Designation: ~~D6519 – 15~~ D6519/D6519M – 23

Standard Practice for Sampling of Soil Using the Hydraulically Operated Stationary Piston Sampler[1]

This standard is issued under the fixed designation ~~D6519;~~D6519/D6519M; 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 a procedure for sampling of cohesive, organic, or fine-grained soils, or combination thereof, using a thin-walled metal tube that is inserted into the soil formation by means of a hydraulically operated piston. It is used to collect relatively intact soil samples suitable for laboratory tests to determine structural and chemical properties for geotechnical and environmental site characterizations.

1.1.1 Guidance on preservation and transport of samples in accordance with Practice ~~D4220~~D4220/D4220M may apply. Samples for classification may be preserved using procedures similar to Class A. In most cases, a thin-walled tube sample can be considered as Class B, C, or D. Refer to Guide ~~D6169~~D6169/D6169M for use of the hydraulically operated stationary piston soil sampler for environmental site characterization. This sampling method is often used in conjunction with rotary drilling methods such as fluid rotary; Guide D5783; and hollow stem augers, Practice ~~D6151~~D6151/D6151M. Sampling data ~~should~~shall be reported in the field log in accordance with Guide D5434.

1.2 The hydraulically operated stationary piston sampler is limited to soils and unconsolidated materials that can be penetrated with the available hydraulic pressure that can be applied without exceeding the structural strength of the thin-walled tube. This standard addresses typical hydraulic piston samplers used on land or shallow water in drill holes. The standard does not address specialized offshore samplers for deep marine applications that may or may not be hydraulically operated. This standard does not address operation of other types of mechanically advanced piston samplers. For information on other soil samplers, refer to Guide ~~D6169~~D6169/D6169M.

1.3 *Units*—~~All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice~~The values stated in either inch-pound units or SI units [presented in brackets] are to be regarded separately as standard. The values stated in each ~~D6026, unless superseded by~~ system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. Reporting of results in units other than shall not be regarded as nonconformance with this standard.

~~1.3.1 The values stated in either inch-pound units or SI units [presented in brackets] are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.~~

1.4 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this standard.

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations

Current edition approved ~~July 1, 2015~~Nov. 1, 2023. Published ~~July 2015~~November 2023. Originally approved in 2000. Last previous edition approved in ~~2008~~2015 as ~~D6519 – 08.~~D6519 – 15. DOI: ~~10.1520/D6519-15.~~10.1520/D6519_D6519M-23.

***A Summary of Changes section appears at the end of this standard**

1.5 *This practice does not purport to address all the safety concerns, if any, associated with its use and may involve use of hazardous materials, equipment, and operations. It is the responsibility of the user of this practice to establish and adopt appropriate safety and health practices. appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. Also, the user must comply with prevalent regulatory codes, such as OSHA (Occupational Health and Safety Administration) guidelines, while using this practice. For good safety practice, consult applicable OSHA regulations and other safety guides on drilling.*[2]

1.6 *This practice offers a set of instructions for performing one or more specific operations. This documentpractice cannot replace education or experience and should be used in conjunction with professional judgement. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard practice is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title means only that the document has been approved through the ASTM consensus process. This practice does not purport to comprehensively address all of the methods and thepotential issues associated with sampling of soil. Users should seek qualified professionals for decisions as to the proper equipment and methods that would be most successful for their site exploration. Other methods may be available for drilling and sampling of soil, and qualified professionals should have flexibility to exercise judgment as to possible alternatives not covered in this practice. The practice is current at the time of issue, but new alternative methods may become available prior to revisions, therefore, users should consult with manufacturers or producers prior to specifying program requirements.*

1.7 *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—Testing and Soil Classification:*[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)
D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
D5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock (Withdrawn 2021)[4]
D6026 Practice for Using Significant Digits and Data Records in Geotechnical Data

2.2 *ASTM Standards—Drilling Methods:*

D5782 Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5784D5784/D5784M Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water Quality Monitoring Devices
D6151D6151/D6151M Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
D6286D6286/D6286M Guide for Selection of Drilling and Direct Push Methods for Geotechnical and Environmental Subsurface Site Characterization

2.3 *ASTM Standards—Soil Sampling:*

D1587D1587/D1587M Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes
D4220D4220/D4220M Practices for Preserving and Transporting Soil Samples (Withdrawn 2023)[4]
D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
D5299D5299/D5299M Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
D6169D6169/D6169M Guide for Selection of Subsurface Soil and Rock Sampling Devices for Environmental and Geotechnical Investigations
D6282D6282/D6282M Guide for Direct Push Soil Sampling for Environmental Site Characterizations (Withdrawn 2023)[4]

3. Terminology

3.1 *Definitions:*

[2] *Drilling Safety Guide*, National Drilling Assn., 3008 Millwood Ave., Columbia, SC 29205.

