# ATTACHMENT C1

# WASTE CHARACTERIZATION SAMPLING METHODS

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# ATTACHMENT C1

# WASTE CHARACTERIZATION SAMPLING METHODS

## Introduction

The Permittees will require generator/storage sites (**sites**) to use the following methods, as applicable, for characterization of TRU mixed waste which is managed, stored, or disposed at WIPP. These methods include requirements for headspace-gas sampling, sampling of homogeneous solids and soil/gravel, and radiography or visual examination. Additionally, this Attachment provides quality control, sample custody, and sample packing and shipping requirements.

## C1-1 Sampling of Debris Waste (Summary Category S5000)

Headspace gas sampling and analysis shall be used to resolve the assignment of Environmental Protection Agency (**EPA**) hazardous waste numbers to debris waste streams.

### C1-1a Method Requirements

The Permittees shall require all headspace-gas sampling be performed in an appropriate radiation containment area on waste containers that are in compliance with the container equilibrium requirements (i.e., 72 hours at 18° C or higher).

For those waste streams without an acceptable knowledge (**AK**) Sufficiency Determination approved by the U.S. Department of Energy (**DOE**), containers shall be randomly selected from waste streams designated as summary category S5000 (Debris waste) and shall be categorized under one of the sampling scenarios shown in Table C1-5 and depicted in Figure C1-1. If the container is categorized under Scenario 1, the applicable drum age criteria (**DAC**) from Table C1-6 must be met prior to headspace gas sampling. If the container is categorized under Scenario 2, the applicable Scenario 1 DAC from Table C1-6 must be met prior to venting the container and then the applicable Scenario 2 DAC from Table C1-7 must be met after venting the container. The DAC for Scenario 2 containers that contain filters or rigid liner vent holes other than those listed in Table C1-7 shall be determined using footnotes “a” and “b” in Table C1-7. Containers that have not met the Scenario 1 DAC at the time of venting must be categorized under Scenario 3. Containers categorized under Scenario 3 must be placed into one of the Packaging Configuration Groups listed in Table C1-8. If a specific packaging configuration cannot be determined based on the data collected during packaging and/or repackaging (Attachment C, Section C-3d(1)), a conservative default Packaging Configuration Group of 3 for 55-gallon drums, 6 for Standard Waste Boxes (**SWBs**) ten-drum overpacks (**TDOPs**), and standard larged box 2s (**SLB2s**), and 8 for 85-gallon and 100-gallon drums must be assigned, provided the drums do not contain pipe component packaging. If a container is designated as Packaging Configuration Group 4 (i.e., a pipe component), the headspace gas sample must be taken from the pipe component headspace. Drums, TDOPs, SLB2s, or SWBs that contain compacted 55-gallon drums containing a rigid liner may not be disposed of under any packaging configuration unless headspace gas sampling was performed before compaction in accordance with this waste analysis plan (**WAP**). The DAC for Scenario 3 containers that contain rigid liner vent holes that are undocumented during packaging, repackaging, and/or venting (Section C1-1a[4][ii]) shall be determined using the default conditions in footnote “b” in

Table C1-9.The DAC for Scenario 3 containers that contain filters that are either undocumented or are other than those listed in Table C1-9 shall be determined using footnote 'a' in Table C1-9. Each of the Scenario 3 containers shall be sampled for headspace gas after waiting the DAC in Table C1-9 based on its packaging configuration (note: Packaging Configuration Groups 4, 5, 6, 7, and 8 are not summary category group dependent, and 85-gallon drum, 100-gallon drum, SWB, TDOP, and SLB2 requirements apply when the 85-gallon drum, 100-gallon drum, SWB, TDOP, or SLB2 is used for the direct loading of waste).

C1-1a(1) General Requirements

The determination of packaging configuration consists of identifying the number of confinement layers and the identification of rigid poly liners when present. Generator/storage sites shall use either the default conditions specified in Tables C1-7 through C1-9 for retrievably stored waste or the data documented during packaging, repackaging, and/or venting (Section C1-1a[4][ii]) for determining the appropriate DAC for each container from which a headspace gas sample is collected. These drum age criteria are to ensure that the container contents have reached 90 percent of steady state concentration within each layer of confinement (Lockheed, 1995; BWXT, 2000). The following information must be reported in the headspace gas sampling documents for each container from which a headspace gas sample is collected:

- sampling scenario from Table C1-5 and associated information from Tables C1-6 and/or Table C1-7;
- the packaging configuration from Table C1-8 and associated information from Table C1-9, including the diameter of the rigid liner vent hole, the number of inner bags, the number of liner bags, the presence/absence of drum liner, and the filter hydrogen diffusivity,
- the permit-required equilibrium time,
- the drum age,
- for supercompacted waste, both
    - the absence of rigid liners in the compacted 55-gallon drums which have not been headspace gas sampled in accordance with this permit prior to compaction, and
    - the absence of layers of confinement must be documented in the WWIS if Packaging Configuration Group 7 is used.

For all retrievably stored waste containers, the rigid liner vent hole diameter must be assumed to be 0.3 inches unless a different size is documented during drum venting or repackaging. For all retrievably stored waste containers, the filter hydrogen diffusivity must be assumed to be the most restrictive unless container-specific information clearly identifies a filter model and/or diffusivity characteristic that is less restrictive. For all retrievably stored waste containers that have not been repackaged, acceptable knowledge shall not be used to justify any packaging configuration less conservative than the default (i.e., Packaging Configuration Group 3 for 55-gallon drums, 6 for SWBs TDOPs, and SLB2s, and 8 for 85-gallon and 100-gallon drums). For information reporting purposes listed above, sites may report the default packaging configuration for retrievably stored waste without further verification.

All waste containers with unvented rigid containers greater than 4 liters (exclusive of rigid poly liners) shall be subject to innermost layer of containment sampling or shall be vented prior to initiating drum age and equilibrium criteria. When sampling the rigid poly liner under Scenario 1, the sampling device must form an airtight seal with the rigid poly liner to ensure that a representative sample is collected (using a sampling needle connected to the sampling head to pierce the rigid poly liner, and that allows for the collection of a representative sample, satisfies this requirement). The configuration of the containment area and remote-handling equipment at each sampling facility are expected to differ. Headspace-gas samples will be analyzed for the analytes listed in Table C3-2 of Permit Attachment C3. If additional packaging configurations are identified, an appropriate Permit Modification will be submitted to incorporate the DAC using the methodology in BWXT (2000). Consistent with footnote "a" in Table C1-8, any waste container selected for headspace gas sampling that cannot be assigned a packaging configuration specified in Table C1-8 shall be assigned a conservative default packaging configuration..

Drum age criteria apply only to 55-gallon drums, 85-gallon drums, 100-gallon drums, SWBs, TDOPs, and SLB2s. Drum age criteria for all other container types must be established through permit modification prior to performing headspace gas sampling.

The Permittees shall require site personnel to collect samples in SUMMA® or equivalent canisters using standard headspace-gas sampling methods that meet the general guidelines established by the EPA in the Compendium Method TO-14A or TO-15, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (EPA, 1999) or by using on-line integrated sampling/analysis systems. Samples will be directed to an analytical instrument instead of being collected in SUMMA® or equivalent canisters if a single-sample on-line integrated sampling/analysis system is used. If a multi-sample on-line integrated sampling/analysis system is used, samples will be directed to an integrated holding area that meets the cleaning requirements of Section C1-1c(1). The leak proof and inert nature of the integrated holding area interior surface must be demonstrated and documented. Samples are not transported to another location when using on-line integrated sampling/analysis systems; therefore, the sample custody requirements of Section C1-4 and C1-5 do not apply. The same sampling manifold and sampling heads are used with on-line integrated sampling/analysis systems and all of the requirements associated with sampling manifolds and sampling heads must be met. However, when using an on-line integrated sampling/analysis system, the sampling batch and analytical batch quality control (**QC**) samples are combined as on-line batch QC samples as outlined in Section C1-1b.

### <u>C1-1a(2) Manifold Headspace Gas Sampling</u>

This headspace-gas sampling protocol employs a multiport manifold capable of collecting multiple simultaneous headspace samples for analysis and QC purposes. The manifold can be used to collect samples in SUMMA® or equivalent canisters or as part of an on-line integrated sampling/analysis system. The sampling equipment will be leak checked and cleaned prior to first use and as needed thereafter. The manifold and sample canisters will be evacuated to 0.0039 inches (in.) (0.10 millimeters [mm]) mercury (**Hg**) prior to sample collection. Cleaned and evacuated sample canisters will be attached to the evacuated manifold before the manifold inlet valve is opened. The manifold inlet valve will be attached to a changeable filter connected to either a side port needle sampling head capable of forming an airtight seal (for penetrating a filter or rigid poly liner when necessary), a drum punch sampling head capable of forming an airtight seal (capable of punching through the metal lid of a drum for sampling through the drum lid), or a sampling head with an airtight fitting for sampling through a pipe overpack container filter vent hole. Refer to Section C1-1a(4) for descriptions of these sampling heads.

The manifold shall also be equipped with a purge assembly that allows applicable QC samples to be collected through all sampling components that may affect compliance with the quality assurance objectives (**QAOs**). The Permittees shall require the sites to demonstrate and document the effectiveness of the sampling equipment design in meeting the QAOs. Field blanks shall be samples of room air collected in the sampling area in the immediate vicinity of the waste container to be sampled. If using SUMMA® or equivalent canisters, field blanks shall be collected directly into the canister, without the use of the manifold.

The manifold, the associated sampling heads, and the headspace-gas sample volume requirements shall be designed to ensure that a representative sample is collected. The manifold internal volume must be calculated and documented in a field logbook dedicated to headspace-gas sample collection. The total volume of headspace gases collected during each sampling operation will be determined by adding the combined volume of the canisters attached to the manifold and the internal volume of the manifold. The sample volume should remain small in comparison to the volume of the waste container. When an estimate of the available headspace gas volume in the drum can be made, less than 10 percent of that volume should be withdrawn.

As illustrated in Figure C1-2, the sampling manifold must consist of a sample side and a standard side. The dotted line in Figure C1-2 indicates how the sample side shall be connected to the standard side for cleaning and collecting equipment blanks and field reference standards. The sample side of the sampling manifold shall consist of the following major components:

- An applicable sampling head that forms a leak-tight connection with the headspace sampling manifold.

- A flexible hose that allows movement of the sampling head from the purge assembly (standard side) to the waste container.

- A pressure sensor(s) that must be pneumatically connected to the manifold. This manifold pressure sensor(s) must be able to measure absolute pressure in the range from 0.002 in. (0.05 mm) Hg to 39.3 in. (1,000 mm) Hg. Resolution for the manifold pressure sensors must be ±0.0004 in. (0.01 mm) Hg at 0.002 in. (0.05 mm) of Hg. The manifold pressure sensor(s) must have an operating range from approximately 59°F (15°C) to 104°F (40°C).

- Available ports for attaching sample canisters. If using canister-based sampling methods, a sufficient number of ports shall be available to allow simultaneous collection of headspace-gas samples and duplicates for VOC analyses. If using an on-line integrated sampling/analysis system, only one port is necessary for the collection of comparison samples. Ports not occupied with sample canisters during cleaning or headspace-gas sampling activities require a plug to prevent ambient air from entering the system. In place of using plugs, sites may choose to install valves that can be closed to prevent intrusion of ambient air into the manifold. Ports shall have VCR® fittings for connection to the sample canister(s) to prevent degradation of the fittings on the canisters and manifold.

- Sample canisters, as illustrated in Figure C1-3, are leak-free, stainless steel pressure vessels, with a chromium-nickel oxide (**Cr-NiO**) SUMMA®-passivated interior surface, bellows valve, and a pressure/vacuum gauge. Equivalent designs, such as Silco Steel canisters, may be used so long as the leak proof and inert nature of the canister interior surface is demonstrated and documented. All sample canisters must have VCR® fittings for connection to sampling and analytical equipment. The pressure/vacuum gauge must be mounted on each manifold. The canister must be helium-leak tested to $1.5 \times 10^{-7}$ standard cubic centimeters per second (cc/s), have all stainless steel construction, and be capable of tolerating temperatures to 125°C. The gauge range shall be capable of operating in the leak test range as well as the sample collection range.

- A dry vacuum pump with the ability to reduce the pressure in the manifold to 0.05 mm Hg. A vacuum pump that requires oil may be used, but precautions must be taken to prevent diffusion of oil vapors back to the manifold. Precautions may include the use of a molecular sieve and a cryogenic trap in series between the headspace sampling ports and the pump.

- A minimum distance, based upon the design of the manifold system, between the tip of the needle and the valve that isolates the pump from the manifold in order to minimize the dead volume in the manifold.

- If real-time equipment blanks are not available, the manifold must be equipped with an organic vapor analyzer (**OVA**) that is capable of detecting all analytes listed in Table C3-2 of Permit Attachment C3. The OVA shall be capable of measuring total VOC concentrations below the lowest headspace gas PRQL. Detection of 1,1,2-trichloro-1,2,2-trifluoroethane may not be possible if a photoionization detector is used. The OVA measurement shall be verified by the collection of equipment blanks at the frequency specified in Section C1-1 to check for manifold cleanliness.

