Designation: ~~D6640 – 01 (Reapproved 2015)~~ D6640 – 21

Standard Practice for Collection and Handling of Soils Obtained in Core Barrel Samplers for Environmental Investigations[1]

This standard is issued under the fixed designation D6640; 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 procedures for obtaining soils from core barrel samplers for chemical and physical analysis, with an emphasis on the collection and handling procedures that maintain the representativeness of the chemical contaminants of concern. Core barrel samplers are initially empty (hollow) until they are pushed into the ground to collect and retrieve a cylindrical soil sample with minimal disturbance. The selection of equipment and the sample handling procedures are dependent on the soil properties, the depth of sampling, and the general properties of the chemical contaminants of concern, that is, volatile organic compounds, semi-volatile organic compounds, and inorganic constituents. The sampling procedures described are designed to maintain representative concentrations of the contaminants regardless of their physical state(s), that is, solid, liquid, or gas.

1.2 This practice covers soil samplers used in Guide D6169 on soils and rock sampling and included in Guide D6232 for waste sampling. Guide D6169 provides additional information on samplers and procedures that will preserve representative contaminate concentrations. Guide D6282 is on direct-push soil samplers that are most frequently used for environmental work. Guide D4547 addresses special sampling of soils for volatile compounds. This standard does not include sediment samplers in Guide D4823, but the same principles may apply to handling of those cores. Guide D4700 includes information on shallow manual push soil samplers.

1.3 ~~Four~~Five general types of core barrel samplers are discussed in this practice: split-barrel, soil corer, ring-lined barrel, thin-walled tube, and solid-barrel samplers.

1.4 This document does not cover all the core barrel devices that are available for the collection of soil samples.

1.5 The procedures described may or may not be applicable to handling of samples for assessing certain geotechnical properties, for example, soil porosity.

NOTE 1—Prior to commencement of any intrusive exploration, the site should be checked for underground utilities.

1.6 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard. All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026. Reporting of test results in units other than SI shall not be regarded as nonconformance with this standard.

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

[1] This practice is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.01.03 on Sampling Equipment.

Current edition approved ~~Sept. 1, 2015~~Oct. 1, 2021. Published ~~September 2015~~October 2021. Originally approved in 2001. Last previous edition approved in ~~2010~~2015 as D6640 – 01 ~~(2010).~~(2015). DOI: ~~10.1520/D6640-01R15.~~10.1520/D6640-21.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D1586 Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
D1587 Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes
D3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
D3694 Practices for Preparation of Sample Containers and for Preservation of Organic Constituents
D4547 Guide for Sampling Waste and Soils for Volatile Organic Compounds
D4687 Guide for General Planning of Waste Sampling
D4700 Guide for Soil Sampling from the Vadose Zone
D4823 Guide for Core Sampling Submerged, Unconsolidated Sediments
D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
D5681 Terminology for Waste and Waste Management
D5784 Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water Quality Monitoring Devices
D5792 Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives
D5875 Guide for Use of Cable-Tool Drilling and Sampling Methods for Geoenvironmental Exploration and Installation of Subsurface Water Quality Monitoring Devices
D5876 Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices
D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data
D6051 Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities
D6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
D6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations
D6232 Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities
D6282 Guide for Direct Push Soil Sampling for Environmental Site Characterizations
D6286 Guide for Selection of Drilling and Direct Push Methods for Geotechnical and Environmental Subsurface Site Characterization
D8170 Guide for Using Disposable Handheld Soil Core Samplers for the Collection and Storage of Soil for Volatile Organic Analysis

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this standard, see Terminology D5681.

3.1.2 *PFAS, n*—per- and polyfluorinated akyl substances: a group of man-made chemicals that includes PFOA (perfluorooctanoate acid), PFOS (perfluorooctane sulfonate), GenX, and many other chemicals.

3.1.2.1 *Discussion*—

PFAS include thousands of fluorinated compounds that have been manufactured and used in a variety of industries around the globe, including in the United States, since the 1940s. PFAS are bioaccumulative and very persistent in the environment under natural conditions due to their strong carbon-fluorine bonds. PFAS can be found in consumer products (for example, stain and water repellants and nonstick cookware) and non-consumer products, including aqueous fire-fighting foams (AFFF) previously used at military and commercial airports. A common PFAS is polytetrafluorethylene (PTFE), which should be excluded from use when PFAS sampling is conducted.

4. Summary of Practice

4.1 Obtaining soil samples from the surface and subsurface for chemical and physical analysis often involves the advancement

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

of a core barrel sampler into the ground. A core barrel sampler can be operated by hand or mechanically, and it may be of a closed or open design ~~(Guide~~(Guides D6169 and D6282). Once the core barrel has been filled, the sampler is recovered from the bore hole and the soil sample is handled appropriately for the chemical constituents of concern.