[3] 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.

[4] The last approved version of this historical standard is referenced on www.astm.org.

~~3.1.1 For definitions of technical terms in this standard, refer to Terminology D653.~~

~~3.1.2 *incremental drilling and sampling*—insertion method where rotary drilling and sampling events are alternated for incremental sampling, incremental drilling is often needed to penetrate harder or deeper formations.~~

~~3.1.3 *sample recovery*—the length of material recovered divided by the length of sampler advancement and stated as a percentage.~~

~~3.1.4 *sample interval*—defined zone within a subsurface strata from which a sample is gathered.~~

~~3.1.5 *soil core*—cylindrically shaped soil specimen recovered from a sampler.~~

3.1 *Definitions:*

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *friction* ~~*clutch*—~~*clutch, n*—a device to lock the thin-walled tube head to the outer barrel of the stationary piston sampler to prevent uncontrolled thin-walled tube rotation.

3.2.2 *hydraulically* ~~*activated*~~*operated stationary piston* ~~*sampler*—~~*sampler, n*—a stationary piston sampler in which the thin-walled tube is ~~forced~~advanced over a fixed piston into the soil strata by hydraulic fluid pressure or pneumatic pressure. It is also known as an "Osterberg" piston sampler, which was developed by Professor Jori Osterberg of Northwestern University.

3.2.3 *incremental drilling and sampling, n*—insertion method where rotary drilling and sampling events are alternated for incremental sampling, incremental drilling is often needed to penetrate stiffer or deeper formations.

3.2.4 *sample interval, n*—defined zone within a subsurface strata from which a sample is gathered.

3.2.5 *sample recovery, n*—the length of material recovered divided by the length of sampler advancement and stated as a percentage.

3.2.6 *soil core, n*—cylindrically shaped soil specimen recovered from a sampler.

4. Summary of Practice

4.1 ~~Hydraulic~~ Hydraulically operated stationary piston sampling of soils consists of advancing a thin-walled sampling ~~device~~tube into subsurface soils generally through a predrilled bore hole to the desired sampling depth. See Fig. 1 for a schematic drawing of the sampling process. The sampler is sealed by the stationary piston to prevent any intrusion of formation material. At the desired depth, fluid or air is forced into the sampling barrel, above the inner sampler head, forcing the thin-walled tube sampler over the piston into the soil formation. The hydraulically operated stationary piston sampler has a prescribed length of travel. At the termination of the sampler travel length the fluid flow is terminated. The sample is allowed to stabilize in the thin-walled tube. The ~~sample is then sheared by rotating the sampler. The~~ sampler is retrieved from the borehole, and the thin-walled tube with the sample is removed from the sampler. The sample tube is then sealed properly or field-extruded as desired. The stationary piston sampler is cleaned and a clean thin-walled tube installed. The procedure is repeated for the next desired sampling interval. Sampling can be continuous for full-depth borehole logging or incremental for specific interval sampling.

5. Significance and Use

5.1 Hydraulically ~~activated~~operated stationary piston samplers are used to gather soil samples for laboratory or field testing and analysis for geologic investigations, soil chemical composition studies, and water quality investigations. The sampler is sometimes used when attempts to recover unstable soils with thin-walled tubes, Practice ~~D1587~~D1587/D1587M, are unsuccessful. Examples of a few types of investigations in which hydraulic stationary piston samplers may be used include building site foundation studies containing soft sediments, highway and dam foundation investigations where softer soil formation need evaluation, wetland crossings utilizing floating structures, and hazardous waste site investigations. Hydraulically ~~activated~~operated stationary piston

