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Standard Practice for Sampling Surface Soil for Radionuclides[1]

This standard is issued under the fixed designation C 998; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the sampling of surface soil for the purpose of obtaining a sample representative of a particular area for subsequent chemical analysis of selected radionuclides. This practice describes one acceptable approach to collect soil samples for radiochemical analysis.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 420 Guide to Site Characterization for Engineering, Design, and Construction Purposes[2]

D 1129 Terminology Relating to Water[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *sampling*—obtaining a representative portion of the material concerned (see Terminology D 1129).

4. Summary of Practice

4.1 Guidance is provided for the collection of soil samples to a depth of 50 mm. Ten core samples are collected in a specified pattern and composited to obtain sufficient sample so as to be representative of the area.

5. Significance and Use

5.1 Soil provides a source material for the determination of selected radionuclides and serves as an integrator of the deposition of airborne materials. Soil sampling should not be used as the primary measurement system to demonstrate compliance with applicable radionuclides in air standards. This should be done by air sampling or by measuring emission rates. Soil sampling does serve as a secondary system, and in many cases, is the only available avenue if insufficient air sampling occurred at the time of an incident. For many insoluble radionuclides, the primary exposure pathway to the general population is by inhalation. The resuspension of transuranic elements has received considerable attention **(1, 2)**[4] and their measurement in soil is one means of establishing compliance with the U.S. Environmental Protection Agency (EPA) guidelines on exposure to transuranic elements. Soil sampling can provide useful information for other purposes, such as plant uptake studies, total inventory of various radionuclides in soil due to atmospheric nuclear tests, and the accumulation of radionuclides as a function of time. A soil sampling and analysis program as part of a preoperational environmental monitoring program serves to establish baseline concentrations. Consideration was given to these criteria in preparing this practice.

5.2 Soil collected by this practice and subsequent analysis is used to monitor radionuclide deposition of emissions from nuclear facilities. The critical factors necessary to provide this information are sampling location, time of sampling, frequency of sampling, sample size, and maintenance of the integrity of the sample prior to analysis. Since the soil is considered to be a heterogeneous medium, multipoint sampling is necessary. The samples must represent the conditions existing in the area for which data are desired.

6. Apparatus

6.1 *Sampling Instrument*[5]—In order to standardize the sample collection, it is suggested that the coring tool be that instrument used by golf courses to place the hole in the putting green. This instrument is commercially available at reasonable cost, has approximately a 0.105-m diameter barrel, and can take samples down to 0.3 m. An illustration of the sampling instrument and its use is provided in Fig. 1.

6.2 *Sample Container*, such as metal cans with lids, plastic bags, etc.

6.3 *Meter Stick*.

6.4 *Small Scoop*.

7. Sampling

7.1 *Introduction*— The sampling depth for this practice is the top 50 mm of soil. Experience has shown this depth is best

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[1] This practice is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.05 on Test Methods.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 11.01.

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

[5] Model 28200 Scalloped Style of the Standard Manufacturing Company of Cedar Falls, IA, or its equivalent, has been found satisfactory for this purpose.