The standard side must consist of the following major elements:

- A cylinder of compressed zero air, helium, argon, or nitrogen gas that is hydrocarbon and carbon dioxide (**$CO_2$**)-free (only hydrocarbon and $CO_2$-free gases required for Fourier Transform Infrared System [**FTIRS**]) to clean the manifold between samples and to provide gas for the collection of equipment blanks or on-line blanks. These high-purity gases shall be certified by the manufacturer to contain less than one ppm total VOCs. The gases must be metered into the standard side of the manifold using devices that are corrosion proof and that do not allow for the introduction of manifold gas into the purge gas cylinders or generator. Alternatively, a zero air or nitrogen generator may be used, provided a sample of the zero air or nitrogen is collected and demonstrated to contain less than one ppm total VOCs. Zero air or nitrogen from a generator shall be humidified (except for use with FTIRS).

- Cylinders of field-reference standard gases or on-line control sample gases. These cylinders provide gases for evaluating the accuracy of the headspace-gas sampling process. Each cylinder of field-reference gas or on-line control sample gas shall have a flow-regulating device. The field-reference standard gases or on-line control sample gas shall be certified by the manufacturer to contain analytes from Table C3-2 of Permit Attachment C3 at known concentrations.

- If using an analytical method other than FTIRS a humidifier filled with American Society for Testing and Materials (**ASTM**) Type I or II water, connected, and opened to the standard side of the manifold between the compressed gas cylinders and the purge assembly shall be used. Dry gases flowing to the purge assembly will pick up moisture from the humidifier. Moisture is added to the dry gases to condition the equipment blanks and field-reference standards and to assist with system cleaning between headspace-gas sample collection. If using FTIRS for analysis, the sample and sampling system shall be kept dry.

  NOTE: Caution should be exercised to isolate the humidifier during the evacuation of the system to prevent flooding the manifold. In lieu of the humidifier, the compressed gas cylinders (e.g., zero air and field-reference standard gas) may contain water vapor in the concentration range of 1,000 to 10,000 parts per million by volume (**ppmv**).

- A purge assembly that allows the sampling head (sample side) to be connected to the standard side of the manifold. The ability to make this connection is required to transfer gases from the compressed gas cylinders to the canisters or on-line analytical instrument. This connection is also required for system cleaning.

- A flow-indicating device or a pressure regulator that is connected to the purge assembly to monitor the flow rate of gases through the purge assembly. The flow rate or pressure through the purge assembly shall be monitored to assure that excess flow exists during cleaning activities and during QC sample collection. Maintaining excess flow will prevent ambient air from contaminating the QC samples and allow samples of gas from the compressed gas cylinders to be collected near ambient pressure.

In addition to a manifold consisting of a sample side and a standard side, the area in which the manifold is operated shall contain sensors for measuring ambient pressure and ambient temperature, as follows:

- The ambient-pressure sensor must have a sufficient measurement range for the ambient barometric pressures expected at the sampling location. It must be kept in the sampling area during sampling operations. Its resolution shall be 0.039 in. (1.0 mm) Hg or less, and calibration performed by the manufacturer shall be based on National Institute of Standards and Technology (**NIST**), or equivalent, standards.

- The temperature sensor shall have a sufficient measurement range for the ambient temperatures expected at the sampling location. The measurement range of the temperature sensor must be from 18°C to 50°C. The temperature sensor calibration shall be traceable to NIST, or equivalent, standards.

C1-1a(3) Direct Canister Headspace Gas Sampling

This headspace-gas sampling protocol employs a canister-sampling system to collect headspace-gas samples for analysis and QC purposes without the use of the manifold described above. Rather than attaching sampling heads to a manifold, in this method the sampling heads are attached directly to an evacuated sample canister as shown in Figure C1-4.

Canisters shall be evacuated to 0.0039 in. (0.10 mm) Hg prior to use and attached to a changeable filter connected to the appropriate sampling head. The sampling head(s) must be capable of either punching through the metal lid of the drums (and/or the rigid poly liner when necessary) while maintaining an airtight seal when sampling through the drum lid, penetrating a filter or the septum in the orifice of the self-tapping screw, or maintaining an airtight seal for sampling through a pipe overpack container filter vent hole to obtain the drum headspace samples. Field duplicates must be collected at the same time, in the same manner, and using the same type of sampling apparatus as used for headspace-gas sample collection. Field blanks shall be samples of room air collected in the immediate vicinity of the waste-drum sampling area prior to removal of the drum lid. Equipment blanks and field-reference standards must be collected using a purge assembly equivalent to the standard side of the manifold described above. These samples shall be collected from the needle tip through the same components (e.g., needle and filter) that the headspace-gas samples pass through.

The sample canisters, associated sampling heads, and the headspace-sample volume requirements ensure that a representative sample is collected. When an estimate of the available headspace-gas volume of the waste container can be made, less than 10 percent of that volume should be withdrawn. A determination of the sampling head internal volume shall be made and documented. The total volume of headspace gases collected during each headspace gas sampling operation can be determined by adding the volume of the sample canister(s) attached to the sampling head to the internal volume of the sampling head. Every effort shall be made to minimize the internal volume of sampling heads.

Each sample canister used with the direct canister method shall have a pressure/vacuum gauge capable of indicating leaks and sample collection volumes. Canister gauges are intended to be gross leak-detection devices not vacuum-certification devices. If a canister pressure/vacuum gauge indicates an unexpected pressure change, determination of whether the change is a result of ambient temperature and pressure differences or a canister leak shall be made. This gauge shall be helium-leak tested to $1.5 \times 10^{-7}$ standard cc/s, have all stainless steel construction, and be capable of tolerating temperatures to 125°C.

The SUMMA® or equivalent sample canisters as specified in EPA's Compendium Method TO-14A or TO-15 (EPA 1999) shall be used when sampling each drum. These heads shall form a leak-tight connection with the canister and allow sampling through the drum-lid filter, through the drum lid itself and/or rigid poly liner when necessary (by use of a punch or self-tapping screw), using an airtight fitting to collect the sample through the filter vent hole of a pipe overpack container, or using a hollow side port needle. Figure C1-4 illustrates the direct canister-sampling equipment.

### C1-1a(4) Sampling Heads

A sample of the headspace gas directly under the container lid, pipe overpack filter vent hole, or rigid poly liner shall be collected. Several methods have been developed for collecting a representative sample: sampling through the filter, sampling through the drum lid by drum punching, sampling through a pipe overpack container filter vent hole, and sampling through the rigid poly liner. The chosen sampling method shall preserve the integrity of the drum to contain radionuclides (e.g., replace the damaged filter, replace set screw in filter housing, seal the punched drum lid).

## C1-1a(4)(i) Sampling Through the Filter

To sample the drum-headspace gas through the drum's filter, a side-port needle (e.g., a hollow needle sealed at the tip with a small opening on its side close to the tip) shall be pressed through the filter and into the headspace beneath the drum lid. This permits the gas to be drawn into the manifold or directly into the canister(s). To assure that the sample collected is representative, all of the general method requirements, sampling apparatus requirements, and QC requirements described in this section shall be met in addition to the following requirements that are pertinent to drum headspace-gas sampling through the filter:

- The lid of the drum's 90-mil rigid poly liner shall contain a hole for venting to the drum headspace. A representative sample cannot be collected from the drum headspace until the 90-mil rigid poly liner has been vented. If the DAC for Scenario 1 is met, a sample may be collected from inside the 90-mil rigid poly liner. If the sample is collected by removing the drum lid, the sampling device shall form an airtight seal with the rigid poly liner to prevent the intrusion of outside air into the sample (using a sampling needle connected to the sampling head to pierce the rigid poly liner satisfies this requirement). If headspace-gas samples are collected from the drum headspace prior to venting the 90-mil rigid poly liner, the sample is not acceptable and a nonconformance report shall be prepared, submitted, and resolved. Nonconformance procedures are outlined in Permit Attachment C3.

- For sample collection, the drum's filter shall be sealed to prevent outside air from entering the drum and diluting and/or contaminating the sample.

The sampling head for collecting drum headspace by penetrating the filter shall consist of a side-port needle, a filter to prevent particles from contaminating the gas sample, and an adapter to connect the side-port needle to the filter. To prevent cross contamination, the sampling head shall be cleaned or replaced after sample collection, after field-reference standard collection, and after field-blank collection. The following requirements shall also be met:

- The housing of the filter shall allow insertion of the sampling needle through the filter element or a sampling port with septum that bypasses the filter element into the drum headspace.

- The side-port needle shall be used to reduce the potential for plugging.

- The purge assembly shall be modified for compatibility with the side-port needle.

## C1-1a(4)(ii) Sampling Through the Drum Lid By Drum Lid Punching

Sampling through the drum lid at the time of drum punching or thereafter may be performed as an alternative to sampling through the drum's filter if an airtight seal can be maintained. To sample the drum headspace-gas through the drum lid at the time of drum punching or thereafter, the lid shall be breached using an appropriate punch. The punch shall form an airtight seal between the drum lid and the manifold or direct canister sampling equipment. To assure that the sample collected is representative, all of the general method requirements, sampling apparatus requirements, and QC requirements specified in EPA's Compendium Method TO-14A or TO-15 (EPA 1999) as appropriate, shall be met in addition to the following requirements:

- The seal between the drum lid and sampling head shall be designed to minimize intrusion of ambient air.

- All components of the sampling system that come into contact with sample gases shall be purged with humidified zero air, nitrogen, or helium prior to sample collection.

- Equipment blanks and field reference standards shall be collected through all the components of the punch that contact the headspace-gas sample.

- Pressure shall be applied to the punch until the drum lid has been breached.

- Provisions shall be made to relieve excessive drum pressure increases during drum-punch operations; potential pressure increases may occur during sealing of the drum punch to the drum lid.

- The lid of the drum's 90-mil rigid poly liner shall contain a hole for venting to the drum headspace. A representative sample cannot be collected from the drum headspace until the 90-mil rigid poly liner has been vented. If the DAC for Scenario 1 is met, a sample may be collected from inside the 90-mil rigid poly liner. If headspace-gas samples are collected from the drum headspace prior to venting the 90-mil rigid poly liner, the sample is not acceptable and a nonconformance report shall be prepared, submitted, and resolved. Nonconformance procedures are outlined in Permit Attachment C3.

- During sampling, the drum's filter, if present, shall be sealed to prevent outside air from entering the drum.

- While sampling through the drum lid using manifold sampling, a flow-indicating device or pressure regulator to verify flow of gases shall be pneumatically connected to the drum punch and operated in the same manner as the flow-indicating device described above in Section C1-1a(2).

- Equipment shall be used to adequately secure the drum-punch sampling system to the drum lid.

- If the headspace gas sample is not taken at the time of drum punching, the presence and diameter of the rigid liner vent hole shall be documented during the punching operation for use in determining an appropriate Scenario 2 DAC.

C1-1a(4)(iii) Sampling Through a Pipe Overpack Container Filter Vent Hole

Sampling through an existing filter vent hole in a pipe overpack container (**POC**) may be performed as an alternative to sampling through the POC's filter if an airtight seal can be maintained. To sample the container headspace-gas through a POC filter vent hole, an appropriate airtight seal shall be used. The sampling apparatus shall form an airtight seal between the POC surface and the manifold or direct canister sampling equipment. To assure that the sample collected is representative, all of the general method, sampling apparatus, and QC requirements specified in EPA's Compendium Method TO-14A or TO-15 (EPA 1999) as appropriate, shall be met in addition to the following requirements:

- The seal between the POC surface and sampling apparatus shall be designed to minimize intrusion of ambient air.
- The filter shall be replaced as quickly as is practicable with the airtight sampling apparatus to ensure that a representative sample can be taken. Sites must provide documentation demonstrating that the time between removing the filter and installing the airtight sampling device has been established by testing to assure a representative sample.
- All components of the sampling system that come into contact with sample gases shall be cleaned according to requirements for direct canister sampling or manifold sampling, whichever is appropriate, prior to sample collection.
- Equipment blanks and field reference standards shall be collected through all the components of the sampling system that contact the headspace-gas sample.
- During sampling, openings in the POC shall be sealed to prevent outside air from entering the container.
- A flow-indicating device shall be connected to sampling system and operated according to the direct canister or manifold sampling requirements, as appropriate.

### C1-1b Quality Control

For manifold and direct canister sampling systems, field QC samples shall be collected on a per sampling batch basis. A sampling batch is a suite of samples collected consecutively using the same sampling equipment within a specific time period. A sampling batch can be up to 20 samples (excluding QC samples), all of which shall be collected within 14 days of the first sample in the batch. For on-line integrated sampling/analysis systems, QC samples shall be collected and analyzed on a per on-line batch basis. Holding temperatures and container requirements for gas sample containers are provided in Table C1-1. An on-line batch is the number of headspace-gas samples collected within a 12-hour period using the same on-line integrated analysis system. The analytical batch requirements are specified by the analytical method being used in the on-line system. Table C1-2 provides a summary of field QC sample collection requirements. Table C1-3 provides a summary of QC sample acceptance criteria.

For on-line integrated sampling analysis systems, the on-line batch QC samples serve as combined sampling batch/analytical batch QC samples as follows:

- The on-line blank replaces the equipment blank and laboratory blank
- The on-line control sample replaces the field reference standard and laboratory control sample
- The on-line duplicate replaces the field duplicate and laboratory duplicate

The acceptance criteria for on-line batch QC samples are the same as for the sampling batch and analytical batch QC samples they replace. Acceptance criteria are shown in Table C1-3. A separate field blank shall still be collected and analyzed for each on-line batch. However, if the results of a field blank collected through the sampling manifold meets the acceptance criterion, a separate on-line blank need not be collected and analyzed.