4.2 This practice describes collection and handling procedures used with four types of core barrel samplers. The standards related to data quality objectives (Practice D5792), equipment specifications (Guides D6286, D6232, D6169, D4700~~and~~, and ~~D4700~~D4823), their limitations and advantages ~~(Guide~~(Guides D6282 and D6232), and the site-specific geological and hydrological data should be reviewed to determine the soil coring equipment that is best suited for a specific project.

5. Significance and Use

5.1 Often during environmental investigations, soils are analyzed after being collected from the surface, the vadose zone (Terminology D653~~)~~), and sometimes from below the ~~ground water~~ groundwater table to identify and quantify the presence of a chemical contaminant. A contaminant is a substance that is typically hazardous and either is not normally present or that occurs naturally but is of an uncharacteristically high concentration (Guide D4687). A three-dimensional spatial array of samples can often provide information as to the source and route(s) of migration of the contaminant. The resultant information is used to direct remedial and corrective actions or can be used for monitoring purposes. Obtaining a soil sample with a core barrel sampler involves driving this device into the ground and then retrieving it for sample processing. Several methods for advancing a core barrel are generally acceptable (for example, Test Method D1586~~, Practice~~; Practices D1587, ~~Practice~~ D3550, ~~Guide~~and ~~D4700~~D6151~~, Guide~~; Guides D5784, ~~Guide~~ D5875, ~~Guide~~ D5876, ~~Practice~~ ~~D6151~~D6169, ~~Guide~~and D6282~~, and Guide D6286~~). Drilling methods that use drilling fluids (liquids or air) should be avoided because they are more susceptible to cross-contamination ~~(See~~(Guide D6286) (see ~~5.1.6~~6.1.6).

5.2 If samples are to be collected for the determination of per- and poly-fluorinated alkyl substances (PFAS), all sampling equipment should be made of fluorine-free materials. Other considerations for PFAS sampling may exist but are beyond the scope of this standard.

6. Equipment Selection Criteria

6.1 Important criteria to consider when selecting a core barrel sampler for soil sampling are:

6.1.1 The materials that come into direct contact with the soil sample (barrel or barrel liner) should be compatible with the chemical or physical properties of the contaminant(s) of concern and the chemical properties of the soil. As a general rule, samples obtained for semi-volatile organic compound analysis can be obtained within a core barrel or core barrel liner that is composed of stainless steel, steel, or brass. When only inorganic constituents are of concern, a plastic core barrel liner would be more appropriate than the previously cited materials. All of these materials are suitable for volatile organic compounds as long as the contact time is minimized. Often all of the above samples (semi-volatile organic, inorganic, and volatile organic compounds) are obtained from a single soil core. In this situation, soils should be taken from the interior of the soil core to avoid potential interferences between the contaminants of concern and the surface of the core barrel that is in direct contact with the sample.

6.1.2 The design of the core barrel sampler should allow for easy access to the sampled substrate for all subsequent handling procedures.

6.1.3 Core barrel size requirements depend on the type and number of chemical constituents of concern. For example, more soil is needed for the collection of samples intended for semi-volatile organic compound analysis than for the analysis of volatile organic compounds or inorganic constituents, or both. Typically, a 250-mL (8-oz) bottle is filled for the analysis of semi-volatile organic compounds, a 125-mL (4-oz) bottle for inorganic constituents, and only 5-g subsamples are taken for volatile organic compounds.

6.1.4 Suitability for soil type, that is, grain size, cohesion properties, and moisture content. For example, when sampling non-cohesive materials or when sampling below the water table, a core catcher (basket) should be used to limit the loss of sample and ~~ground water~~ groundwater during retrieval (Guides ~~D4700~~D6169 and D6282).

6.1.5 The spreading of contamination between sampling depths should be minimized. Sealed hollow-barrel samplers (~~6.1.4~~7.1.5) or cased bore holes (7.1.7) and proper advancement techniques should be used to limit cross-contamination between sampling depths in the vadose zone. To avoid cross-contamination, open-barrel samplers (7.1.1 – 7.1.3) should not be used in uncased bore holes. Although a cased bore hole does not guarantee that contamination will not be spread from one sampling depth to another,

it lowers the possibility and eliminates the potential for bore hole collapse and ~~side wall~~ sidewall slough that can compromise the integrity of the samples removed from uncased bore holes. When there is standing ~~ground water~~ groundwater in the bore hole, a sealed sampler system should be used.