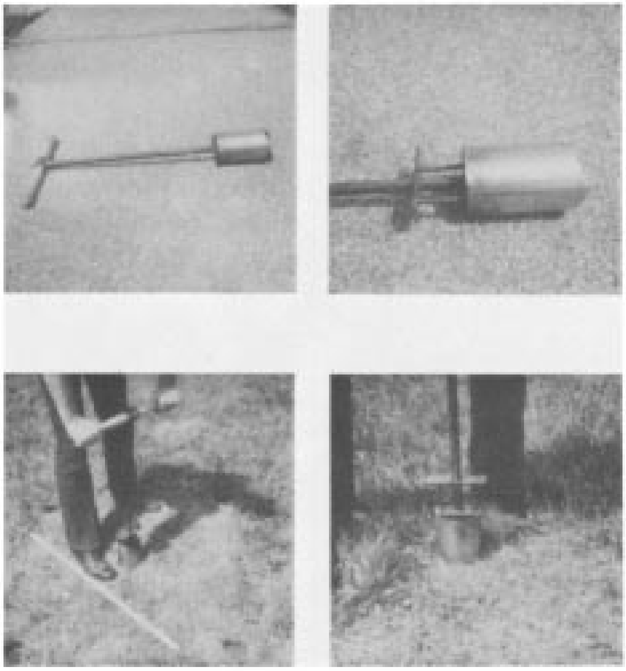

FIG. 1 Soil Sampling Instrument and Use

for this purpose **(3)** and provides samples for the analysis of deposited radionuclides following a recent airborne release. The difference in concentration from previously collected samples at the same locations would be a measure of the contamination. If the purpose of the sampling is to measure the total amount of a radionuclide deposited onto the soil, that is, from fallout of previous atmospheric nuclear tests, then sampling must be conducted to an 0.3-m depth. It is recommended by the EPA **(2)** that soil sampling for plutonium be the top 10 mm of soil. Although this may be a desirable depth for resuspension studies in certain parts of the country that have powdery, dry, loose, sandy soils, in most areas, the vegetative cover and root mat make this an unworkable sampling depth. Because the data may be used in various ways, it is important to accurately record the sample location, the depth of the sample, and the sample weight. In order to obtain sufficient sample to be representative of the area, due to the inherent heterogeneity of soil, it is recommended that a total sampling area of greater than 0.05 m^2 be collected as described in Section 8.

7.2 *Site Selection*:

7.2.1 As an idealized guideline, each site should be selected on the basis that the soil appears, or was known to have been, undisturbed for a number of years. Open, level, grassy areas that are mowed at reasonable intervals, such as public parks, are suitable choices. The site should have moderate to good permeability and there should be little or no runoff during heavy rains. The site should not be near enough to buildings, trees, or other obstructions that it is sheltered or shielded. High earthworm activity or aeration of the root zone may result in uneven mixing of the surface soil and, therefore, this type of site should be avoided. Care should be taken not to select a site that is fertilized or watered with sources that may add radioactive materials to the soil, that is, some fertilizers have high uranium concentrations. It is important to be able to accurately describe the location at which the sample was collected if it becomes necessary to return and resample the location.

7.2.2 The number of sites sampled is determined by the purpose of the sampling and the information required from the particular analysis. If the sampling is part of a preoperational survey around a facility, one acceptable distribution is that proposed in HASL-300 **(4)** and depicted in Fig. 2. This distribution of 13 sampling sites extending up to 10 km in the downwind direction from the facility should be adequate to provide the background concentration of the nuclides of interest. Sampling for other purposes may require other distribution of sites, while sampling to define the distribution of a nuclide from a specific incident would require extensive knowledge of meteorological and climatological factors. It is important that the purpose of the sampling dictate the sample distribution.

8. Procedure

8.1 *Sampling Procedure*:

8.1.1 Select the sampling location based on Section 7.

8.1.2 Measure out two 1-m^2 areas, about 3 m apart.

8.1.3 Remove all vegetation to a height of 10 to 20 mm above the soil and save if desired.

8.1.4 Collect soil from the center and each corner of the two 1-m^2 areas.

8.1.5 Insert the sampling tool to a depth of 50 mm below the soil surface and remove the soil plug.

8.1.6 Place the soil plug and residual vegetation and roots in an appropriate container.

8.1.7 Repeat the procedure until the ten cores are collected. Composite the ten cores as one sample.

8.1.8 Label the container with such information as location, time, date, collector, depth of core, and area sampled.

8.1.9 Clean the sampling tools in water and detergent and dry before collecting the next sample.

8.2 *Sampling Rationale*—The intent of the sampling procedure is to define the operational steps necessary to collect a representative sample from a desired location. The selection of the sampling tool should be dictated by local soil conditions as

