Designation: C1052 – 20

Standard Practice for Bulk Sampling of Liquid Uranium Hexafluoride[1]

This standard is issued under the fixed designation C1052; 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 covers methods for withdrawing representative samples of liquid uranium hexafluoride (UF_6) from bulk quantities of the material. Such samples are then prepared for further analytical testing in accordance with Practices C1689 and C1346. Multiple different methods are used for determining compliance with the applicable commercial specification, for example Specifications C787 and C996. Methods used for compliance to each of these standards can be found in the Referenced Documents section of each respective specification.

1.2 It is assumed that the bulk liquid UF_6 being sampled comprises a single quality and quantity of material. This practice does not address any special additional arrangements that might be required for taking proportional or composite samples. When the sampled bulk material is being added to UF_6 residues already in a container ("heels recycle") additional arrangements are required to avoid cross contamination of the bulk UF_6, these are addressed in Specifications C787 and C996.

1.3 The number of samples to be taken, their nominal sample weight, and their disposition shall be agreed upon between the parties.

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

1.5 *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.*

1.6 *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]

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

C1346 Practice for Dissolution of UF_6 from P-10 Tubes

C1689 Practice for Subsampling of Uranium Hexafluoride

2.2 *Other Documents:*

ANSI N14.1 Uranium Hexafluoride: Packaging for Transport[3]

ISO/DIS 7195 Packaging of Uranium Hexafluoride (UF_6) for Transport[3,4]

USEC-651 Uranium Hexafluoride: A Manual of Good Handling Practices[5]

3. Terminology

3.1 *Definitions:*

3.1.1 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 *container, n*—the bulk vessel either holding or receiving by transfer, the UF_6 to be sampled; it may consist of, for example, a fixed vessel in a UF_6 handling plant or a cylinder to be used for the transport of UF_6.

3.2.2 *sample bottle, n*—the small vessel into which the sample of UF_6 is withdrawn for transfer to the laboratory for characterization.

4. Summary of Practice

4.1 Two methods of withdrawing a sample are described, namely: (*1*) direct withdrawal from a filled container, and (*2*)

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

[5] Available from United States Enrichment Corp., 6903 Rockledge Dr., Bethesda, MD 20817.

withdrawal from the inlet-line during the filling of a container by liquid transfer. The first method involves tilting or turning the container in such a way that its valve is below the surface of the liquefied UF_6, and dependent on the equipment, this requires that the container holds more than a specified minimum quantity of UF_6. Liquid UF_6 is withdrawn into a graduated volume and then transferred to the respective sample bottle(s). In the second method, a small proportion of the UF_6 flowing from one container to another is withdrawn into a graduated volume and then transferred to the respective sample bottle(s).

4.2 For both methods of sampling, the presence of residues may have significant implications for the quality of the UF_6. For safety and quality reasons, containers and bottles shall be clean, dry, and empty before filling.

4.3 Various types of sample bottles are in use and are described in detail in the applicable national and international standards, for example, ANSI N14.1 and ISO/DIS 7195. For a given type of sample bottle, the detailed configuration, for example, valve orientation, terminal fittings, and the like, may vary. Hence, the type and configuration of bottles to be used for the withdrawal of samples shall be agreed upon between the parties.

5. Significance and Use

5.1 Uranium hexafluoride is normally produced and handled in large (typically 1- to 20-ton) quantities and must, therefore, be characterized by reference to representative samples. The quantities involved, physical properties, chemical reactivity, and hazardous nature of UF_6 are such that for representative sampling, specially designed equipment must be used and operated in accordance with the most carefully controlled and stringent procedures. This practice indicates appropriate principles, equipment, and procedures currently in use for bulk sampling of liquid UF_6. It is used by UF_6 converters, enrichers, and fuel fabricators to review the effectiveness of existing procedures or as a guide to the design of equipment and procedures for future use.

5.2 It is emphasized that this practice is not meant to address conventional or nuclear criticality safety issues.

6. Hazards

6.1 Because of its chemical, radiochemical, and toxic properties, UF_6 is a hazardous material. UF_6 is very reactive and corrosive. It reacts readily with water, atmospheric moisture, certain metals, and many organic materials. For reasons of safety and to avoid contamination, precautions must be taken to avoid contact with such materials. Suitable handling procedures are described in USEC-651.

