12 ft long (random). Exact lengths may be specified by the purchaser when necessary.

4.4 *Filler Metal or Weld Wire*—Wire for welding filler metal application has special requirements for more restrictive chemistry that allows for oxygen increase inherent in most welding processes used for titanium, and has tighter limits on iron, carbon, nitrogen, and hydrogen. AWS ER Ti-XX grades are specifically designed for welding the corresponding ASTM XX wrought or cast material grades. In addition, special requirements for spooling, such as layer winding, cast, and helix, packaging to maintain cleanliness, and identification are necessary. Use AWS A5.16/A5.16M-2007 for wire for titanium and titanium alloy filler metal.

5. Ordering Information

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

5.1.1 Grade number (Section 1),

5.1.2 Product description (Sections 3 and 4),

5.1.3 Chemistry (Table 1),

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~~ standard's Document Summary page on the ASTM website.

³ Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, <http://www.aws.org>.

TABLE 1 Chemical Requirements

Composition, Weight Percent^{A,B,C,D,E}

| Grade | UNS Number | Carbon, max. | Oxygen range or max. | Nitrogen, max. | Hydrogen, max. | Iron range or max. | Aluminum | Vanadium | Palladium | Ruthenium | Nickel | Molybdenum | Chromium | Cobalt | Zirconium | Niobium | Tin | Silicon | Other Elements, max. each | Other Elements, max. total |
|--------|------------|--------------|----------------------|----------------|----------------|--------------------|----------|----------|-----------|-----------|---------|------------|----------|-----------|-----------|---------|---------|-----------|---------------------------|----------------------------|
| 1 | R50250 | 0.08 | 0.18 | 0.03 | 0.015 | 0.20 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 2/2H | R50400 | 0.08 | 0.25 | 0.03 | 0.015 | 0.30 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 3 | R50550 | 0.08 | 0.35 | 0.05 | 0.015 | 0.30 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 4 | R50700 | 0.08 | 0.40 | 0.05 | 0.015 | 0.50 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 5 | R56400 | 0.08 | 0.20 | 0.05 | 0.015 | 0.40 | 5.5-6.75 | 3.5-4.5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 6 | R54520 | 0.08 | 0.20 | 0.03 | 0.015 | 0.50 | 4.0-6.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.0-3.0 | -- | 0.1 | 0.4 |
| 7/7H | R52400 | 0.08 | 0.25 | 0.03 | 0.015 | 0.30 | -- | -- | 0.12-0.25 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 9 | R56320 | 0.08 | 0.15 | 0.03 | 0.015 | 0.25 | 2.5-3.5 | 2.0-3.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 11 | R52250 | 0.08 | 0.18 | 0.03 | 0.015 | 0.20 | -- | -- | 0.12-0.25 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 12 | R53400 | 0.08 | 0.25 | 0.03 | 0.015 | 0.30 | -- | -- | -- | -- | 0.6-0.9 | 0.2-0.4 | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 13 | R53413 | 0.08 | 0.10 | 0.03 | 0.015 | 0.20 | -- | -- | 0.04-0.06 | 0.04-0.06 | 0.4-0.6 | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 14 | R53414 | 0.08 | 0.15 | 0.03 | 0.015 | 0.30 | -- | -- | 0.04-0.06 | 0.04-0.06 | 0.4-0.6 | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 15 | R53415 | 0.08 | 0.25 | 0.05 | 0.015 | 0.30 | -- | -- | 0.04-0.06 | 0.04-0.06 | 0.4-0.6 | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 16/16H | R52402 | 0.08 | 0.25 | 0.03 | 0.015 | 0.30 | -- | -- | 0.04-0.08 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 17 | R52252 | 0.08 | 0.18 | 0.03 | 0.015 | 0.20 | -- | -- | 0.04-0.08 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 18 | R56322 | 0.08 | 0.15 | 0.03 | 0.015 | 0.25 | 2.5-3.5 | 2.0-3.0 | 0.04-0.08 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 19 | R58640 | 0.05 | 0.12 | 0.03 | 0.02 | 0.30 | 3.0-4.0 | 7.5-8.5 | -- | -- | -- | 3.5-4.5 | 5.5-6.5 | -- | 3.5-4.5 | -- | -- | -- | 0.15 | 0.4 |
| 20 | R58645 | 0.05 | 0.12 | 0.03 | 0.02 | 0.30 | 3.0-4.0 | 7.5-8.5 | 0.04-0.08 | -- | -- | 3.5-4.5 | 5.5-6.5 | -- | 3.5-4.5 | -- | -- | -- | 0.15 | 0.4 |
| 21 | R58210 | 0.05 | 0.17 | 0.03 | 0.015 | 0.40 | 2.5-3.5 | -- | -- | -- | -- | 14.0-16.0 | -- | -- | -- | 2.2-3.2 | -- | 0.15-0.25 | 0.1 | 0.4 |
| 23 | R56407 | 0.08 | 0.13 | 0.03 | 0.0125 | 0.25 | 5.5-6.5 | 3.5-4.5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 24 | R56405 | 0.08 | 0.20 | 0.05 | 0.015 | 0.40 | 5.5-6.75 | 3.5-4.5 | 0.04-0.08 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 25 | R56403 | 0.08 | 0.20 | 0.05 | 0.015 | 0.40 | 5.5-6.75 | 3.5-4.5 | 0.04-0.08 | -- | 0.3-0.8 | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 26/26H | R52404 | 0.08 | 0.25 | 0.03 | 0.015 | 0.30 | -- | -- | -- | 0.08-0.14 | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 27 | R52254 | 0.08 | 0.18 | 0.03 | 0.015 | 0.20 | -- | -- | -- | 0.08-0.14 | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 28 | R56323 | 0.08 | 0.15 | 0.03 | 0.015 | 0.25 | 2.5-3.5 | 2.0-3.0 | -- | 0.08-0.14 | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 29 | R56404 | 0.08 | 0.13 | 0.03 | 0.0125 | 0.25 | 5.5-6.5 | 3.5-4.5 | -- | 0.08-0.14 | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 30 | R53530 | 0.08 | 0.25 | 0.03 | 0.015 | 0.30 | -- | -- | 0.04-0.08 | -- | -- | -- | -- | 0.20-0.80 | -- | -- | -- | -- | 0.1 | 0.4 |
| 31 | R53532 | 0.08 | 0.35 | 0.05 | 0.015 | 0.30 | -- | -- | 0.04-0.08 | -- | -- | -- | -- | 0.20-0.80 | -- | -- | -- | -- | 0.1 | 0.4 |