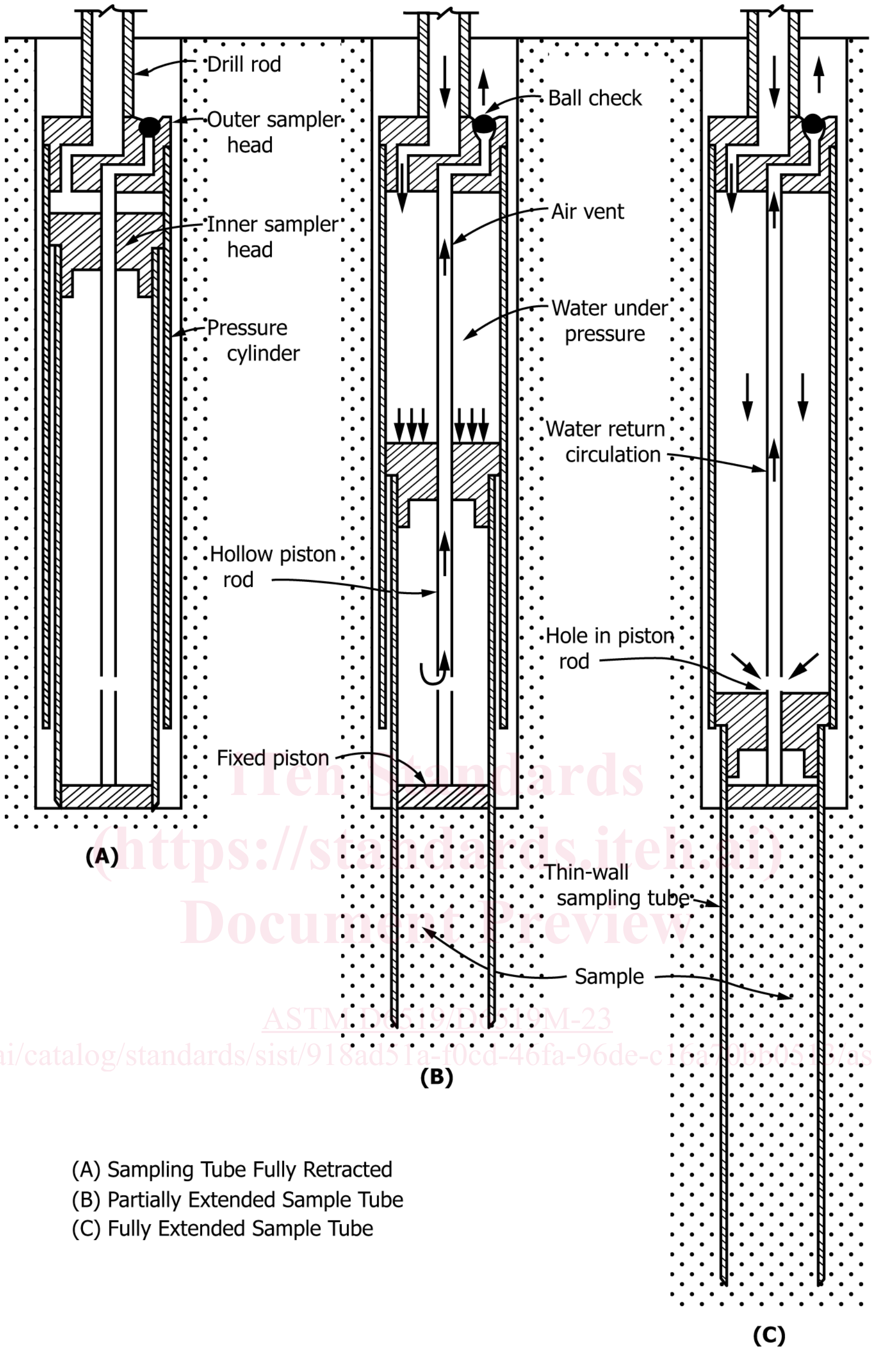

FIG. 1 Sampler in Operation

samplers provide specimens necessary to determine the physical and chemical composition of soils and, in certain circumstances, contained pore fluids (see Guide ~~D6169~~D6169/D6169M).

5.2 Hydraulically ~~activated~~operated stationary piston samplers can provide relatively intact soil samples of soft or loose formation materials for testing to determine accurate information on the physical characteristics of that soil. Samples of soft formation materials can be tested to determine numerous soil characteristics such as; soil stratigraphy, particle size, ~~moisture~~water content, permeability, shear strength, compressibility, and so forth. The chemical composition of soft formation soils can also be determined from the sample if provisions are made to ensure that clean, decontaminated tools are used in the sample gathering procedure. Field-extruded samples can be field-screened or laboratory-analyzed to determine the chemical composition of soil and contained pore fluids. Using sealed or protected sampling tools, cased boreholes, and proper advancement techniques can help in the acquisition of good representative samples. A general knowledge of subsurface conditions at the site is beneficial.

