Designation: C1462 – 21

Standard Specification for Uranium Metal Enriched to Less Than 20 % ^{235}U[1]

This standard is issued under the fixed designation C1462; 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 nuclear grade uranium metal that has either been processed through an enrichment plant, or has been produced by the blending of highly enriched uranium with other uranium, to obtain uranium of any ^{235}U mass fraction below 20 % and that is intended for research reactor and generation IV nuclear reactor fuel fabrication. The scope of this specification includes specifications for enriched uranium metal derived from commercial natural uranium, reprocessed uranium, or highly enriched uranium. Commercial natural uranium, reprocessed uranium and highly enriched uranium are defined in Section 3. The objectives of this specification are to define the impurity and uranium isotope limits for commercial grade enriched uranium metal.

1.2 This specification is intended to provide the nuclear industry with a standard for enriched uranium metal which is to be used in the production of research reactor and generation IV nuclear reactor fuel. In addition to this specification, the parties concerned may agree to other appropriate conditions.

1.3 The scope of this specification does not comprehensively cover all provisions for preventing criticality accidents or requirements for health and safety or for shipping. Observance of this standard does not relieve the user of the obligation to conform to all applicable international, federal, state, and local regulations for processing, shipping, or any other way of using uranium metal (see, for example, C996 regarding references).

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C696 Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Uranium Dioxide Powders and Pellets

C799 Test Methods for Chemical, Mass Spectrometric, Spectrochemical, Nuclear, and Radiochemical Analysis of Nuclear-Grade Uranyl Nitrate Solutions

C859 Terminology Relating to Nuclear Materials

C996 Specification for Uranium Hexafluoride Enriched to Less Than 5 % ^{235}U

C1233 Practice for Determining Equivalent Boron Contents of Nuclear Materials

C1295 Test Method for Gamma Energy Emission from Fission and Decay Products in Uranium Hexafluoride and Uranyl Nitrate Solution

C1347 Practice for Preparation and Dissolution of Uranium Materials for Analysis

2.2 *ANSI Standard*[3]

ANSI-ASME NQA-1 Quality Assurance Program Requirements for Nuclear Facility Applications

2.3 *U.S. Government Documents*[4]

Code of Federal Regulations, Title 10, Part 50, (Appendix B)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 Terms shall be defined in accordance with Terminology C859, except for the following:

3.1.2 *commercial grade enriched uranium metal, n*—uranium metal derived from commercial natural uranium, reprocessed uranium, or uranium obtained from the blending of highly enriched uranium with commercial natural uranium, reprocessed uranium, or depleted uranium.

[1] This specification is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.02 on Fuel and Fertile Material Specifications.

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[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.

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

[4] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

3.1.3 *commercial natural uranium, n*—any form of natural unirradiated uranium (containing 0.711 g ± 0.004 g ^{235}U per 100 g U).

3.1.4 *depleted uranium, n*—any form of unirradiated uranium with a ^{235}U mass fraction less than commercial natural uranium.

3.1.5 *highly enriched uranium, n*—any form of uranium having a ^{235}U mass fraction equal to or in excess of 20 %.

3.1.6 *reprocessed uranium, n*—any form of uranium that has been exposed in a neutron irradiation facility and either has been subsequently chemically separated from the fission products and transuranic isotopes so generated, or may be used as is, due to low irradiation levels.

3.1.6.1 *Discussion*—The requirements for reprocessed uranium are intended to be typical of reprocessed spent fuel from research reactors that have achieved burn-up levels of up to 50 % of the originally contained fissile material or may have been utilized in critical facilities. It is recognized that different limits would be necessary to accommodate different fuel histories.

3.1.7 For enriched uranium metal transactions, "buyer" usually represents the research reactor operator or the fuel fabricator, and "seller" usually represents the supplier of the enriched uranium metal.

4. Health Physics Requirements

4.1 For commercial grade enriched uranium metal, the gamma activity from fission products shall not exceed 600 Bq/gU. The measurements are to be made by Test Method C1295 or equivalent. (See Note 1.)