The Permittees shall require the site project manager to monitor and document field QC sample results and fill out a nonconformance report if acceptance or frequency criteria are not met. The Permittees shall require the site project manager to ensure appropriate corrective action is taken if acceptance criteria are not met.

#### C1-1b(1) Field Blanks

Field blanks shall be collected to evaluate background levels of program-required analytes. Field blanks shall be collected prior to sample collection, and at a frequency of one per sampling batch. The Permittees shall require the site project manager to use the field blank data to assess impacts of ambient contamination, if any, on the sample results. Field blank results determined by gas chromatography/mass spectrometry and gas chromatography/flame ionization detection shall be acceptable if the concentration of each VOC analyte is less than or equal to three times the method detection limit (**MDL**) listed in Table C3-2 in Permit Attachment C3. Field blank results determined by FTIRS shall be acceptable if the concentration of each VOC analyte is less than the program required quantitation limit listed in Table C3-2. A nonconformance report shall be initiated and resolved if the final reported QC sample results do not meet the acceptance criteria.

#### C1-1b(2) Equipment Blanks

Equipment blanks shall be collected to assess cleanliness prior to first use after cleaning of all sampling equipment. On-line blanks will be used to assess equipment cleanliness as well as analytical contamination. After the initial cleanliness check, equipment blanks collected through the manifold shall be collected at a frequency of one per sampling batch for VOC analysis or one per day, whichever is more frequent. If the direct canister method is used, field blanks may be used in lieu of equipment blanks. The Permittees shall require the site project manager to use the equipment blank data to assess impacts of potentially contaminated sampling equipment on the sample results. Equipment blank results determined by gas chromatography/mass spectrometry or gas chromatography/flame ionization detection shall be acceptable if the concentration of each VOC analyte is less than or equal to three times the MDL listed in Table C3-2 in Permit Attachment C3. Equipment blank results determined by FTIRS shall be acceptable if the concentration of each VOC analyte is less than the program required quantitation limit listed in Table C3-2.

#### C1-1b(3) Field Reference Standards

Field reference standards shall be used to assess the accuracy with which the sampling equipment collects VOC samples into SUMMA® or equivalent canisters prior to first use of the sampling equipment. The on-line control sample will be used to assess the accuracy with which the sampling equipment collects VOC samples as well as an indicator of analytical accuracy for the on-line sampling system. Field reference standards shall contain a minimum of six of the analytes listed in Table C3-2 in Permit Attachment C3 at concentrations within a range of 10 to 100 ppmv and greater than the MDL for each compound. Field reference standards shall have a known valid relationship to a nationally recognized standard (e.g., NIST), if available. If NIST traceable standards are not available and commercial gases are used, a Certificate of Analysis from the manufacturer documenting traceability is required. Commercial stock gases shall not be used beyond their manufacturer-specified shelf life. After the initial accuracy check, field reference standards collected through the manifold shall be collected at a frequency of one per sampling batch and submitted as blind samples to the analytical laboratory. For the direct canister method, field reference standard collection may be discontinued if the field reference standard results demonstrate the QAO for accuracy specified in Attachment C3. Field reference standard results shall be acceptable if the accuracy for each tested compound has a recovery of 70 to 130 percent.

C1-1b(4) Field Duplicates

Field duplicate samples shall be collected sequentially and in accordance with Table C1-1 to assess the precision with which the sampling procedure can collect samples into SUMMA® or equivalent canisters. Field duplicates will also serve as a measure of analytical precision for the on-line sampling system. Field duplicate results shall be acceptable if the relative percent difference is less than or equal to 25 for each tested compound found in concentrations greater than the PRQL in both duplicates.

C1-1c Equipment Testing, Inspection and Maintenance

All sampling equipment components that come into contact with headspace sample gases shall be constructed of relatively inert materials such as stainless steel or Teflon®. A passivated interior surface on the stainless steel components is recommended.

To minimize the potential for cross contamination of samples, the headspace sampling manifold and sample canisters shall be properly cleaned and leak-checked prior to each headspace-gas sampling event. Procedures used for cleaning and preparing the manifold and sample canisters shall be equivalent to those provided in EPA's Compendium Method TO-14A or TO-15 (EPA 1999). Cleaning requirements are presented below.

C1-1c(1) Headspace-Gas Sample Canister Cleaning

SUMMA® or equivalent canisters used in these methods shall be subjected to a rigorous cleaning and certification procedures prior to use in the collection of any samples. Guidance for the development of this procedure has been derived from Method TO-14A or TO-15 (EPA 1999). Specific detailed instructions shall be provided in laboratory standard operating procedures (**SOPs**) for the cleaning and certification of canisters.

Canisters shall be cleaned and certified on an equipment cleaning batch basis. An equipment cleaning batch is any number of canisters cleaned together at one time using the same cleaning method. A cleaning system, capable of processing multiple canisters at a time, composed of an oven (optional) and a vacuum manifold which uses a dry vacuum pump or a cryogenic trap backed by an oil sealed pump shall be used to clean SUMMA® or equivalent canisters. Prior to cleaning, a positive or negative pressure leak test shall be performed on all canisters. The duration of the leak test must be greater than or equal to the time it takes to collect a sample, but no greater than 24 hours. For a leak test, a canister passes if the pressure does not change by a rate greater than ±2 psig per 24 hours. Any canister that fails shall be checked for leaks, repaired, and reprocessed. One canister per equipment cleaning batch shall be filled with humid zero air or humid high purity nitrogen and analyzed for VOCs. The equipment cleaning batch of canisters shall be considered clean if there are no VOCs above three times the MDLs listed in

Table C3-2 of Permit Attachment C3. After the canisters have been certified for leak-tightness and found to be free of background contamination, they shall be evacuated to 0.0039 in. (0.10 mm) Hg or less for storage prior to shipment. The Permittees shall require the laboratory responsible for canister cleaning and certification to maintain canister certification documentation and initiate the canister tags as described in Permit Attachment C3.

C1-1c(2) Sampling Equipment Initial Cleaning and Leak Check

The surfaces of all headspace-gas sampling equipment components that will come into contact with headspace gas shall be thoroughly inspected and cleaned prior to assembly. The manifold and associated sampling heads shall be purged with humidified zero air, nitrogen, or helium, and leak checked after assembly. This cleaning shall be repeated if the manifold and/or associated sampling heads are contaminated to the extent that the routine system cleaning is inadequate.

C1-1c(3) Sampling Equipment Routine Cleaning and Leak Check

The manifold and associated sampling heads which are reused shall be cleaned and checked for leaks in accordance with the cleaning and leak check procedures described in EPA's Compendium Method TO-14A or TO-15 (EPA 1999). The procedures shall be conducted after headspace gas and field duplicate collection; after field blank collection, after field blanks are collected through the manifold; and after the additional cleaning required for field reference standard collection has been completed. The protocol for routine manifold cleaning and leak check requires that sample canisters be attached to the canister ports, or that the ports be capped or closed by valves, and requires that the sampling head be attached to the purge assembly.

VOCs shall be removed from the internal surfaces of the headspace sampling manifold to levels that are less than or equal to three times the MDLs of the analytes listed in Table C3-2 of Permit Attachment C3, as determined by analysis of an equipment blank or through use of an OVA. It is recommended that the headspace sampling manifold be heated to 150° Centigrade and periodically evacuated and flushed with humidified zero air, nitrogen, or helium. When not in use, the manifold shall be demonstrated clean before storage with a positive pressure of high purity gas (i.e., zero air, nitrogen, or helium) in both the standard and sample sides.

Sampling shall be suspended and corrective actions shall be taken when the analysis of an equipment blank indicates that the VOC limits have been exceeded or if a leak test fails. The Permittees shall require the site project manager to ensure that corrective action has been taken prior to resumption of sampling.

C1-1c(4) Manifold Cleaning After Field Reference Standard Collection

The sampling system shall be specially cleaned after a field reference standard has been collected, because the field reference standard gases contaminate the standard side of the headspace sampling manifold when they are regulated through the purge assembly. This cleaning requires the installation of a gas-tight connector in place of the sampling head, between the flexible hose and the purge assembly. This configuration allows both the sample and standard sides of the sampling system to be flushed (evacuated and pressurized) with humidified zero air, nitrogen, or helium which, combined with heating the pneumatic lines, should sweep and adequately clean the system's internal surfaces. After this protocol has been completed and prior to collecting another sample, the routine system cleaning and leak check (see previous section) shall also be performed.

### C1-1c(5) Sampling Head Cleaning

To prevent cross contamination, the needle, airtight fitting or airtight seal, adapters, and filter of the sampling heads shall be cleaned in accordance with the cleaning procedures described in EPA's Compendium Method TO-14A or TO-15 (EPA 1999). After sample collection, a sampling head shall be disposed of or cleaned in accordance with EPA's Compendium Method TO-14A or TO-15 (EPA1999), prior to reuse. As a further QC measure, the needle, airtight fitting or airtight seal, and filter, after cleaning, should be purged with zero air, nitrogen, or helium and capped for storage to prevent sample contamination by VOCs potentially present in ambient air.

### C1-1d Equipment Calibration and Frequency

The manifold pressure sensor shall be certified prior to initial use, then annually, using NIST traceable, or equivalent, standards. If necessary, the pressure indicated by the pressure sensor(s) shall be temperature compensated. The ambient air temperature sensor, if present, shall be certified prior to initial use, then annually, to NIST traceable, or equivalent, temperature standards.

The OVA shall be calibrated once per day, prior to first use, or as necessary according to the manufacturer's specifications. Calibration gases shall be certified to contain known analytes from Table C3-2 of Permit Attachment C3 at known concentrations. The balance of the OVA calibration gas shall be consistent with the manifold purge gas when the OVA is used (i.e., zero air, nitrogen, or helium).

## C1-2 Sampling of Homogeneous Solids and Soil/Gravel (Summary Categories S3000/S4000)

For those waste streams without an AK Sufficiency Determination approved by DOE, randomly selected containers of homogeneous solid and/or soil/gravel waste streams (S3000/S4000) shall be sampled and analyzed to resolve the assignment of EPA hazardous waste numbers. For example, analytical results may be useful to resolve uncertainty regarding hazardous constituents used in a process that generated the waste stream when the hazardous constituents are not documented in the acceptable knowledge information for the waste.

### C1-2a Method Requirements

The methods used to collect samples of transuranic (**TRU**) mixed waste, classified as homogeneous solids and soil/gravel from waste containers, shall be such that the samples are representative of the waste from which they were taken. To minimize the quantity of investigation-derived waste, laboratories conducting the analytical work may require no more sample than is required for the analysis, based on the analytical methods. However, a sufficient number of samples shall be collected to adequately represent waste being sampled. For those waste streams defined as Summary Category Groups S3000 or S4000 in Attachment C, debris that may also be present within these wastes need not be sampled.

Samples of retrievably stored waste containers will be collected using appropriate coring equipment or other EPA approved methods to collect a representative sample. Newly generated wastes that are sampled from a process as it is generated may be sampled using EPA approved methods, including scoops and ladles, that are capable of collecting a representative sample. All sampling and core sampling will comply with the QC requirements specified in C1-2b.

C1-2a(1) Core Collection

Coring tools shall be used to collect cores of homogeneous solids and soil/gravel from waste containers, when possible, in a manner that minimizes disturbance to the core. A rotational coring tool (i.e., a tool that is rotated longitudinally), similar to a drill bit, to cut, lift the waste cuttings, and collect a core from the bore hole, shall be used to collect sample cores from waste containers. For homogeneous solids and soil/gravel that are relatively soft, non-rotational coring tools may be used in lieu of a rotational coring tool.

To provide a basis for describing the requirements for core collection, diagrams of a rotational coring tool (i.e., a light weight auger) and a non-rotational coring tool (i.e., a thin-walled sampler) are provided in Figures C1-5 and C1-6, respectively.

The following requirements apply to the use of coring tools:

- Each coring tool shall contain a removable tube (liner) that is constructed of fairly rigid material unlikely to affect the composition and/or concentrations of target analytes in the sample core. Materials that are acceptable for use for coring device sleeves are polycarbonate, teflon, or glass for most samples, and stainless steel or brass if samples are not to be analyzed for metals. The Permittees shall require site quality assurance project plans (**QAPjPs**) to document that analytes of concern are not present in liner material. The Permittees shall also require sites to document that the materials are unlikely to affect sample results through the collection and analysis of an equipment blank prior to first use as specified in the 'Equipment Blanks' section of this appendix. Liner outer diameter is recommended to be no more than 2 in. and no less than one in. Liner wall thickness is recommended to be no greater than 1/16 in. Before use, the liner shall be cleaned in accordance the requirements in Section C1-2b. The liner shall fit flush with the inner wall of the coring tool and shall be of sufficient length to hold a core that is representative of the waste along the entire depth of the waste. The depth of the waste is calculated as the distance from the top of the sludge to the bottom of the drum (based on the thickness of the liner and the rim at the bottom of the drum). The liner material shall have sufficient transparency to allow visual examination of the core after sampling. If sub-sampling is not conducted immediately after core collection and liner extrusion, then end caps constructed of material unlikely to affect the composition and/or concentrations of target analytes in the core (e.g., Teflon®) shall be placed over the ends of the liner. End caps shall fit tightly to the ends of the liner. The Permittees shall require site specific QAPjPs to indicate the acceptable materials for core liners and end caps.

- A spring retainer, similar to that illustrated in Figures C1-5 and C1-6, shall be used with each coring tool when the physical properties of the waste are such that the waste may fall out of the coring tool's liner during sampling activities. The spring retainer shall be constructed of relatively inert material (e.g., stainless steel or Teflon®) and its inner diameter shall not be less than the inner diameter of the liner. Before use, spring retainers shall be cleaned in accordance with the requirements in Section C1-2b.