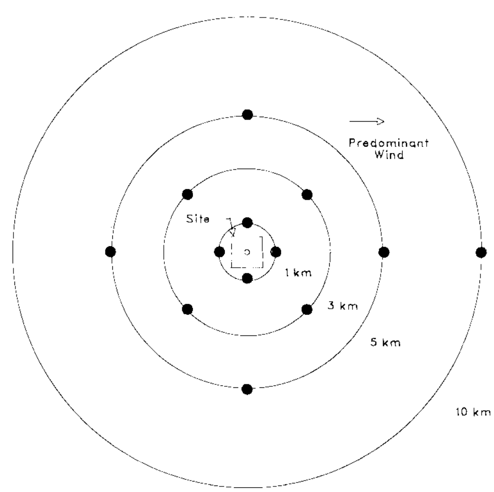

FIG. 2 Soil Sampling Pattern

it is not the intent of this practice to identify one instrument to the exclusion of all others. However, two common procedures, or variations thereof, are most frequently used. These two procedures are the core procedure and the ring procedure. Because of the large variation in soil types, the core method described in HASL-300 **(4)** is recommended where applicable, and a ring method used by the Nevada Applied Ecology Group (NAEG) is offered as an option **(5)** for dry, sandy soils. The concepts and techniques in this practice are applicable to most situations requiring sampling surface soil for radionuclides.

8.3 *Core Procedure*— The collection of ten cores will sample about 0.086 m^2 of soil surface. Composite the ten cores to produce a single sample of about 4 to 5 kg. Most soils contain sufficient moisture to be cohesive and the plug can be removed intact. For some types of dry, loose soils, wetting the ground by sprinkling prior to sampling may allow the plug to be removed. Place the plugs in a container, seal, and carefully label. Clean the sampling tools in water and detergent and dry before proceeding to the next sample collection site.

8.4 *Ring Procedure*— For the dry, loose, sandy soil for which the core method is not applicable, press a ring, 100 mm in diameter and 50 mm deep, into the soil. Remove the soil inside the ring with a small scoop to a depth of 50 mm and place into a container. Repeat this until a total of ten cores are collected, using the procedure outlined in Section 7 for sample location selection. Clean the sampling tools in water and detergent and dry before proceeding to the next sample collection site.

9. Discussion

9.1 Either method works well for fine-grained soils, but difficulties occur with rocky soils. For samples in which plutonium is the element of interest, the rocks may be considered voids in the sample and usually are discarded during sample preparation. If this is the case, larger numbers of cores, and therefore larger areas, should be sampled to ensure that the sample is representative of the site.

9.2 The sampling techniques described in this practice will provide sufficient information to allow the calculation of results in terms of deposition per unit area or concentration. If the sampling is part of a routine monitoring program, it may be necessary to repeat the sampling at each location and compare results to determine the effect of facility operation.

10. Keywords

10.1 environmental; radionuclides; sampling; soil

REFERENCES

(**1**) "Proposed Guidance on Dose Limits for Persons Exposed to Transuranium Elements in the General Environment," Environmental Protection Agency 520/4-77-016, October 1977.

(**2**) "Persons Exposed to Transuranium Elements in the Environment," Federal Register, Vol 42, No. 230, Nov. 30, 1977.

(**3**) "Measurements of Radionuclides in the Environment: Sampling and Analysis of Plutonium in Soil," Atomic Energy Commission Regulatory Guide 4.5, May 1974.

(**4**) Harley, J. H., ed, "EML Procedures Manual," D.O.E. Report HASL-300, August 1979.

(**5**) Fowler, F. B., Gilbert, R. O., and Essington, E. H.," Sampling of Soils for Radioactivity: Philosophy, Experience, and Results," Atmospheric-Surface Exchange of Particulate and Gaseous Pollutants, ERDA Symposium Series 38, 1974, pp 706–727.