Designation: C1913 – 21

Standard Practice for Sampling Gaseous Uranium Hexafluoride Using Zeolite in Single-Use Destructive Assay Sampler[1]

This standard is issued under the fixed designation C1913; 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 practice is applicable to sampling gaseous uranium hexafluoride (UF_6) from processing facilities, isotope enrichment cascades or storage cylinders, using the sorbent properties of zeolite in a single-use destructive assay (SUDA) sampler.

1.2 This practice is based on the SUDA method developed at Pacific Northwest National Laboratory (**1**)[2] for collection of samples of UF_6 for determination of uranium isotopic content for nuclear material safeguards and other applications.

1.3 The UF_6 collected is converted to uranyl fluoride (UO_2F_2), allowing samples to be handled and categorized for transport under less stringent conditions than are required for UF_6.

1.4 This practice can be used to collect samples for safeguards measurements. Safeguards samples collected with this practice have been shown to provide suitable isotopic measurements (**1**).

1.5 This practice has not been demonstrated for suitability for compliance with Specifications C787 and C996. Practices C1052 or C1703 can be used to collect samples for compliance with these specifications.

1.6 The scope of this practice does not include provisions for preventing criticality.

1.7 *Units*—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.

1.8 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *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:*[3]

C787 Specification for Uranium Hexafluoride for Enrichment
C859 Terminology Relating to Nuclear Materials
C996 Specification for Uranium Hexafluoride Enriched to Less Than 5 % ^{235}U
C1052 Practice for Bulk Sampling of Liquid Uranium Hexafluoride
C1474 Test Method for Analysis of Isotopic Composition of Uranium in Nuclear-Grade Fuel Material by Quadrupole Inductively Coupled Plasma-Mass Spectrometry
C1477 Test Method for Isotopic Abundance Analysis of Uranium Hexafluoride and Uranyl Nitrate Solutions by Multi-Collector, Inductively Coupled Plasma-Mass Spectrometry
C1672 Test Method for Determination of Uranium or Plutonium Isotopic Composition or Concentration by the Total Evaporation Method Using a Thermal Ionization Mass Spectrometer
C1703 Practice for Sampling of Gaseous Uranium Hexafluoride for Enrichment
C1832 Test Method for Determination of Uranium Isotopic Composition by Modified Total Evaporation (MTE) Method Using Thermal Ionization Mass Spectrometer
C1871 Test Method for Determination of Uranium Isotopic Composition by the Double Spike Method Using a Thermal Ionization Mass Spectrometer
C1880 Practice for Sampling Gaseous Uranium Hexafluoride using Alumina Pellets
D1193 Specification for Reagent Water

[1] This practice 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] The boldface numbers in parentheses refer to the list of references at the end of this standard.

[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.

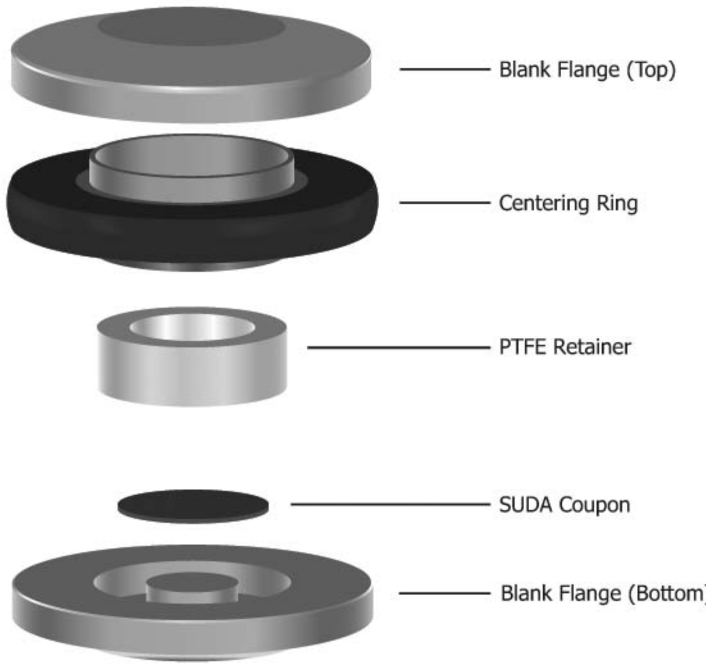

FIG. 1 Exploded View of SUDA Sampler

D1418 Practice for Rubber and Rubber Latices—Nomenclature

2.2 *ISO Standards:*[4]

ISO 2861:2020 Vacuum technology — Dimensions of clamped-type quick-release couplings

3. Terminology

3.1 For definitions of terms used in this practice but not defined herein, refer to Terminology C859.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *sampling coupon, n*—silicon wafer coated with an engineered zeolite sorbent thin film (see 7.5).

3.2.2 *sampling manifold, n*—piping with apertures used to connect the SUDA sampler to the UF_6 processing lines, isotope enrichment cascades or storage cylinders, and tap valves to allow introduction of UF_6 to the sampling coupon.

3.2.3 *SUDA sampler, n*—apparatus that is connected to the sampling manifold for sample collection (see Fig. 1 and Section 6).

4. Summary of Practice

4.1 A SUDA sampler (see Figs. 1 and 2) is attached to a sampling manifold and exposed to gaseous UF_6 for a specified time period. At a gas pressure of 5.3 kPa to 10.6 kPa (40 Torr to 80 Torr), this is typically 2 to 5 min (**1, 2**). UF_6 is hydrolyzed by the water content in the sorbent film to form chemically-stable uranyl fluoride, which typically forms as a hydrate, $UO_2F_2 \cdot 2H_2O$, in the presence of water.

4.2 At the end of the sampling period, the tap valve is closed. A total uranium mass of 0.1 mg to 3 mg is collected per SUDA sampler using the sampler described in this practice (**3**). A larger SUDA sampler is available that can collect up to 100 mg of total uranium mass; this sampler is not described in this practice.

4.3 The SUDA sampler is removed from the sampling manifold, reassembled, and may be stored indefinitely until it can be transported for laboratory analysis.

4.4 Samples of depleted uranium or natural uranium may be transported as unregulated radioactive materials. Samples of low enriched uranium (LEU) may be packaged and transported in excepted quantities (for example, as UN 2910 excepted packages (**4**)), which are significantly less burdensome to transport than gaseous UF_6 samples (UN 3507).

4.5 At the analytical laboratory, the UO_2F_2 is extracted from the sampling coupon with 2 % nitric acid or water. The uranium isotopic composition is then determined by mass spectrometric techniques such as thermal ionization mass spectrometry (TIMS) using Test Methods C1672, C1832, or C1871, multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) using Test Method C1477, or quadrupole inductively coupled plasma mass spectrometry (Q-ICP-MS) using Test Method C1474.

5. Significance and Use

5.1 Facility operators and safeguards inspectors routinely collect UF_6 samples from processing lines, isotopic enrichment cascades or storage cylinders to determine uranium isotopic composition. The isotope ratio $n(^{235}U)/n(^{238}U)$ is particularly important since it is used to calculate the amount of fissile ^{235}U in the sample.

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.