7. Principles

7.1 The essential purpose of the sample is to be representative of the bulk material for the purpose of determining compliance with the applicable material specification. To ensure that the sample is representative for this purpose, certain principles, as described below, must be observed.

7.2 Special attention must be given to ensuring that the bulk material from which the sample is withdrawn is homogeneous, particularly in those circumstances when it has been prepared by the blending together of materials having different compositions. In practice, the low viscosity, and hence easy mobility, of liquid UF_6 facilitates the process of homogenization by the action of convection currents within the bulk upon heating. It is necessary to determine and establish for each set of sampling equipment the physical conditions, normally a combination of the minimum time and temperature for which liquefied uranium hexafluoride is held, which guarantee homogeneity of the bulk UF_6.

7.3 The sampling equipment is fabricated to appropriate high standards of vacuum integrity, and components in direct contact with UF_6 are made from nickel, high-nickel alloys, or materials having equivalent resistance to UF_6 corrosion. The formation of an inert fluoride layer is often an important feature of UF_6 corrosion resistance, and hence, internal surfaces are generally conditioned with a suitable fluorinating agent, sometimes UF_6 itself.

7.4 Cross-contamination may occur between subsequent samples taken using the same equipment, and appropriate precautions must be taken to prevent this. It is therefore recommended that, before taking definitive samples, the equipment is flushed through with an aliquot of the material to be sampled. This is normally accomplished by taking an initial volume which is then rejected and not used for definitive analysis. Alternative procedures to prevent cross-contamination are possible and should be validated individually.

7.5 If the sample bottles are taken for an analytical need such as liquid UF_6 subsampling for P10 tubes or liquid UF_6 transfer for FTIR quantification, it is recommended, in order to minimize the gas phase contribution to the sample bottle, to fill the bottle with more than 10 % of its total volume.

8. Procedure for Sampling Directly From Filled Containers (See Fig. 1)

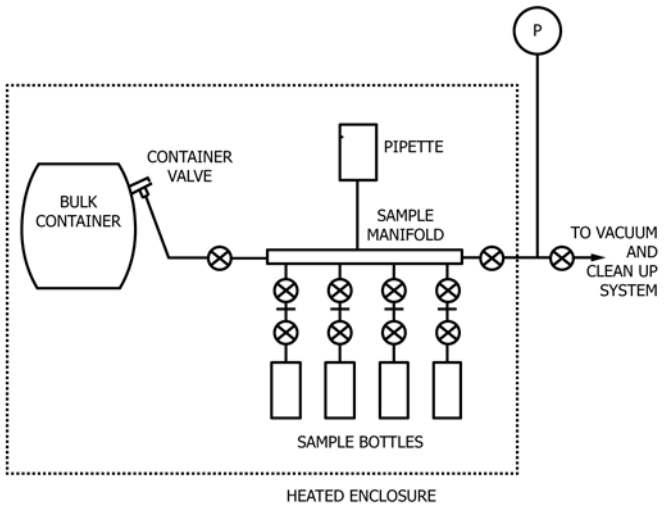

FIG. 1 Schematic Arrangement for Sampling Directly From Filled Container

8.1 The equipment consists of a sample manifold that is connected directly to the valve of the transport container and has facilities for connecting one or more sample bottles. The graduated volume is appropriately sized so that when filled either completely or visually to a predetermined level it will contain a known quantity of UF_6. The graduated volume may consist of the manifold and associated pipework, or may include an additional metering volume (pipette). The equipment may be designed to withdraw either single or multiple sample quantities of UF_6 at each operation. The total graduated volume of the connected equipment (excluding the vacuum system) should not exceed the designated maximum fill volume of the connected sample bottles. Certain valves may be remotely operated as necessary. The sampling equipment must be heated to prevent solidification of the UF_6 and may be located within the same heated enclosure as the container. The sample bottles may be heated separately to permit independent cooling, if necessary.

8.2 Load the container to be sampled into the heating enclosure (for example, autoclave) and attach the sampling equipment, including sample bottles. Evacuate and test the equipment to ensure vacuum integrity.

8.2.1 When local safety regulations permit, a container of hot, liquid UF_6 may be loaded into the sampling equipment and the sample bottles attached.

