Standard Specification for Niobium and Niobium Alloy Ingots

1. Scope

1.1 This specification covers unalloyed and alloyed niobium ingots prepared by vacuum- or plasma-arc melting or electron-beam melting to produce consolidated metal for processing to various mill shapes.

1.2 The materials covered by this specification are:

   1.2.1 R04200-Type 1—Reactor grade unalloyed niobium,
   1.2.2 R04210-Type 2—Commercial grade unalloyed niobium,
   1.2.3 R04251-Type 3—Reactor grade niobium alloy containing 1 % zirconium, and
   1.2.4 R04261-Type 4—Commercial grade niobium alloy containing 1 % zirconium.

1.3 Unless a single unit is used, 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.

1.4 The following precautionary caveat pertains only to the test method 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:

   E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
   E2626 Guide for Spectrometric Analysis of Reactive and Refractory Metals

3. Ordering Information

3.1 Orders for material under this specification shall include the following information, as applicable:

   3.1.1 ASTM standard number and year of issue,
   3.1.2 Type (see 1.2),
   3.1.3 Quantity in weight or pieces,
   3.1.4 Size, diameter and length,
   3.1.5 Chemistry (see 5.2),
   3.1.6 Permissible overshipment (see 6.1),
   3.1.7 Quality and finish (see 7.2 and 7.6),
   3.1.8 Sampling (Section 8),
   3.1.9 Packaging (Section 15), and
   3.1.10 Required reports (Section 13).

4. Materials and Manufacture

4.1 The ingot metal for all four types may be vacuum or plasma arc melted, vacuum electron-beam melted, or any combination of these three methods.

5. Chemical Requirements

5.1 The finished ingot shall conform to the requirements for chemical composition as prescribed in Table 1.

5.2 Analysis for elements not listed in Table 1 and not normally expected in niobium shall not be required unless specified at time of purchase.

6. Permissible Variations

6.1 Quantity—For orders requiring up to 100 lb (45.4 kg) of ingots, the manufacturer may overship up to a maximum of 20 %. For orders up to and including 1000 lb (454 kg), the manufacturer may overship up to a maximum of 10 %. The permissible overshipment shall be negotiated for orders larger than 1000 lb (454 kg).

7. Quality and Finish

7.1 The manufacturer shall use care to have each lot of ingot material as uniform in quality as possible.

7.2 When specified, the ingots shall be conditioned on the surface to standards agreed upon between the manufacturer and the purchaser.
7.3 Subsequent fabrication will be permitted. The difference between the maximum and minimum radius of the conditioned ingot shall not exceed 20% of the maximum radius. Lands, grooves, and local depressions shall be blended to a maximum angle of 30° to the axis of the ingot.

7.4 Each ingot shall be tested for soundness by nondestructive test methods, such as dye penetrant or ultrasonic tests. Methods and acceptance standards shall be as mutually agreed upon between the purchaser and the manufacturer.

7.5 Defects in the ingots that exceed the acceptance standards shall be removed by cropping or surface conditioning, whichever is appropriate. The manufacturer shall be permitted to remove surface imperfections provided that after such removal the requirements of conditioning are met (7.2).

7.6 The ingots shall be free of imperfections that would be deemed injurious by the standards of acceptability agreed upon between the purchaser and the manufacturer.

8. Sampling

8.1 Care shall be exercised to ensure that the sample selected for testing is representative of the material and that it is not contaminated by the sampling procedure. If there is any question relating to the sampling techniques or to the analysis thereof, the methods for sampling and analysis shall be as agreed upon between the purchaser and the manufacturer.

8.2 Sampling is typically performed at the top, middle and bottom of the ingot.

9. Number of Tests and Retests

9.1 Each ingot shall be tested for chemical composition.

9.2 If any sample or specimen exhibits obvious surface contamination or improper preparation, disqualifying it as a truly representative sample, it shall be discarded and a new sample or specimen substituted.

9.3 In case of failure, retest two additional specimens. If both specimens conform to this specification, discard the original values and consider the material acceptable; otherwise the ingot shall be rejected or reworked and retested.

10. Significance of Numerical Limits

10.1 For the purpose of determining compliance with the specified limits for requirements of the properties listed in the following tables, an observed value or a calculated value shall be rounded as indicated in accordance with the rounding method of Practice E29.

11. Test Method

11.1 Analysis shall be made using the manufacturer’s standard methods. In the event of disagreement as to the chemical composition of the metal, methods of chemical analysis for reference purposes shall be determined by a mutually acceptable laboratory.

11.2 Guide E2626 is recommended as a guide, where applicable.

12. Rejection and Rehearing

12.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

12.2 In the event of disagreement between the manufacturer and the purchaser on the conformance of the material to the requirements of this specification or any special test specified by the purchaser, a mutually acceptable referee shall perform the tests in question. The results of the referee’s testing shall be used in determining conformance of the material to this specification.
13. Certification

13.1 A producer’s or supplier’s certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with the specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

14. Product Marking

14.1 Each ingot shall be marked for identification by metal die stamping the manufacturer’s ingot number on the top of the ingot. Each box or skid shall be marked or tabbed legibly and conspicuously with the number, type of material, ingot number(s), manufacturer’s identification, nominal size, and the gross, net, and tare weights.

15. Packaging and Package Marking

15.1 Unless otherwise specified, material purchased under this specification must be boxed or banded on skids in such a manner as to secure safe delivery to their destination when properly transported by any common carrier.

16. Keywords

16.1 niobium; niobium alloy ingots