- Coring tools may have an air-lock mechanism that opens to allow air inside the liners to escape as the tool is pressed into the waste (e.g., ball check valve). If used, this air-lock mechanism shall also close when the core is removed from the waste container.

- After disassembling the coring tool, a device (extruder) to forcefully extrude the liner from the coring tool shall be used if the liner does not slide freely. All surfaces of the extruder that may come into contact with the core shall be cleaned in accordance with the requirements in Section C1-2(b) prior to use.

- Coring tools shall be of sufficient length to hold the liner and shall be constructed to allow placement of the liner leading edge as close as possible to the coring tools leading edge.

- All surfaces of the coring tool that have the potential to contact the sample core or sample media shall be cleaned in accordance with the requirements in Section C1-2(b) prior to use.

- The leading edge of the coring tools may be sharpened and tapered to a diameter equivalent to, or slightly smaller than, the inner diameter of the liner to reduce the drag of the homogeneous solids and soil/gravel against the internal surfaces of the liner, thereby enhancing sample recovery.

- Rotational coring tools shall have a mechanism to minimize the rotation of the liner inside the coring tool during coring activities, thereby minimizing physical disturbance to the core.

- Rotational coring shall be conducted in a manner that minimizes transfer of frictional heat to the core, thereby minimizing potential loss of VOCs.

- Non-rotational coring tools shall be designed such that the tool's kerf width is minimized. Kerf width is defined as one-half of the difference between the outer diameter of the tool and the inner diameter of the tool's inlet.

### C1-2a(2) Sample Collection

Sampling of cores shall be conducted in accordance with the following requirements:

- Sampling shall be conducted as soon as possible after core collection. If a substantial delay (i.e., more than 60 minutes) is expected between core collection and sampling, the core shall remain in the liner and the liner shall be capped at each end. If the liner containing the core is not extruded from the coring tool and capped, then two alternatives are permissible: 1) the liner shall be left in the coring tool and the coring tool shall be capped at each end, or 2) the coring tool shall remain in the waste container with the air-lock mechanism attached.

- Samples of homogeneous solids and soil/gravel for VOC analyses shall be collected prior to extruding the core from the liner. These samples may be collected by collecting a single sample from the representative subsection of the core, or three sub-samples may be collected from the vertical core to form a single 15-gram composite sample.

Smaller sample sizes may be used if method PRQL requirements are met for all analytes. The sampling locations shall be randomly selected. If a single sample is used, the representative subsection is chosen by randomly selecting a location along the portion of the core (i.e. core length). If the three sub-sample method is used, the sampling locations shall be randomly selected within three equal-length subsections of the core along the long axis of the liner and access to the waste shall be gained by making a perpendicular cut through the liner and the core. The Permittees shall require sites to develop documented procedures to select, and record the selection, of random sampling locations. True random sampling involves the proper use of random numbers for identifying sampling locations. The procedures used to select the random sampling locations will be subject to review as part of annual audits by DOE. A sampling device such as the metal coring cylinder described in EPA's SW-846 Manual (1996), or equivalent, shall be immediately used to collect the sample once the core has been exposed to air. Immediately after sample collection, the sample shall be extruded into 40-ml volatile organics analysis (**VOA**) vials (or other containers specified in appropriate SW-846 methods), the top rim of the vial visually inspected and wiped clean of any waste residue, and the vial cap secured. Sample handling requirements are outlined in Table C1-4. Additional guidance for this type of sampling can be found in SW-846 (EPA 1996).

- Samples of the homogeneous solids and soil/gravel for semi-volatile organic compound and metals analyses shall be collected. These samples may be collected from the same sub-sample locations and in the same manner as the sample collected for VOC analysis, or they may be collected by splitting or compositing the representative subsection of the core. The representative subsection is chosen by randomly selecting a location along the portion of the core (i.e. core length). The Permittees shall require sites to develop documented procedures to select, and record the selection, of random sampling locations. True random sampling involves the proper use of random numbers for identifying sampling locations. The procedures used to select the random sampling locations will be subject to review as part of annual audits by DOE. Guidance for splitting and compositing solid materials can be found in SW-846 (EPA 1996). All surfaces of the sampling tools that have the potential to come into contact with the sample shall be constructed of materials unlikely to affect the composition or concentrations of target analytes in the waste (e.g., Teflon®). In addition, all surfaces that have the potential to come into contact with core sample media shall either be disposed or decontaminated according to the procedures found in Section C1-2(b). Sample sizes and handling requirements are outlined in Table C1-4.

Newly generated waste samples may be collected using methods other than coring, as discussed in Section C1-2a. Newly generated wastes samples will be collected as soon as possible after sampling, but the spatial and temporal homogeneity of the waste stream dictate whether a representative grab sample or composite sample shall be collected. As part of the site audit, DOE shall assess waste sampling to ensure collection of representative samples.

## C1-2b Quality Control

QC requirements for sampling of homogeneous solids and soil/gravel include collecting co-located samples from cores or other sample types to determine precision; equipment blanks to verify cleanliness of the sampling and coring tools and sampling equipment; and analysis of reagent blanks to ensure reagents, such as deionized or high pressure liquid chromatography (**HPLC**) water, are of sufficient quality. Coring and sampling of homogeneous solids and soil/gravel shall comply, at minimum, with the following QC requirements.

### C1-2b(1) Co-located Samples

In accordance with the requirement to collect field duplicates required by the EPA methods found in SW-846 (EPA 1996), samples shall be collected to determine the combined precision of the coring and sampling procedures. The co-located core methodology is a duplicate sample collection methodology intended to collect samples from a second core placed at approximately the same location within the drum when samples are collected by coring. Waste may not be amenable to coring in some instances. In this case, a co-located sample may be collected from a sample (e.g. scoop) collected from approximately the same location in the waste stream. A sample from each co-located core or waste sample collected by other means shall be collected side by side as close as feasible to one another, handled in the same manner, visually inspected through the transparent liner (if cored), and sampled in the same manner at the same randomly selected sample location(s). If the visual examination detects inconsistencies such as color, texture, or waste type in the waste at the sample location, another sampling location may be randomly selected, or the samples may be invalidated and co-located samples or cores may again be collected. Co-located samples, from either core or other sample type, shall be collected at a frequency of one per sampling batch or once per week, whichever is more frequent. A sampling batch is a suite of homogeneous solids and soil/gravel samples collected consecutively using the same sampling equipment within a specific time period. A sampling batch can be up to 20 samples (excluding field QC samples), all of which shall be collected within 14 days of the first sample in the batch.

### C1-2b(2) Equipment Blanks

In accordance with SW-846 (EPA 1996), equipment blanks shall be collected from fully assembled sampling and coring tools (i.e., at least those portions of the sampling equipment that contact the sample) prior to first use after cleaning at a frequency of one per equipment cleaning batch. An equipment cleaning batch is the number of sampling equipment items cleaned together at one time using the same cleaning method. The equipment blank shall be collected from the fully assembled sampling or coring tool, in the area where the sampling or coring tools are cleaned, prior to covering with protective wrapping and storage. The equipment blank shall be collected by pouring clean water (e.g., deionized water, HPLC water) down the inside of the assembled sampling or coring tool. The water shall be collected in a clean sample container placed at the leading edge of the sampling or coring tool and analyzed for the analytes listed in Tables C3-4, C3-6, and C3-8 of Permit Attachment C3. The results of the equipment blank will be considered acceptable if the analysis indicates no analyte at a concentration greater than three times the MDLs listed in Tables C3-4 and C3-6 or in the Program Required Detection Limits (**PRDL**) in Table C3-8 of Permit Attachment C3. If analytes are detected at concentrations greater than three times the MDLs (or PRDLs for metals), then the associated equipment cleaning batch of sampling or coring tools shall be cleaned again and another equipment blank collected. Equipment from an equipment cleaning batch may not be used until analytical results have been received verifying an adequately low level of contamination in the equipment blank.

Equipment blanks for coring tools shall be collected from liners that are cleaned separately from the coring tools. These equipment blanks shall be collected at a frequency of one per equipment cleaning batch. The equipment blanks shall be collected by randomly selecting a liner from the equipment cleaning batch, pouring clean water (e.g., deionized water or HPLC water) across its internal surface, collecting the water in a clean sample container, and analyzing the water for the analytes listed in Tables C3-4, C3-6, and the PRDLs in Table C3-8 of Permit Attachment C3. The results of the equipment blank analysis will be considered acceptable if the results indicate no analyte at a concentration greater than three times the MDLs listed in Tables C3-4, C3-6, or C3-8 of Permit Attachment C3. If analytes are detected at concentrations greater than three times the MDLs (or PRDLs for metals), then the associated equipment cleaning batch of liners shall be cleaned again and another equipment blank collected. Equipment from an equipment cleaning batch may not be used until analytical results have been received verifying an adequately low level of contamination in the equipment blank.

Sampling equipment (e.g., bowls, spoons, chisel, VOC sub-sampler) shall also be cleaned. Equipment blanks shall be collected for the sampling equipment at a frequency of one per equipment cleaning batch. After the sampling equipment has been cleaned, one item from the equipment cleaning batch is randomly selected, water (e.g., deionized water, HPLC water) is passed over its surface, collected in a clean container, and analyzed for the analytes listed in Tables C3-4, C3-6, and C3-8 of Permit Attachment C3. The results of the equipment blank will be considered acceptable if the results indicate no analyte present at a concentration greater than three times the MDLs listed in Tables C3-4 and C3-6 and in the PRDLs in C3-8 of Permit Attachment C3. If analytes are detected at concentrations greater than three times the MDLs (or PRDLs for metals), then the associated equipment cleaning batch of sampling equipment shall be cleaned again and another equipment blank collected. Equipment from an equipment cleaning batch may not be used until analytical results have been received verifying an adequately low level of contamination in the equipment blank. The above equipment blanks may be performed on a purchased batch basis for sampling equipment purchased sterile and sealed in protective packaging. Equipment blanks need not be performed for equipment purchased in sealed protective packaging accompanied by a certificate certifying cleanliness.

The results of equipment blanks shall be traceable to the items in the equipment cleaning batch that the equipment blank represents. All sampling items should be identified, and the associated equipment cleaning batch should be documented. The method of documenting the connection between equipment and equipment cleaning batches shall be documented. Equipment blank results for the coring tools, liners, and sampling equipment shall be reviewed prior to use. A sufficient quantity of these items should be maintained in storage to prevent disruption of sampling operations.

The Permittees may require a site to use certified clean disposable sampling equipment and discard liners and sampling tools after one use. In this instance, cleaning and equipment blank collection is not required.

C1-2b(3) Coring Tool and Sampling Equipment Cleaning

Coring tools and sampling equipment shall be cleaned in accordance with the following requirements:

- All surfaces of coring tools and sampling equipment that will come into contact with the samples shall be clean prior to use. All sampling equipment shall be cleaned in the same manner. Immediately following cleaning, coring tools and sampling equipment shall be assembled and sealed inside clean protective wrapping.

- Each reusable sampling or coring tool shall have a unique identification number. Each number shall be referenced to the waste container on which it was used. This information shall be recorded in the field records. One sampling or coring tool from each equipment cleaning batch shall be tested for cleanliness in accordance with the requirements specified above. The identification number of the sampling or coring tool from which the equipment blank was collected shall be recorded in the field records. The results of the equipment blank analysis for the equipment cleaning batch in which each sampling or coring tool was cleaned shall be submitted to the sampling facility with the identification numbers of all sampling or coring tools in the equipment cleaning batch. If analytes are detected at concentrations greater than three times the MDLs (or PRDLs for metals), then the associated equipment cleaning batch of sampling equipment shall be cleaned again and another equipment blank collected. Equipment from an equipment cleaning batch may not be used until analytical results have been received verifying an adequately low level of contamination in the equipment blank.

- Sample containers shall be cleaned in accordance with SW-846 (EPA 1996).

### C1-2c Equipment Testing, Inspection and Maintenance

Prior to initiation of sampling or coring activities, sampling and coring tools shall be tested in accordance with manufacturer specifications to ensure operation within the manufacturer's tolerance limits. Other specifications specific to the sampling operations (e.g., operation of containment structure and safety systems) should also be tested and verified as operating properly prior to initiating coring activities. Coring tools shall be assembled, including liners, and tested. Air-lock mechanisms and rotation mechanisms shall be inspected for free movement of critical parts. Sampling and coring tools found to be malfunctioning shall be repaired or replaced prior to use.

Coring tools and sample collection equipment shall be maintained in accordance with manufacturer's specifications. Clean sampling and coring tools and sampling equipment shall be sealed inside clean protective wrapping and maintained in a clean storage area prior to use. Sampling equipment shall be properly maintained to avoid contamination. A sufficient supply of spare parts should be maintained to prevent delays in sampling activities due to equipment down time. Records of equipment maintenance and repair shall be maintained in the field records in accordance with site SOPs.

Inspection of sampling equipment and work areas shall include the following:

- Sample collection equipment in the immediate area of sample collection shall be inspected daily for cleanliness. Visible contamination on any equipment (e.g., waste on floor of sampling area, hydraulic fluid from hoses) that has the potential to contaminate a waste core or waste sample shall be thoroughly cleaned upon its discovery.

- The waste coring and sampling work areas shall be maintained in clean condition to minimize the potential for cross contamination between waste (including cores) and samples.