8.3 Heat the bulk UF_6 for a sufficient period to ensure homogeneity in accordance with the procedure established for the equipment (see 7.2). During heating, monitor and check the vapor pressure against the applicable pressure limit (if any) to ensure compliance with the relevant specification and maintenance of a safe pressure level. In case of overpressure, follow appropriate procedures.

8.4 When the conditions for homogeneity have been met, withdraw the appropriate quantity of liquid UF_6 into the graduated volume. This is usually effected by changing the position of the container in such a way, for example, by tilting or turning, that the UF_6 flows under the influence of gravity and any differential pressures established within the equipment. Restore the container to its original position leaving the graduated volume filled with liquid UF_6. This may be indicated by the use of suitable temperature sensors or pressure transducers or strain gauges.

8.5 If the equipment is designed to withdraw a single sample at each operation, open the appropriate sample valve to allow the UF_6 to flow into the sample bottle. Isolate the sample bottle from the sampling manifold.

8.5.1 The first sample may be used to condition internal surfaces of the equipment (see 7.3) by suitable manipulation of the vacuum system or rejected to prevent cross-contamination from previously sampled materials, or both (see 7.4).

8.5.2 Take successive samples by repeating steps 8.4 and 8.5 as necessary.

8.6 If the equipment is designed to withdraw multiple samples at each operation, transfer the samples to the sample bottles by operating the valves associated with the successive sample bottles in the appropriate sequence.

8.7 At the completion of sampling, close the container valve and evacuate the sampling equipment through the vacuum system to remove residual UF_6.

8.8 Fill the equipment to atmospheric pressure with dry gas and remove, identify, cap, and weigh the sample bottles. Local safety regulations may demand that the UF_6 is allowed to cool and solidify (below atmospheric pressure) before this operation is carried out.

9. Procedure for Sampling During Filling of Transport Containers (See Fig. 2)

9.1 The equipment consists of a sample manifold that has facilities for connecting one or more sample bottles and is connected to the filling manifold between the main and secondary (for example, transport) containers. The graduated volume is appropriately sized to contain the quantity of UF_6 required for a single sample and normally consists of the manifold and associated pipework itself or may include an additional metering volume (pipette). The total graduated volume of the connected equipment (excluding the vacuum system) should not exceed the designated maximum fill volume of the attached sample bottles. Certain valves may be remotely operated as necessary. Heat the sampling equipment to prevent the solidification of UF_6. The sample bottles may be contained in a separate enclosure to permit independent cooling if necessary (see 9.6).

9.2 Conditions for homogeneity must be met within the UF_6 main container immediately before the run-off to the secondary (for example, transport) container (see 7.2). This main container may typically be a plant vessel (for example, condenser) or another larger transport container (mother-container). In order to ensure that representative samples are obtained in case

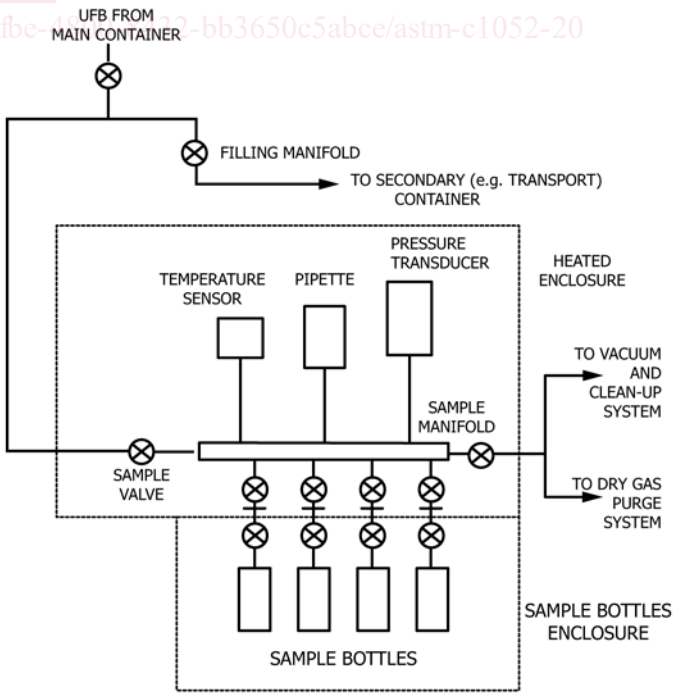

FIG. 2 Schematic Arrangement for Sampling During Filling of Transport Container