NOTE 1—Depending upon the requirements of the fabricator utilizing enriched uranium metal, gamma activity from fission products as high as 6,000 Bq/gU may be acceptable, due to the utilization of reprocessed enriched uranium in producing the enriched uranium metal.

4.2 For commercial grade enriched uranium metal, the total alpha activity from transuranium elements per gram of uranium shall be less than 250 Bq.

5. Chemical, Physical, and Isotopic Requirements

5.1 *Physical Requirements:*

5.1.1 The uranium mass fraction of commercial grade enriched uranium metal shall be greater than or equal to 99.85 %.

5.1.2 The product shall be supplied as spherical, cubical, cylindrical, or broken pieces. Dimensional requirements shall be agreed upon between the buyer and the seller. Requirements for the mass of individual pieces shall be agreed upon between the buyer and the seller.

5.1.3 The individual pieces of product shall be free of loose or excessive oxides or contaminants. A tightly adhering oxide film is allowable.

5.1.4 The following impurity elements shall not exceed these values:

Element		µg/gU	Element		µg/gU
Aluminum	Al	150	Magnesium	Mg	150
Boron	B	1	Manganese	Mn	50
Beryllium	Be	10	Molybdenum	Mo	100
Carbon	C	800	Nickel	Ni	300
Calcium	Ca	300	Phosphorus	P	100
Cadmium	Cd	1	Silicon	Si	250
Chromium	Cr	50	Sodium	Na	25
Cobalt	Co	10	Tin	Sn	100
Copper	Cu	50	Vanadium	V	30
Iron	Fe	250	Tungsten	W	100
Lead	Pb	10	Zirconium	Zr	250
Lithium	Li	10			
Rare Earths (Dy, Eu, Gd, Sm)					3.0

The sum of the impurity elements shall not exceed 1500 µg/gU.

5.1.5 *Equivalent Boron Content*—For research and generation IV reactor use, the total equivalent boron content (EBC) shall not exceed 4.0 µg/gU. The list of elements to be considered for the EBC calculation shall be agreed upon between the buyer and the seller. The method of performing the calculation and the EBC Factors shall be as indicated in C1233. For fast reactor use, the above limitation on total EBC does not apply.

5.2 *Isotopic Requirements:*

5.2.1 The following limits for commercial grade enriched uranium metal shall not be exceeded:

^{232}U	0.014 µg ^{232}U/g ^{235}U
^{234}U	22 100 µg ^{234}U/g ^{235}U
^{236}U	0.0046 g ^{236}U/gU see Note 2

NOTE 2—Some Generation IV reactor types are able to utilize fuel with a higher ^{236}U mass fraction, a level up to 0.04 g ^{236}U/gU may be agreed upon between buyer and seller.

5.2.2 Uranium isotopic concentrations shall be determined and reported for ^{232}U, ^{234}U, ^{235}U, and ^{236}U. The allowable variation for the ^{235}U mass fraction should be ± 0.20 % absolute from the nominal ^{235}U assay.

6. Sampling

6.1 A representative sample of sufficient size to perform tests prescribed shall be taken from each lot. The size of a lot should be as agreed upon between seller and buyer and shall be from a single melt. Typically, a lot should not be greater than 10 kg.

6.2 All samples shall be clearly identified including the seller's lot number.

6.3 All containers used for a lot shall be positively identified as containing material from a particular lot.

6.4 ASTM standard practice for preparation of uranium materials (Practice C1347) or demonstrated equivalent shall be used as mutually agreed upon between the buyer and seller.

7. Test Methods for Chemical and Isotopic Analysis

7.1 ASTM test methods for chemical and isotopic analysis (Test Methods C696 or C799), or demonstrated equivalent, shall be used as mutually agreed upon between the buyer and seller.

8. Packaging, Handling, and Shipping

8.1 Procedures for packaging, handling, and shipping commercial grade enriched uranium metal are as agreed between