6.1.6 Other criteria that should be considered when selecting a core barrel sampler for soil sampling include sampling depth (see Guide D6286~~,~~ for selection of drilling method), site accessibility, time constraints, and appropriate equipment availability.

7. Sampling Equipment

7.1 The types of core barrel samplers discussed in this practice are the split-barrel, ring-lined barrel, thin-walled tube, and sealed or unsealed solid-barrel samplers. These samplers are part of equipment that is either manually or mechanically powered, are designed to excavate a bore hole to the sampling depth, and may remain in the bore hole during the sample collection activity (that is, cased bore hole or dual-walled casing).

7.1.1 *Split-Barrel ~~Sampler—~~Sampler, Direct Push—*As described in Test Method D1586 and Guide ~~D4700~~D6169, the split-barrel sampler is composed of a core barrel cut in half along the length of the barrel, a hardened metal drive shoe (cutting ~~tip)~~tip), and a sample head that vents (for example, a ball check valve) to allow air to be displaced as it is filled (see Fig. 1). The shoe and the head thread onto opposite ends of the split barrel and hold the two halves together. A common barrel size is 5.08 cm (2 in.) outside diameter and 3.81 cm (1.5 in.) inside diameter. The drive shoe used with this particular barrel size has an inside diameter of 3.49 cm (1.375 in.). If fitted with a liner for encasing the sample, the inside diameter of the core barrel liner should not be less than the drive shoe. Several other sizes of split-barrel samplers are available, with inside diameters ranging from 2.5 to 10 ~~cm.~~ cm (1 to 4 in.). A core barrel catcher (basket) can be used with this type of sampler to help retain non-cohesive materials. The split-barrel sampler is often used in conjunction with hollow-stem ~~continuous-flight~~ continuous flight augers or an equivalent drilling or direct-push probe system (Guides ~~D4700~~D6286 and D6282).

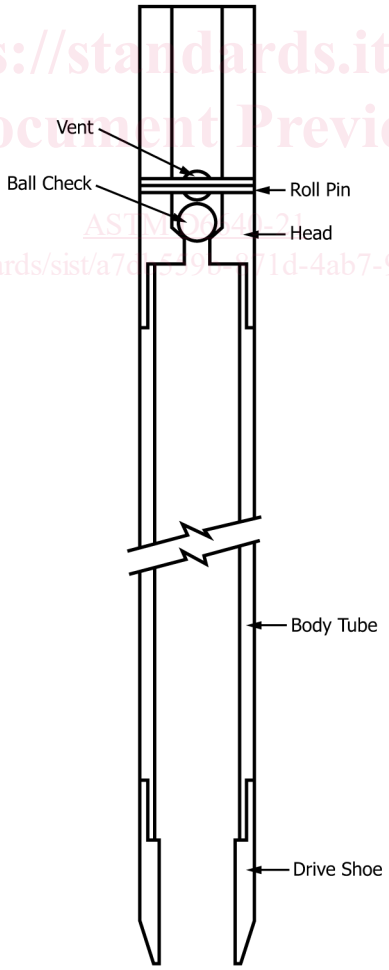

FIG. 1 ~~Split-Barrel~~ Split-Barrel Sampler

7.1.2 *Split-Barrel Soil Corer, Manual Push*—A variant of the split-barrel sampler is the split-barrel soil corer (see Fig. 2). This sampler is a short version of the split-barrel sampler that is manually pushed into the soil to collect soil surface or near-surface samples (Guide D4700). Typical split-barrel soil corers are between 15.2 cm (6 in.) and 30.5 cm (12 in.) in length and between 2.5 cm (1 in.) and 7.6 cm (3 in.) in diameter. Liners may be available for the split-barrel soil corer.

7.1.3 *Ring-Lined Barrel Sampler*—As described in Practice D3550 and Guide ~~D4700~~D6169, the ring-lined barrel sampler consists of an intact barrel or two split-barrel halves, a drive shoe, rings, a waste barrel, and a sampler head that vents (for example, a ball check valve) to allow air to be displaced as it is filled (Fig. ~~2~~3). The rings, which come in various lengths and are made of several different materials, should fit snugly within the barrel. The inside diameter of the rings should not be less than that of the drive shoe opening. The lengths of the rings will depend on the sampling plan so as to either allow quick access to a cross section of the soil core at a depth of interest or allow the appropriate size sample to be collected (see 8.1.2). The waste barrel section allows the rings to be filled with undisturbed soil by leaving space to contain the disturbed soil that often is present at the bottom of a hole. A core catcher (basket) can be used with this type of sampler to help retain non-cohesive materials. This sampler is often used in conjunction with hollow-stem continuous flight ~~augers,~~augers or an equivalent drilling or direct-push probe system (Guides ~~D4700~~D6286 and D6282).