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TABLE 1 Continued

Composition, Weight Percent^{A,B,C,D,E}

| Grade | UNS Number | Carbon, max. | Oxygen range or max. | Nitrogen, max. | Hydrogen, max. | Iron range or max. | Aluminum | Vanadium | Palladium | Ruthenium | Nickel | Molybdenum | Chromium | Cobalt | Zirconium | Niobium | Tin | Silicon | Other Elements, max. each | Other Elements, max. total |
|-------|------------|--------------|----------------------|----------------|----------------|--------------------|----------|----------|-----------|-----------|-----------|------------|----------|--------|-----------|-----------|---------|-----------|---------------------------|----------------------------|
| 32 | R55111 | 0.08 | 0.11 | 0.03 | 0.015 | 0.25 | 4.5-5.5 | 0.6-1.4 | -- | -- | -- | 0.6-1.2 | -- | -- | 0.6-1.4 | -- | 0.6-1.4 | 0.06-0.14 | 0.1 | 0.4 |
| 33 | R53442 | 0.08 | 0.25 | 0.03 | 0.015 | 0.30 | -- | -- | 0.01-0.02 | 0.02-0.04 | 0.35-0.55 | -- | 0.1-0.2 | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 34 | R53445 | 0.08 | 0.35 | 0.05 | 0.015 | 0.30 | -- | -- | 0.01-0.02 | 0.02-0.04 | 0.35-0.55 | -- | 0.1-0.2 | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 35 | R56340 | 0.08 | 0.25 | 0.05 | 0.015 | 0.20-0.80 | 4.0-5.0 | 1.1-2.1 | -- | -- | -- | 1.5-2.5 | -- | -- | -- | -- | -- | 0.20-0.40 | 0.1 | 0.4 |
| 36 | R58450 | 0.04 | 0.16 | 0.03 | 0.015 | 0.03 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 42.0-47.0 | -- | -- | 0.1 | 0.4 |
| 37 | R52815 | 0.08 | 0.25 | 0.03 | 0.015 | 0.30 | 1.0-2.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 38 | R54250 | 0.08 | 0.20-0.30 | 0.03 | 0.015 | 1.2-1.8 | 3.5-4.5 | 2.0-3.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.4 |
| 39 | R53390 | 0.08 | 0.15 | 0.03 | 0.015 | 0.15-0.40 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.30-0.50 | 0.1 | 0.4 |

^A At minimum, the analysis of samples from the top and bottom of the ingot shall be completed and reported for all elements listed for the respective grade in this table.

^B Final product hydrogen shall be reported. Ingot hydrogen need not be reported. Lower hydrogen may be obtained by negotiation with the manufacturer.

^C Single values are maximum. The percentage of titanium is determined by difference.

^D Other elements need not be reported unless the concentration level is greater than 0.1 % each, or 0.4 % total. Other elements may not be added intentionally. Other elements may be present in titanium or titanium alloys in small quantities and are inherent to the manufacturing process. In titanium these elements typically include aluminum, vanadium, tin, chromium, molybdenum, niobium, zirconium, hafnium, bismuth, ruthenium, palladium, yttrium, copper, silicon, cobalt, tantalum, nickel, boron, manganese, and tungsten.

^E The purchaser may, in the written purchase order, request analysis for specific elements not listed in this specification.