5.3 The use of this practice may not be the correct method for investigations of softer formations in all cases. As with all sampling methods, subsurface conditions affect the performance of the sample gathering equipment and methods used. For example, research indicates that clean sands may undergo volume changes in the sampling process, due to drainage.[5] The hydraulically activatedoperated stationary piston sampler is generally not effective for cohesive formations with unconfined, undrained shear strength in excess of 2.0 tons per square foot, coarse sands, compact gravelly tills containing boulders and cobbles, compacted gravel, cemented soil, or solid rock. These formations may damage the sample or cause refusal to penetration. A small percentage of gravel or gravel cuttings in the base of the borehole can cause the tube to bend and deform, resulting in sample disturbance. Certain cohesive soils, depending on their water content, can create friction on the thin-walled tube which can exceed the hydraulic delivery force. Some rock formations can weather into soft or loose deposits where the hydraulically activatedoperated stationary piston sampler may be functional. The absence of groundwater can affect the performance of this sampling tool. tool, and since this sampling method can introduce water to the borehole, it may not be suitable for sampling above the groundwater table when water is utilized as the activation fluid. As with all sampling and borehole advancement methods, precautions must be taken to prevent cross-contamination of aquifers through migration of contaminates up or down the borehole. Refer to Guide D6286D6286/D6286M on selecting drilling methods for environmental site characterization for additional information about work at hazardous waste sites.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective sampling. testing/sampling/inspection/etc. Users of this practice are cautioned that compliance with Practice D3740 does not in itself ensureassure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

Practice D3740 was developed for agencies engaged in the laboratory testing and/or inspection of soil and rock. As such, it is not totally applicable to agencies performing this practice. However, user of this practice shouldmust recognize that the framework of Practice D3740 is appropriate for evaluating the quality of an agency performing this practice. Currently, there is no known qualifying national authority that inspects agencies that perform this practice.

6. Criteria for Selection

6.1 Important criteria to consider when selecting the hydraulically activatedoperated stationary piston sampler include the following:

6.1.1 Size of sample.

6.1.2 Sample quality (Class A, B, C, or D) for physical testing. Refer to Practices D4220D4220/D4220M.

6.1.3 Sample handling requirements such as containers and preservation requirements.

6.1.4 Soil conditions anticipated (cohesiveness).(cohesiveness and particle size).

6.1.5 Groundwater depth anticipated.

6.1.6 Boring depth required.

6.1.7 Chemical composition of soil and contained pore fluids.

6.1.8 Available funds.

6.1.9 Estimated cost.

6.1.10 Time constraints.

6.1.11 History of tool performance under anticipated conditions (consult experienced users and manufacturers).

6.1.12 Site accessibility.

6.1.13 Decontamination requirements.

[5] Marcosion and Bieganovsky, "Liquefaction Potential of Dams & Foundations, Report 4, Determination of In situ Density of Sands," *Research Report S-76-2*, U.S. Army Engineer Water Way Experimental Station, Vicksburg, MS, 1977.

7. Apparatus

7.1 The hydraulically ~~activated~~operated stationary piston sampler consists of an outer barrel, an outer barrel head with threaded connection for drill rod with a fluid-injection port leading into the inner barrel, a fluid-exit port fitted with a check valve, a friction clutch assembly to control rotation, a piston rod that attaches to the sampler head and serves as a conduit from the base of the piston for the discharge of fluid, an inner sampler head which slides over the piston rod to which the thin-walled tube is attached, a piston that attaches to the lower end of the piston rod, a thin-walled tube, and in some cases a removable outer barrel shoe. Necessary expendable supplies are thin-walled tubes, tube sealing material, sample containers for use in field extrusion, and O-ring seals.