- Expendable equipment (e.g., plastic sheeting, plastic gloves) shall be visually inspected for cleanliness prior to use and properly discarded after each sample.

- Prior to removal of the protective wrapping from a coring tool designated for use, the condition of the protective wrapping shall be visually assessed. Coring tools with torn protective wrapping should be returned for cleaning. Coring tools visibly contaminated after the protective wrapping has been removed shall not be used and shall be returned for cleaning or properly discarded.

- Sampling equipment shall be visually inspected prior to use. All sampling equipment that comes into contact with waste samples shall be stored in protective wrapping until use. Prior to removal of the protective wrapping from sampling equipment, the condition of the protective wrapping shall be visually assessed. Sampling equipment with torn protective wrapping should be discarded or returned for cleaning. Sampling equipment visibly contaminated after the protective wrapping has been removed shall not be used and shall be returned for cleaning or properly discarded.

- Cleaned sampling and coring equipment will be physically segregated from all equipment that has been used for a sampling event and has not been decontaminated.

### C1-2d Equipment Calibration and Frequency

The scale used for weighing sub-samples shall be calibrated as necessary to maintain its operation within manufacturer's specification, and after repairs and routine maintenance. Weights used for calibration shall be traceable to a nationally recognized standard. Calibration records shall be maintained in the field records.

## C1-3 Radiography

Radiography has been developed by the Permittees specifically to aid in the examination and identification of containerized waste. The Permittees shall require that sites describe all activities required to achieve the radiography objectives in site QAPjPs and SOPs. These SOPs should include instructions specific to the radiography system(s) used at the site. For example, to detect liquids, some systems require the container to be rotated back and forth while other systems require the container to be tilted.

A radiography system (e.g., real time radiography, digital radiography/computed tomography) normally consists of an X-ray-producing device, an imaging system, an enclosure for radiation protection, a waste container handling system, an audio/video recording system, and an operator control and data acquisition station. Although these six components are required, it is expected there will be some variation within a given component between sites. The radiography system shall have controls or an equivalent process which allow the operator to control image quality. On some radiography systems, it should be possible to vary the voltage, typically between 150 to 400 kilovolts (**kV**), to provide an optimum degree of penetration through the waste. For example, high-density material should be examined with the X-ray device set on the maximum voltage. This ensures maximum penetration through the waste container. Low-density material should be examined at lower voltage settings to improve contrast and image definition. The imaging system typically utilizes either a fluorescent screen and a low-light television camera or x-ray detectors to generate the image.

To perform radiography, the waste container is scanned while the operator views the television screen. A video and audio recording is made of the waste container scan and is maintained as a non-permanent record. A radiography data form is also used to document the Waste Matrix

Code to ensure that the waste container contains no ignitable, corrosive, or reactive waste by documenting the absence of liquids in excess of TSDF-WAC limits or compressed gases, and verify that the physical form of the waste is consistent with the waste stream description documented in the AK Summary. Containers whose contents prevent full examination of the remaining contents shall be subject to visual examination unless the site certifies that visual examination would provide no additional relevant information for that container based on the acceptable knowledge information for the waste stream. Such certification shall be documented in the generator/storage site's record.

For containers which contain classified shapes and undergo radiography, the radiography video and audio recording will be considered classified. The radiography data forms will not contain classified information.

The radiography system involves qualitative and semiquantitative evaluations of visual displays. Operator training and experience are the most important considerations for ensuring quality controls in regard to the operation of the radiography system and for interpretation and disposition of radiography results. Only trained personnel shall be allowed to operate radiography equipment.

Standardized training requirements for radiography operators shall be based upon existing industry standard training requirements.

The Permittees shall require each site to develop a training program that provides radiography operators with both formal and on-the-job (**OJT**) training. Radiography operators shall be instructed in the specific waste generating practices, typical packaging configurations, and associated waste material parameters expected to be found in each Waste Matrix Code at the site. The OJT and apprenticeship shall be conducted by an experienced, qualified radiography operator prior to qualification of the training candidate. The training programs will be site-specific due to differences in equipment, waste configurations, and the level of waste characterization efforts. For example, certain sites use digital radiography equipment, which is more sensitive than real-time radiography equipment. In addition, the particular physical forms and packaging configurations at each site will vary; therefore, radiography operators shall be trained on the types of waste that are generated, stored, and/or characterized at that particular site.

Although the Permittees shall require each site to develop its own training program, all of the radiography QC requirements specified in this WAP shall be incorporated into the training programs and radiography operations. In this way data quality and comparability will not be affected.

Radiography training programs will be the subject of the Audit and Surveillance Program (Permit Attachment C6).

One or more training containers with items (including prohibited items) common to the waste streams to be characterized and internal containers of various sizes shall be scanned semiannually by each operator. The audio and video media shall then be reviewed by a supervisor to ensure that operators' interpretations remain consistent and accurate. Imaging system characteristics shall be verified on a routine basis.

Independent replicate scans and replicate observations of the video output of the radiography process shall be performed under uniform conditions and procedures. Independent replicate scans shall be performed on one waste container per day or once per testing batch, whichever is less frequent, by a qualified radiography operator that was not involved in the original scan of the waste container. Independent observations of one scan (not the replicate scan) shall also be made once per day or once per testing batch, whichever is less frequent, by a qualified radiography operator that was not involved in the original scan of the waste container. A testing batch is a suite of waste containers undergoing radiography using the same testing equipment. A testing batch can be up to 20 waste containers without regard to waste matrix.

Oversight functions include periodic audio/video media reviews of accepted waste containers and shall be performed by qualified radiography operators that were not involved in the original scans of the waste containers. The results of this independent verification shall be available to the radiography operators who performed the original scans. The Permittees shall require the site project manager to be responsible for monitoring the quality of the radiography data and calling for corrective action, when necessary.

## C1-4 Visual Examination

The waste container contents may be verified directly by visual examination (**VE**) of the waste container contents. Visual examination may be performed by physically examining the contents of waste containers to verify the Waste Matrix Code and to verify that the container is properly included in the appropriate waste stream. Visual examination shall be conducted on a waste container to identify and describe all waste items, packaging materials, and waste material parameters in the waste container. Visual examination activities shall be documented on video/audio media, or by using a second operator to provide additional verification by reviewing the contents of the waste container to ensure correct reporting. When VE is performed using a second operator, each operator performing the VE shall observe for themselves the waste being placed in the waste container or the contents within the examined waste container when waste is not removed. The results of all VE shall be documented on VE data forms, which are used to document the Waste Matrix Code, ensure that the waste container contains no ignitable, corrosive, or reactive waste by documenting the absence of liquids in excess of TSDF-WAC limits or compressed gases, and verify that the physical form of the waste is consistent with the waste stream description documented in the AK Summary.

Visual examination recorded on video/audio media shall meet the following minimum requirements:

- The video/audio media shall record the waste packaging event for the container such that all waste items placed into the container are recorded in sufficient detail and shall contain an inventory of waste items in sufficient detail that another trained VE operator can identify the associated waste material parameters.

- The video/audio media shall capture the waste container identification number.

- The personnel loading the waste container shall be identified on the video/audio media or on packaging records traceable to the loading of the waste container.

- The date of loading of the waste container will be recorded on the video/audio media or on packaging records traceable to the loading of the waste container.

Visual examination performed using two generator site personnel shall meet the following minimum requirements:

- At least two generator site personnel who witnessed the packaging of the waste shall approve the data forms or packaging records attesting to the contents of the waste container.

- The data forms or packaging records shall contain an inventory of waste items in sufficient detail that another trained VE operator can identify the associated waste material parameters.

- The waste container identification number shall be recorded on the data forms or packaging records.

Visual examination video/audio media of containers which contain classified shapes shall be considered classified information. Visual examination data forms or packaging records will not contain classified information.

Waste container packaging records may be used to meet the VE data quality objectives (**DQOs**) (Permit Attachment C, Section C-4a(1)). These records must meet the minimum requirements listed above for either VE recorded on video/audio media or VE performed by two generator/storage site personnel, and shall be reviewed by operators trained and qualified to the requirements listed below. The operators will prepare data forms based on the visual examination records. Visual examination batch data reports will be prepared, reviewed, and approved as described in Permit Attachment C, Section C-4, and Permit Attachment C3.

Standardized training for VE shall be developed. Visual examination operators shall be instructed in the specific waste generating processes, typical packaging configurations, and waste material parameters expected to be found in each Waste Matrix Code at the site. The training shall be site specific to include the various waste configurations generated/stored at the site. For example, the particular physical forms and packaging configurations at each site will vary so operators shall be trained to examine the types of waste that are generated, stored, and/or characterized at that particular site. Training will include the following regardless of Summary Category Group:

- Identifying and describing the contents of a waste container by examining all items in waste containers of previously packaged waste

- Identifying when VE cannot be used to meet the DQOs

Visual examination personnel shall be requalified once every two years.

Each VE facility shall designate a VE expert. The VE expert shall be familiar with the waste generating processes that have taken place at that site and also be familiar with all of the types of waste being characterized at that site. The VE expert shall be responsible for the overall direction and implementation of the VE at that facility. The Permittees shall require site QAPjPs to specify the selection, qualification, and training requirements of the VE expert.

## C1-5 Custody of Samples

Chain-of-Custody on field samples (including field QC samples) will be initiated immediately after sample collection or preparation. Sample custody will be maintained by ensuring that samples are custody sealed during shipment to the laboratory. After samples are accepted by the analytical laboratory, custody is maintained by assuring the samples are in the possession of an authorized individual, in that individual's view, in a sealed or locked container controlled by that individual, or in a secure controlled access location. Sample custody will be maintained until the sample is released by the site project manager or until the sample is expended. The Permittees shall require that site QAPjPs or site-specific procedures include a copy of the sample chain-of-custody form and instructions for completing sample chain-of-custody forms in a legally defensible manner. This form will include provisions for each of the following:

- Signature of individual initiating custody control, along with the date and time.
- Documentation of sample numbers for each sample under custody. Sample numbers will be referenced to a specific sampling event description that will identify the sampler(s) through signature, the date and time of sample collection, type/number containers for each sample, sample matrix, preservatives (if applicable), requested methods of analysis, place/address of sample collection and the waste container number.
- For off-site shipping, method of shipping transfer, responsible shipping organization or corporation, and associated air bill or lading number.
- Signatures of custodians relinquishing and receiving custody, along with date and time of the transfer.
- Description of final sample container disposition, along with signature of individual removing sample container from custody.
- Comment section.
- Documentation of discrepancies, breakage or tampering.

All samples and sampling equipment will be identified with unique identification numbers. Sampling Coring tools and equipment will be identified with unique equipment numbers to ensure that all sampling equipment, coring tools, and sampling canisters are traceable to equipment cleaning batches.

All samples will be uniquely identified to ensure the integrity of the sample and can be used to identify the generator/storage site and date of collection. Sample tags or labels will be affixed to all samples and will identify at a minimum:

- Sample ID number
- Sampler initials and organization
- Ambient temperature and pressure (for gas samples only)
- Sample description
- Requested analyses

- Data and time of collection
- QC designation (if applicable)

## C1-6 Sample Packing and Shipping

In the event that the analytical facilities are not at the generator/storage site, the samples shall be packaged and shipped to an off-site laboratory. Sample containers shall be packed to prevent any damage to the sampling container and maintain the preservation temperature, if necessary. Department of Transportation (**DOT**) regulations shall be adhered to for shipment of the package.

When preparing SUMMA® or equivalent canisters for shipment, special care shall be taken with the pressure gauge and the associated connections. Metal boxes which have separate compartments, or cardboard boxes with foam inserts are standard shipping containers. The chosen shipping container shall meet selected DOT regulations. If temperatures shall be maintained, an adequate number of cold packs necessary to maintain the preservation temperature shall be added to the package.

Glass jars are wrapped in bubble wrap or another type of protection. The wrapped jar should be placed in a plastic bag inside of the shipping container, so that if the jar breaks, the inside of the shipping container and the other samples will not be contaminated. The plastic bag will enable the receiving analytical lab to prevent contamination of their shipping and receiving area. Plastic jars do not present a problem for shipping purposes. All shipping containers will contain appropriate blank samples to detect any VOC cross-contamination. A DOT approved cooler, or similar package may be used as the shipping container. If temperatures must be maintained, an adequate number of cold packs necessary to maintain the preservation temperature shall be added to the package. If fill material is needed, compatibility between the samples and the fill should be evaluated prior to use.

All sample containers should be affixed with signed tamper-proof seals or devices so that it is apparent if the sample integrity has been compromised and that the identity of the seal or device is traceable to the individual who affixed the seal. A seal should also be placed on the outside of the shipping container for the same reason. Sample custody documentation shall be placed inside the sealed or locked shipping container, with the current custodian signing to release custody. Transfer of custody is completed when the receiving custodian opens the shipping container and signs the custody documentation. The shipping documentation will serve to track the physical transfer of samples between the two custodians.

A Uniform Hazardous Waste Manifest is not required, since samples are exempted from the definition of hazardous waste under RCRA. All other shipping documentation specified in the site specific SOP for sample shipment (i.e., bill of lading, site-specific shipping documentation) is required.

## C1-7 List of References

Bechtel BWXT Idaho, LLC (BWXT), 2000, Determination of Drum Age Criteria and Prediction Factors Based on Packaging Configurations, INEEL/EXT-2000-01207, October 2000, Liekhus, K.J., S.M. Djordjevic, M. Devarakonda, and M.J. Connolly, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho.