7.1.4 *Thin-Walled Tube Sampler*—As described in Practice D1587 and Guide ~~D4700~~D6169, the thin-walled tube sampler consists of a core barrel attached to a head (Fig. ~~3~~4). The head connects to standard drill rods and contains a vent (for example, a ball check valve) to allow air to be displaced as it is filled. ~~This sampler description is unique to the Shelby tube, which is~~ Thin-walled tubes are available with outside diameters of 5.08, 7.62, and 12.70 cm (2, 3, and 5 in.), and a length of approximately 0.91 m (36 in.). In all cases, the drive end of the thin-walled tube sampler has a slightly smaller diameter than the inside of the tube. A core barrel catcher (basket) cannot be used with this type of sampler; therefore, non-cohesive materials may be lost during retrieval. These samplers are often used in conjunction with hollow-stem ~~continuous-flight~~ continuous flight augers or an equivalent drilling or direct-push probe system (Guides ~~D4700~~D6286 and D6282).

7.1.5 ~~*Solid Barrel Sampler*—~~*Single-Tube Solid-Barrel Sampler, Direct Push*—The single-tube solid-barrel sampler is similar in design to the thin-tube sampler, with some important ~~exceptions;~~exceptions: the walls are thicker and they often can be equipped with a liner(s) and a core catcher ~~(Guide~~(see ~~D6282~~Fig. 5~~, see~~; Guide ~~Figs. 4 and 5~~D6282). Most of the core barrel samplers in Guide D6282 are designed to be a closed chamber until the depth of interest is reached, then either the entire sampler or an inner barrel is driven to a greater depth, without advancing or after retracting the drive point or piston tip. ~~The open chamber (no drive point or piston tip) sampler design is often used for near-surface sampling equipment (Fig. 5).~~

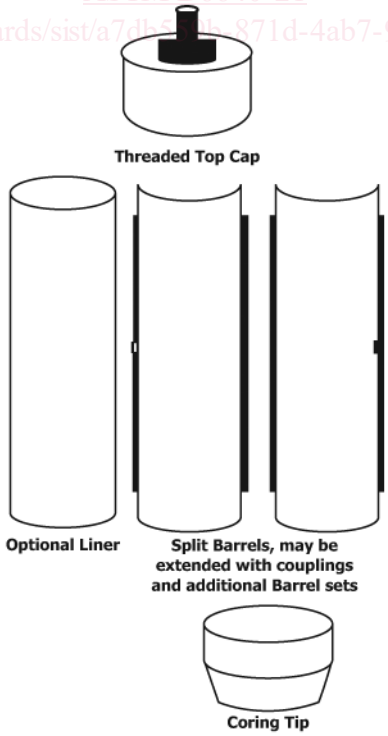

FIG. 2 Split-Barrel Soil Corer

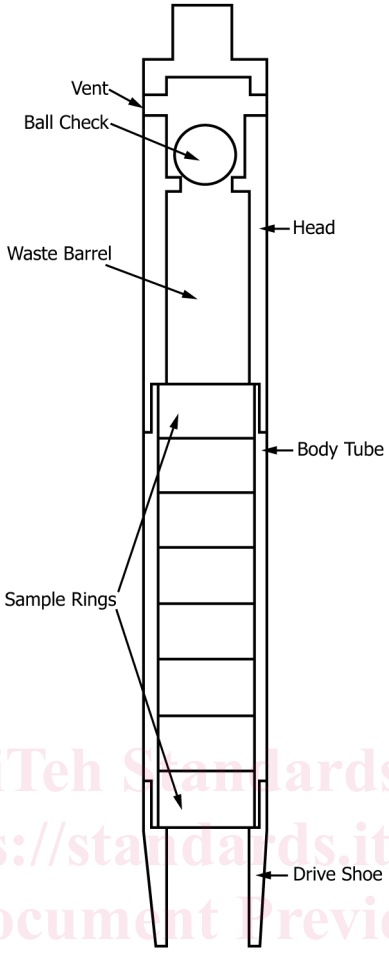

FIG. 23 Ring-Lined Barrel Sampler

7.1.6 *Solid-Tube Soil Corer, Manual Push*—A variant of the single-tube solid-barrel sampler is the solid-tube soil corer (see Fig. 6). This sampler is a short version of the solid-tube soil corer that is manually pushed into the soil to collect soil surface or near-surface samples. Typical solid-tube soil corers are between 15.2 cm (6 in.) and 30.5 cm (12 in.) in length and between 2.5 cm (1 in.) and 7.6 cm (3 in.) in diameter. Liners may be available for the solid-tube soil corer.

