



# Standard Practice for Bulk Sampling of Liquid Uranium Hexafluoride<sup>1</sup>

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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 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 used for determining compliance with the applicable commercial specification, for example Specification **C787** and Specification **C996**.

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 the appropriate section (8.2) of 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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**C787** Specification for Uranium Hexafluoride for Enrichment

**C996** Specification for Uranium Hexafluoride Enriched to Less Than 5 % <sup>235</sup>U

<sup>1</sup> 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.

Current edition approved Jan. 15, 2014. Published February 2014. Originally approved in 1985. Last previous edition approved in 2007 as C1052 – 01 (2007). DOI: 10.1520/C1052-14.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

### 2.2 Other Documents:

**USEC-651** Uranium Hexafluoride: A Manual of Good Handling Practices<sup>3</sup>

**ANSI N14.1** Uranium Hexafluoride: Packaging for Transport<sup>4</sup>

**ISO/DIS 7195** Packaging of Uranium Hexafluoride ( $UF_6$ ) for Transport<sup>4</sup>

## 3. Terminology

### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *container*—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  $UF_6$ .

3.1.2 *sample bottle*—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) 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

<sup>3</sup> Available from United States Enrichment Corp., 6903 Rockledge Dr., Bethesda, MD 20817.

<sup>4</sup> Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

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)

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

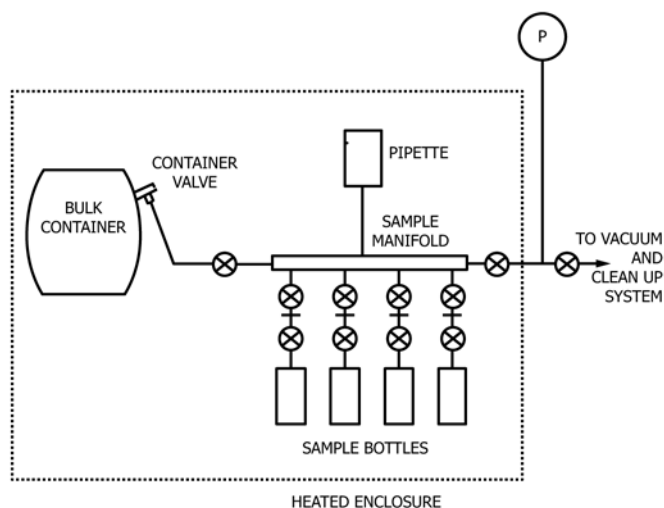


FIG. 1 Schematic Arrangement for Sampling Directly from a Filled Container