Lockheed Idaho Technologies Company, 1995, Position for Determining Gas Phase Volatile Organic Compound Concentrations in Transuranic Waste Containers, INEL-95/0109/Revision 1, M.J. Connolly, et. al.

U.S. Environmental Protection Agency (EPA), 1999, Compendium of Methods for Determination of Toxic Organic Compounds in Ambient Air (EPA/625/R-96/10b, January 1999).

U.S. Environmental Protection Agency (EPA), 1996. Test Methods for Evaluating Solid Waste, "Laboratory Manual Physical/Chemical Methods, SW-846, 3rd ed., U.S. EPA, OSW and ER, Washington D.C.

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# TABLES

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Table C1-1
Gas Sample Requirements

| **Parameter** | **Container [a]** | **Minimum Drum Headspace Sample Volume [b]** | **Holding Temperatures** |
|---|---|---|---|
| VOCs | SUMMA® Canister | 250 ml | 0-40 °C |

[a] Alternately, canisters that meet QAOs may be used.

[b] Alternatively, if available headspace is limited, a single 100 ml sample may be collected for determination of VOCs.

Table C1-2
Summary of Drum Field QC Headspace Sample Frequencies

| QC Samples | Manifold | Direct Canister | On-Line Systems |
|---|---|---|---|
| Field blanks [a] | 1 per sampling batch [d] | 1 per sampling batch [d] | 1 per on-line batch [f] |
| Equipment blanks [b] | 1 per sampling batch [d] | once [e] | 1 per on-line batch [f] |
| Field reference standards [c] | 1 per sampling batch [d] | once [e] | 1 per on-line batch [f] |
| Field duplicates | 1 per sampling batch [d] | 1 per sampling batch [d] | 1 per on-line batch [f] |

[a] Analysis of field blanks for VOCs (Table C3-2 of Attachment C3), only, is required. For on-line integrated sampling/analysis systems, if field blank results meet the acceptance criterion, a separate on-line blank is not required.

[b] One equipment blank or on-line sample shall be collected, analyzed for VOCs (Table C3-2), and demonstrated clean prior to first use of the headspace gas sampling equipment with each of the sampling heads, then at the specified frequency, for VOCs only thereafter. Daily, prior to work, the sampling manifold, if in use, shall be verified clean using an OVA.

[c] One field reference standard or on-line control sample shall be collected, analyzed, and demonstrated to meet the QAOs specified in Permit Attachment C3 prior to first use, then at the specified frequency thereafter.

[d] A sampling batch is a suite of samples collected consecutively using the same sampling equipment within a specific time period. A sampling batch can be up to 20 samples (excluding field QC samples), all of which shall be collected within 14 days of the first sample in the batch.

[e] One equipment blank and field reference standard shall be collected after equipment purchase, cleaning, and assembly.

[f] An on-line batch is the number of samples collected within a 12-hour period using the same on-line integrated sampling/analysis system. The analytical batch requirements are specified by the analytical method being used in the on-line system.

Table C1-3
Summary of Sampling Quality Control Sample Acceptance Criteria

| QC Sample | Acceptance Criteria | Corrective Action [a] |
|---|---|---|
| Field blanks | VOC amounts ≤ 3 × MDLs in Table C3-2 for GC/MS and GC/FID; < PRQLs in Table C3-2 for FTIRS | Nonconformance if any VOC amount > 3 × MDLs in Table C3-2 for GC/MS and GC/FID; ≥ PRQLs in Table C3-2 for FTIRS |
| Equipment blanks | VOC amounts ≤ 3 × MDLs in Table C3-2 of for GC/MS and GC/FID; < PRQLs in Table C3-2 for FTIRS | Nonconformance if any analyte amount > 3 × MDLs in Table C3-2 for GC/MS and GC/FID; ≥ PRQLs in Table C3-2 for FTIRS |
| Field reference standards or on-line control sample | 70 - 130 %R | Nonconformance if %R < 70 or > 130 |
| Field duplicates or on-line duplicate | RPD ≤ 25 | Nonconformance if RPD > 25 |

[a] Corrective action is only required if the final reported QC sample results do not meet the acceptance criteria.

MDL = Method detection limit

%R = Percent recovery

RPD = Relative percent difference

Table C1-4
Sample Handling Requirements for Homogeneous Solids and Soil/Gravel

| Parameter | Suggested Quantity [a] | Required Preservative | Suggested Container | Maximum Holding Time [b] |
|---|---|---|---|---|
| VOCs | 15 grams | Cool to 4°C | Glass Vial [c] | 14 Days Prep/ 40 Days Analyze [d] |
| SVOCs | 50 grams | Cool to 4°C | Glass Jar [e] | 14 Days Prep/ 40 Days Analyze [d] |
| Metals | 10 grams | Cool to 4°C | Plastic Jar [f] | 180 Days [g] |

[a] Quantity may be increased or decreased according to the requirements of the analytical laboratory, as long as the QAOs are met.

[b] Holding time begins at sample collection (holding times are consistent with SW-846 requirements).

[c] 40-ml VOA vial or other appropriate containers shall have an airtight cap.

[d] 40-day holding time allowable only for methanol extract - 14-day holding time for non-extracted VOCs.

[e] Appropriate containers should be used and should have Teflon® lined caps.

[f] Polyethylene or polypropylene preferred, glass jar is allowable.

[g] Holding time for mercury analysis is 28 days.

Note: Preservation requirements in the most recent version of SW-846 may be used if appropriate.

Table C1-5
Headspace Gas Drum Age Criteria Sampling Scenarios

| Scenario | Description |
| --- | --- |
| 1 | A. Unvented 55-gallon drums without rigid poly liners are sampled through the drum lid at the time of venting.<br>B1. Unvented 55-gallon drums with unvented rigid poly liners are sampled through the rigid poly liner at the time of venting or prior to venting.<br>B2. Vented 55-gallon drums with unvented rigid poly liners are sampled through the rigid poly liner at the time of venting or prior to venting.<br>C. Unvented 55-gallon drums with vented rigid poly liners are sampled through the drum lid at the time of venting. |
| 2 | 55-gallon drums that have met the criteria for Scenario 1 and then are vented, but not sampled at the time of venting. [a] |
| 3 | Containers (i.e., 55-gallon drums, 85-gallon drums, 100-gallon drums, SWBs, TDOPs, SLB2s and pipe components) that are initially packaged in a vented condition and sampled in the container headspace and containers that are not sampled under Scenario 1 or 2. |

[a] Containers that have not met the Scenario 1 DAC at the time of venting must be categorized under Scenario 3. This requires the additional information required of each container in Scenario 3 (i.e., determination of packaging configuration), and such containers can only be sampled after meeting the appropriate Scenario 3 DAC.

Table C1-6
Scenario 1 Drum Age Criteria (in days) Matrix

| Summary Category Group | DAC (Days) |
|---|---|
| S5000 | 53 |

Note: Containers that are sampled using the Scenario 1 DAC do not require information on the packaging configuration because the Scenario 1 DAC are based on a bounding packaging configuration. In addition, information on the rigid liner vent hole presence and diameter do not apply to containers that are sampled using the Scenario 1 DAC because they are unvented prior to sampling.

Table C1-7
Scenario 2 Drum Age Criteria (in days) Matrix

| | **Summary Category Group S5000** | | | |
|---|---|---|---|---|
| **Filter $H_2$ Diffusivity** [a] | **Rigid Liner Vent Hole Diameter (in)** [b] | | | |
| (mol/s/mod fraction) | 0.30 | 0.375 | 0.75 | 1.0 |
| $1.9 \times 10^{-6}$ | 29 | 22 | 13 | 12 |
| $3.7 \times 10^{-6}$ | 25 | 20 | 12 | 11 |
| $3.7 \times 10^{-5}$ | 7 | 6 | 6 | 4 |

[a] The documented filter $H_2$ diffusivity must be greater than or equal to the listed value to use the DAC for the listed filter $H_2$ diffusivity (e.g., a container with a filter $H_2$ diffusivity of $4.2 \times 10^{-6}$ must use a DAC for a filter with a $3.7 \times 10^{-6}$ filter $H_2$ diffusivity). If a filter $H_2$ diffusivity for a container is undocumented or unknown or is less than $1.9 \times 10^{-6}$ filter $H_2$ diffusivity, a filter of known $H_2$ diffusivity that is greater than or equal to $1.9 \times 10^{-6}$ filter $H_2$ diffusivity must be installed prior to initiation of the relevant DAC period.

[b] The documented rigid liner vent hole diameter must be greater than or equal to the listed value to use the DAC for the listed rigid liner vent hole diameter (e.g., a container with a rigid liner vent hole of 0.5 in. must use a DAC for a rigid liner vent hole of 0.375 in.). If the rigid liner vent hole diameter for a container is undocumented during packaging (Attachment C, Section C-3d(1)), repackaging (Attachment C, Section C-3d(1)), and/or venting (Section C1-1a[4][ii]), that container must use a DAC for a rigid liner vent hole diameter of 0.30 in.

Note: Containers that are sampled using the Scenario 2 DAC do not require information on the packaging configuration because the Scenario 2 DAC are based on a bounding packaging configuration.

Table C1-8
Scenario 3 Packaging Configuration Groups

| Packaging Configuration Group | Covered S5000 Packaging Configuration Groups |
|---|---|
| Packaging Configuration Group 1, 55-gal drums [a] | • No layers of confinement, filtered inner lid [b]<br>• No inner bags, no liner bags (bounding case) |
| Packaging Configuration Group 2, 55-gal drums [a] | • 1 inner bag<br>• 1 filtered inner bag<br>• 1 liner bag<br>• 1 filtered liner bag<br>• 1 inner bag, 1 liner bag<br>• 1 filtered inner bag, 1 filtered liner bag<br>• 2 inner bags<br>• 2 filtered inner bags<br>• 2 inner bags, 1 liner bag<br>• 2 filtered inner bags, 1 filtered liner bag<br>• 3 inner bags<br>• 3 filtered inner bags<br>• 3 filtered inner bags, 1 filtered liner bag<br>• 3 inner bags, 1 liner bag (bounding case) |
| Packaging Configuration Group 3, 55-gal drums [a] | • 2 liner bags<br>• 2 filtered liner bags<br>• 1 inner bag, 2 liner bags<br>• 1 filtered inner bag, 2 filtered liner bags<br>• 2 inner bags, 2 liner bags<br>• 2 filtered inner bags, 2 filtered liner bags<br>• 3 filtered inner bags, 2 filtered liner bags<br>• 4 inner bags<br>• 3 inner bags, 2 liner bags<br>• 4 inner bags, 2 liner bags (bounding case) |
| Packaging Configuration Group 4, pipe components | • No layers of confinement inside a pipe component<br>• 1 filtered inner bag, 1 filtered metal can inside a pipe component<br>• 2 inner bags inside a pipe component<br>• 2 filtered inner bags inside a pipe component<br>• 2 filtered inner bags, 1 filtered metal can inside a pipe component<br>• 2 inner bags, 1 filtered metal can inside a pipe component (bounding case) |
| Packaging Configuration Group 5, Standard Waste Box, Ten-Drum Overpack, or Standard Large Box 2 [a] | • No layers of confinement<br>• 1 SWB liner bag (bounding case) |
| Packaging Configuration Group 6, Standard Waste Box, Ten-Drum Overpack, or Standard Large Box 2 [a] | • any combination of inner and/or liner bags that is less than or equal to 6<br>• 5 inner bags, 1 SWB liner bag (bounding case) |

| Packaging Configuration Group | Covered S5000 Packaging Configuration Groups |
|---|---|
| Packaging Configuration Group 7, 85-gal. drums and 100-gal. drums [a] | • No inner bags, no liner bags, no rigid liner, filtered inner lid (bounding case) [b]<br>• No inner bags, no liner bags, no rigid liner |
| Packaging Configuration Group 8, 85-gal. drums and 100-gal. drums [a] | • 4 inner bags and 2 liner bags, no rigid liner, filtered inner lid (bounding case) [b] |

[a] If a specific Packaging Configuration Groups cannot be determined based on the data collected during packaging and/or repackaging, a conservative default Packaging Configuration Group of 3 for 55-gallon drums, 6 for SWBs, TDOPs, and SLB2s, and 8 for 85-gallon and 100-gallon drums must be assigned provided the drums do not contain pipe component packaging. If pipe components are present as packaging in the drums, the pipe components must be sampled following the requirements for Packaging Configuration Group 4.

[b] A “filtered inner lid” is the inner lid on a double lid drum that contains a filter.

Definitions:

Liner Bags: One or more optional plastic bags that are used to control radiological contamination. Liner bags for drums have a thickness of approximately 11 mils. Liner bags are typically similar in size to the container. SWB liner bags have a thickness of approximately 14 mils. TDOPs and SLB2s use SWB liner bags.

Inner Bags: One or more optional plastic bags that are used to control radiological contamination. Inner bags have a thickness of approximately 5 mils and are typically smaller than liner bags.