7.1.1 *Thin-walled Tube*—The hydraulically ~~activated~~operated stationary piston sampler is designed to accommodate standard sized 3.0-in. [75-mm] diameter thin-walled tubes. Samplers are also available to utilize 5.0-in. [125.0-mm] diameter thin-walled tubes as well (Fig. 2). The thin-walled tubes are generally manufactured in accordance with Practice ~~D1587~~D1587/D1587M. Thin-walled tube retaining fastener patterns may vary (Fig. 2). The most desirable pattern is the one recommended in Practice ~~D1587~~D1587/D1587M. Regardless of the pattern used, a minimum of four fasteners ~~should~~shall be utilized to provide sufficient strength to resist any rotation or extraction forces. Sealing of thin-walled tube ends ~~should~~shall be completed in accordance with Practice ~~D1587~~D1587/D1587M and with Practices ~~D4220~~D4220/D4220M.

7.1.2 *Sample Tube*—Thin-walled tubes are available in various types of materials, including stainless steel, galvanized steel, and brass (Practice ~~D1587~~D1587/D1587M). There are also different types of materials that can be used to coat the tube surfaces. When using thin-walled tubes in areas with chemically contaminated soil, consideration should be given to the effect these chemicals may have on the tube composition. The reaction of the chemical with the thin-walled tube may affect the sample properties as well as storage procedures. Samples for geotechnical testing require certain minimum volumes and specific handling techniques. Practices ~~D4220~~D4220/D4220M offers guidance for handling samples submitted for physical testing.

7.2 *Power Sources*—Hydraulic activation of the stationary piston sampler requires a power source to supply fluid or air to the sampler. Rotary drilling equipment fitted with fluid pumps or air compressions may be used. The drill rig ~~should~~must have a tower for placing and removing the sampler from the borehole. The drill rig ~~should~~must also have sufficient retraction power to extract the full sample tube, overcoming the suction and the friction of the formation soils. The fluid pump ~~should~~shall be capable of supplying a minimum of 200 psi [1400 kN/m^2]. Piston, progressive cavity, and peristaltic pumps work well. The pump ~~should~~shall be equipped with a pressure-relief valve set at a minimum of 200 psi [1400 kN/m^2]. Air compressors capable of delivering 175 psi [1200 kN/m^2] are acceptable. Pressure requirements are governed by the soil resistance values of the formation being sampled. Drilling tools needed to operate the sampler include drill rods to position the sampler and to transfer the activation fluid, rod-handling tools, pipe wrenches, fluid swivels, and so forth; casing or hollow stem augers to provide a stable borehole; a pipe vise to secure the sampler for thin-walled tube removal and loading; wood blocks for reloading the thin-walled tube into the sampler barrel without damage to the cutting edge; hand tools to remove and install the tube fasteners; and a brush with buckets for cleaning the sampler.

7.2.1 *Rotary Drilling Equipment*—Drills are required that are capable of performing drilling functions in accordance with Practice ~~D6151~~D6151/D6151M and Guide D5783. Drill units generally offer a ready hydraulic system for the retraction of samplers from the sampled formation and downward thrust for pushing the sampler through minimal amounts of borehole cave-in to reach desired sampling depth as well as reactive weight to counteract the thin-walled tube discharge pressure. Because most drills are equipped with leveling jacks, better weight application is achieved. Vertical pushing is improved because of the ability to level the machine. Tool handling is facilitated by high-speed winches common to drilling rigs, extended masts for long tool pulls, and sampler holding devices. Drill units are commonly fitted with fluid pumps that will provide the activation fluid. The unit must have a working pressure measurement gage in the fluid discharge line positioned where it can be easily read. This gage will be the indicator of how the sampler is functioning as well as when the thin-walled tube has been fully ~~extruded.~~extended.

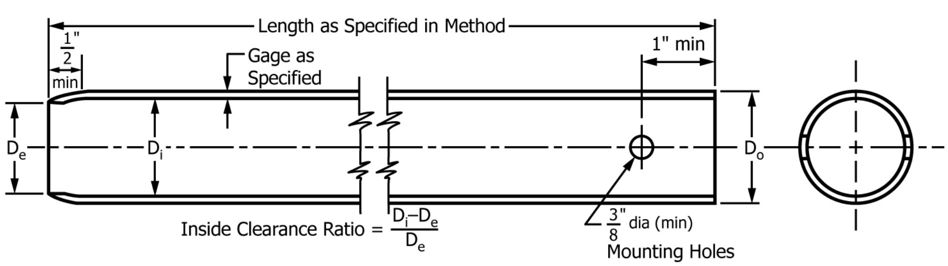

FIG. 2 Thin-Walled Tube Sampler, Practice ~~D1587~~D1587/D1587M