7.1.7 *Dual-Tube Sampler, Direct Push*—The dual-tube sampler is similar in design to the solid-barrel sampler (7.1.5) with the exception that a smaller diameter, solid inner rod is used in conjunction with the outer core tube to advance the sampler to the desired sampling interval (see Fig. 7). The inner rod maintains the sampler as a closed-chamber sampler until the sampling depth interval is reached. The outer core tube(s) remains in place during sampler advancement and sampling, with its primary function being to maintain bore hole stability. The outer core tube provides for greater sample integrity by minimizing cross-contamination from bore hole sidewall slough and prevents bore hole wall collapse, especially at greater depths below the ground surface. At the top of the desired sampling interval, the solid inner rod is removed and replaced with a liner and core catcher (Guide D6282; see Fig. 1, Fig. 3, and Fig. 4) to collect the sample as the dual tube sampler is advanced through the next depth interval.

7.1.8 *Hollow-Stem Soil Core Barrel*—Continuous soil cores using dry coring hollow-stem augers (Practice D6151) can be used to collect samples in a split inner barrel (Fig. 8). The hollow-stem auger can also be used as a casing, and open-tube samplers (7.1.3 and 7.1.4) can be operated inside the augers to obtain soil cores. However, once the water table is encountered and inside the augers, then the possibility of cross-contamination exists and sealed samplers should be used inside the augers.

8. Pre-Sampling

8.1 The pre-sampling activities are:

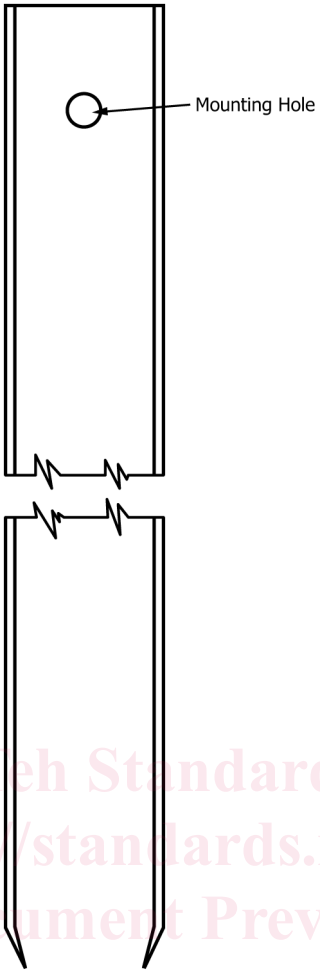

FIG. ~~3~~4 Thin-Walled Tube Sampler

8.1.1 Equipment that comes into direct contact with the sample should be steam cleaned, washed with a detergent solution, and rinsed with contaminant-free water, desorbing agents, and deionized water (Practice D5088). The other pieces of equipment should be either ~~steam-cleaned~~ steam cleaned or washed with a detergent solution and rinsed with contaminant-free water.

8.1.2 The cutting tip or shoe should have a sharp edge. Once dulled, the cutting tip or shoe should be sharpened or replaced.

8.1.3 A ~~work station~~ workstation should be set up for capping the core barrel sampler or when opening to remove subsamples. This ~~work station~~ workstation should consist of a flat, clean surface and be set up in a location ~~which~~that provides protection from extreme weather conditions and that is upwind of any local emission sources.

8.1.4 When sampling for volatile organic compounds or when subsampling ~~on-site~~onsite for constituents that are subject to oxidation or rapid biodegradation, the vessels used for transportation, the ~~on-site~~onsite sample storage chamber, and the equipment used for obtaining subsamples should be prepared for immediate use. For example, when using an ~~on-site~~onsite chemical or physical method of sample preservation, it is necessary to perform all of the steps leading up to the transfer of soil subsample from the sampler to the sample container. This may involve adding a solvent or acid solution to a vessel and recording a tared weight or having a chamber available that is capable of maintaining the appropriate refrigeration temperature.

9. Sampling

9.1 *Sampling Method*—A core barrel sampler can be used at the surface or threaded onto extension rods and lowered to the bottom of a cased or uncased bore hole or pushed as a single unit ~~(direct push~~ (see Guide D6282) to the depth of interest. The core barrel sampler is then driven into the soil manually or by some mechanical means to a depth that does not exceed the length of the core barrel. The filled sampler is then pulled out as smoothly (minimizing vibration) as possible to retain a maximum amount of soil