Table C1-9
Scenario 3 Drum Age Criteria (In Days) Matrix for S5000 Waste by Packaging Configuration Group

**Packaging Configuration Group 1**

| Filter $H_2$ Diffusivity [a] (mol/s/mol fraction) | Rigid Liner Vent Hole Diameter [b] | | | | No Liner Lid | No Liner |
|---|---|---|---|---|---|---|
| | 0.3-inch Diameter Hole | 0.375-inch Diameter Hole | 0.75-inch Diameter Hole | 1-inch Diameter Hole | | |
| $1.9 \times 10^{-6}$ | 131 | 95 | 37 | 24 | 4 | 4 |
| $3.7 \times 10^{-6}$ | 111 | 85 | 36 | 24 | 4 | 4 |
| $3.7 \times 10^{-5}$ | 28 | 28 | 23 | 19 | 4 | 4 |

**Packaging Configuration Group 2**

| Filter $H_2$ Diffusivity [a] (mol/s/mol fraction) | Rigid Liner Vent Hole Diameter [b] | | | | No Liner Lid | No Liner |
|---|---|---|---|---|---|---|
| | 0.3-inch Diameter Hole | 0.375-inch Diameter Hole | 0.75-inch Diameter Hole | 1-inch Diameter Hole | | |
| $1.9 \times 10^{-6}$ | 175 | 138 | 75 | 60 | 30 | 11 |
| $3.7 \times 10^{-6}$ | 152 | 126 | 73 | 59 | 30 | 11 |
| $3.7 \times 10^{-5}$ | 58 | 57 | 52 | 47 | 28 | 8 |

**Packaging Configuration Group 3**

| Filter $H_2$ Diffusivity [a] (mol/s/mol fraction) | Rigid Liner Vent Hole Diameter [b] | | | | No Liner Lid | No Liner |
|---|---|---|---|---|---|---|
| | 0.3-inch Diameter Hole | 0.375-inch Diameter Hole | 0.75-inch Diameter Hole | 1-inch Diameter Hole | | |
| $1.9 \times 10^{-6}$ | 199 | 161 | 96 | 80 | 46 | 16 |
| $3.7 \times 10^{-6}$ | 175 | 148 | 93 | 79 | 46 | 16 |
| $3.7 \times 10^{-5}$ | 72 | 72 | 67 | 62 | 42 | 10 |

**Packaging Configuration Group 4**

| Filter $H_2$ Diffusivity [a] (mol/s/mol fraction) | Headspace Sample Taken Inside Pipe Component |
|---|---|
| $> 1.9 \times 10^{-6}$ | 152 |

**Packaging Configuration Group 5**

| Filter $H_2$ Diffusivity [a, c] (mol/s/mol fraction) | Headspace Sample Taken Inside SWB/TDOP/SLB2 |
|---|---|
| $> 7.4 \times 10^{-6}$ (SWB) | 15 |
| $3.33 \times 10^{-5}$ (TDOP) | 15 |
| $6.60 \times 10^{-4}$ (SLB2) | 21 |

**Packaging Configuration Group 6**

| Filter $H_2$ Diffusivity [a, c] (mol/s/mol fraction) | Headspace Sample Taken Inside SWB/TDOP/SLB2 |
|---|---|
| > $7.4 \times 10^{-6}$ (SWB) | 56 |
| $3.33 \times 10^{-5}$ (TDOP) | 56 |
| $6.60 \times 10^{-4}$ (SLB2) | 56 |

**Packaging Configuration Group 7 [d]**

| Filter $H_2$ Diffusivity [a] (mol/s/mol fraction) | Inner Lid Filter Vent Minimum $H_2$ Diffusivity (mol/s/mol fraction) [a] | | |
|---|---|---|---|
| | $7.4 \times 10^{-6}$ | $1.85 \times 10^{-5}$ | $9.25 \times 10^{-5}$ [e] |
| $3.7 \times 10^{-6}$ | 13 | 7 | 2 |
| $7.4 \times 10^{-6}$ | 10 | 6 | 2 |
| $1.85 \times 10^{-5}$ | 6 | 4 | 2 |

**Packaging Configuration Group 8**

| Filter $H_2$ Diffusivity [a] (mol/s/mol fraction) | Inner Lid Filter Vent Minimum $H_2$ Diffusivity (mol/s/mol fraction) |
|---|---|
| | $7.4 \times 10^{-6}$ |
| $3.7 \times 10^{-6}$ | 21 |

[a] The documented filter $H_2$ diffusivity must be greater than or equal to the listed value to use the DAC for the listed filter $H_2$ diffusivity (e.g., a container with a filter $H_2$ diffusivity of $4.2 \times 10^{-6}$ must use a DAC for a filter with a $3.7 \times 10^{-6}$ filter $H_2$ diffusivity). If a filter $H_2$ diffusivity for a container is undocumented or unknown or is less than $1.9 \times 10^{-6}$ filter $H_2$ diffusivity, a filter of known $H_2$ diffusivity that is greater than or equal to $1.9 \times 10^{-6}$ filter $H_2$ diffusivity must be installed prior to initiation of the relevant DAC period.

[b] The documented rigid liner vent hole diameter must be greater than or equal to the listed value to use the DAC for the listed rigid liner vent hole diameter (e.g., a container with a rigid liner vent hole of 0.5 in. must use a DAC for a rigid liner vent hole of 0.375 in.). If the rigid liner vent hole diameter for a container is undocumented during packaging, repackaging, and/or venting (Section C1-1a[4][ii]), that container must use a DAC for a rigid liner vent hole diameter of 0.30 in.

[c] The filter $H_2$ diffusivity for SWBs, TDOPs, or SLB2s is the sum of the diffusivities for all of the filters on the container because SWBs, TDOPs, and SLB2s have more than 1 filter.

[d] Headspace sample taken between inner and outer drum lids. If headspace sample is taken inside the filtered inner drum lid prior to placement of the outer drum lid, then a DAC value of 2 days may be used. Footnote e is also applicable. Packaging Configuration Group 7 DAC values apply to drums with up to two lids.

[e] While a DAC value of 2 days may be determined, containers must comply with the equilibrium requirements specified in Section C1-1a (i.e., 72 hours at 18°C or higher). The equilibrium requirement for headspace gas sampling shall be met separately.

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# FIGURES

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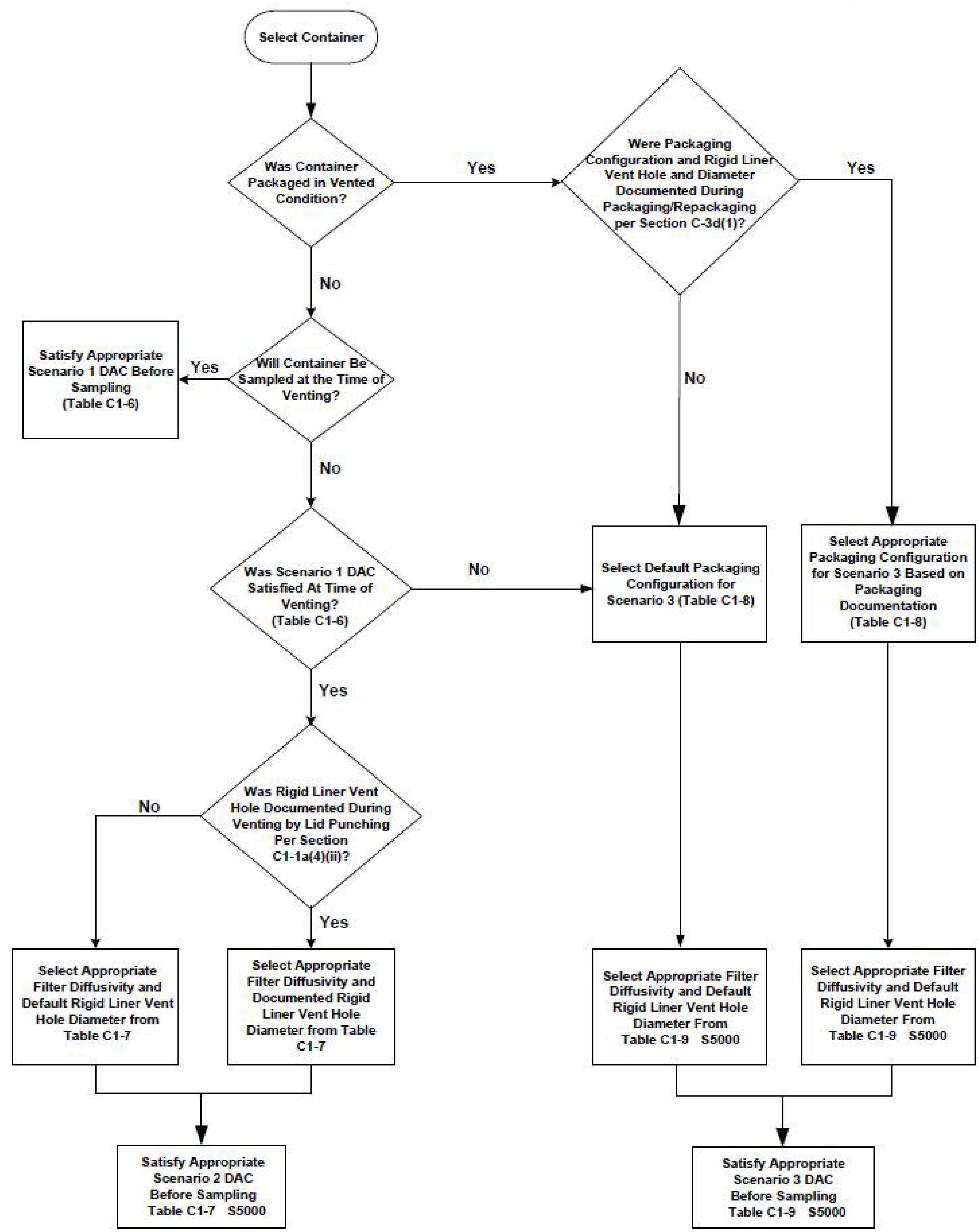


Figure C1-1
Headspace Gas Drum Age Criteria Sampling Scenario Selection Process

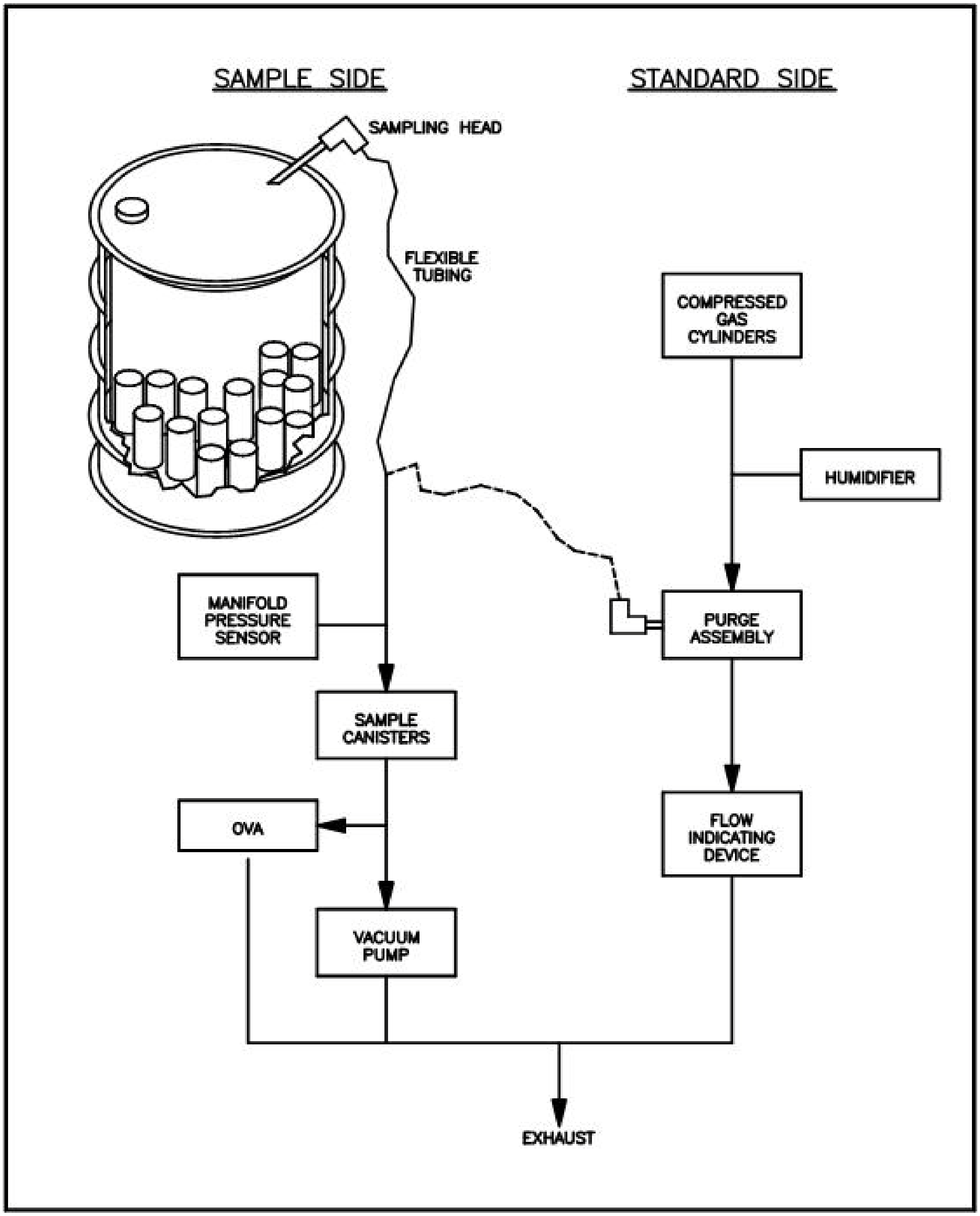


Figure C1-2
Headspace Sampling Manifold

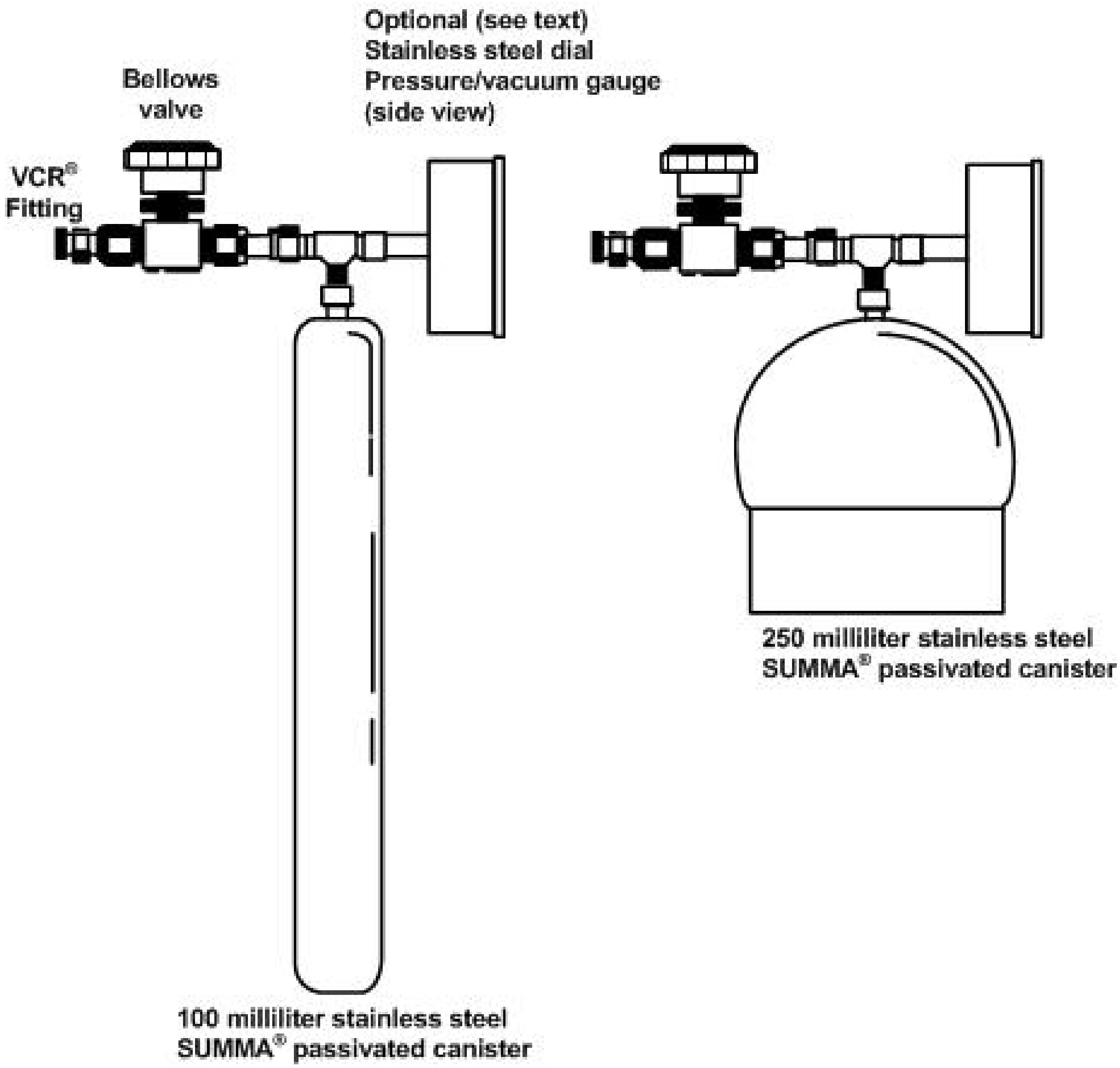


Figure C1-3
SUMMA® Canister Components Configuration (Not to Scale)

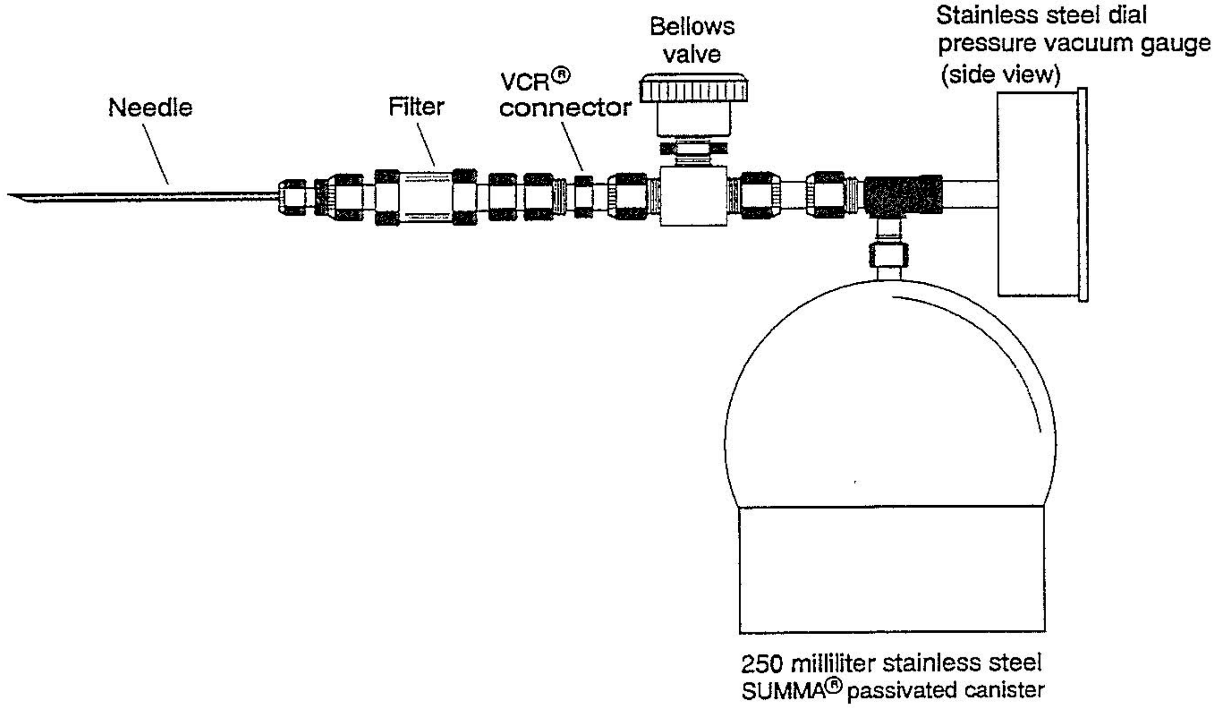


Figure C1-4
Schematic Diagram of Direct Canister with the Poly Bag Sampling Head

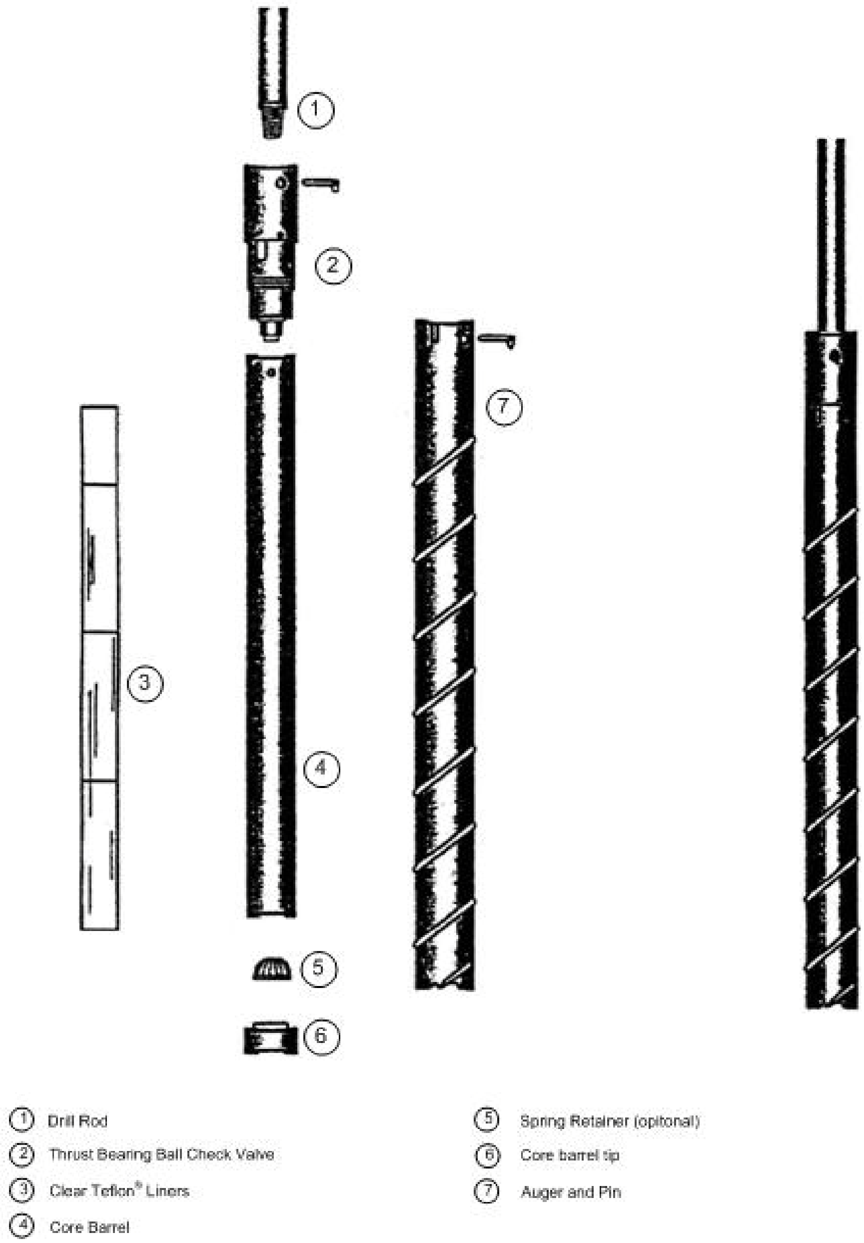


Figure C1-5
Rotational Coring Tool (Light Weight Auger)

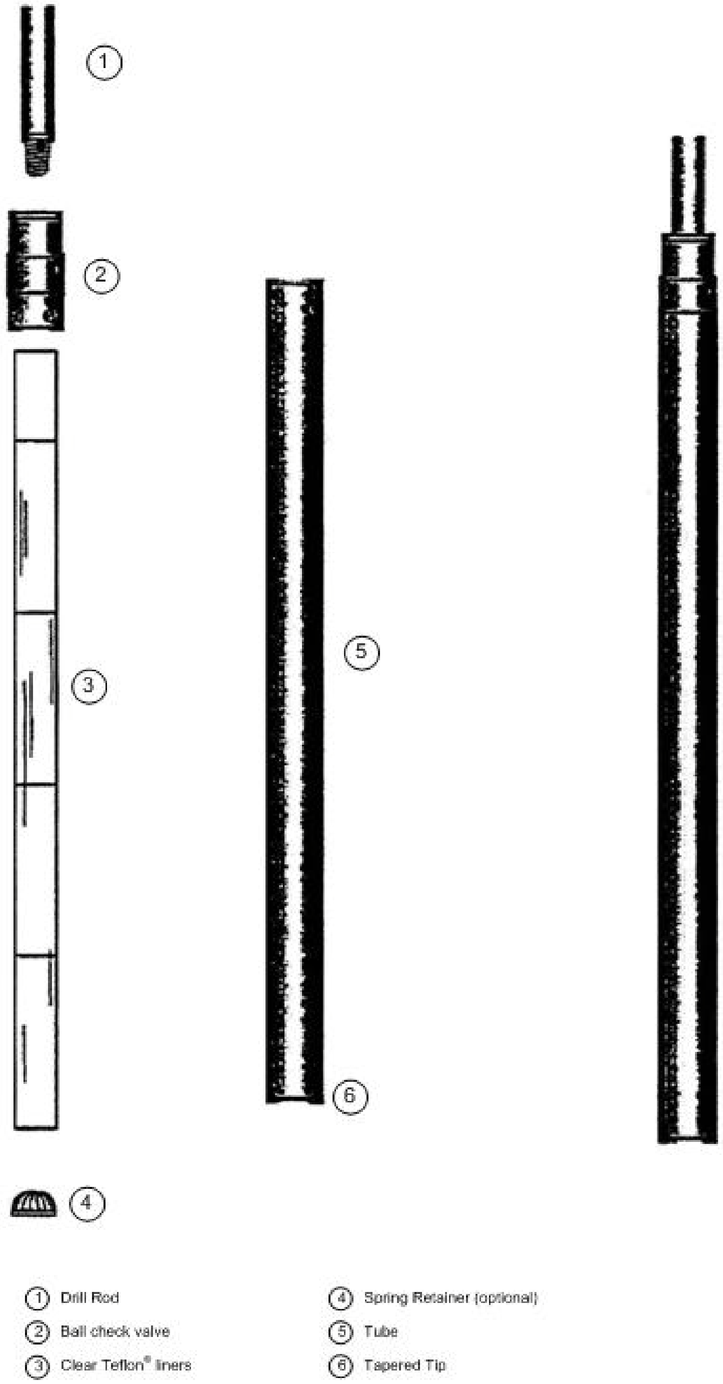


Figure C1-6
Non-Rotational Coring Tool (Thin Walled Sampler)