Designation: D3550/D3550M – 17

Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils[1]

This standard is issued under the fixed designation D3550/D3550M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice covers procedure for thick wall, split barrel drive sampling of soil to obtain representative samples of soil for classification and laboratory testing. The sampler is considered to be a thick wall sampler with sharpened cutting shoe and ball check vent. The middle barrel section is split barrel design containing ring liners. The sampler is often driven, but can also be pushed in softer deposits. Penetration resistance data may be recorded. This standard uses procedures similar to Test Method D1586 on Penetration Resistance and Split Barrel Sampling of Soils. However, in this practice, differing hammer weights, drop heights, and different size samplers are used, so the data must not be reported as conforming to Test Method D1586 and cannot be used to determine Normalized penetration resistance data for sands in accordance with Practice D6066.

1.2 This practice involves use of rotary drilling equipment (Guide D5783, Practice D6151). Other drilling and sampling procedures (Guide D6286, Guide D6169) are available and may be more appropriate. Considerations for hand driving or shallow sampling without boreholes are not addressed. Subsurface explorations should be recorded in accordance with Guide D5434. Soil samples should be classified in accordance with Practice D2488.

1.3 The soil samples from this test will have some degree of disturbance because the sampler is a driven thick walled sample tube. Table 2 of Guide D6169 on Soil and Rock Sampling provides guidance for selection of soil samplers for samples that may require intact samples defined by Terminology D653 for laboratory testing. The degree of disturbance must be evaluated by the user (engineer) to determine the suitability of the sample for use in laboratory tests. If samples are not suitable for laboratory testing, other soil samplers should be used (see 4.4.1).

1.4 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

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values shall conform to the guidelines for significant digits and rounding established in Practice D6026, unless superseded by this standard.

1.6 *This practice offers an organized collection of information or a series of options and does not recommend a specific course of action. This document 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 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 of this document means only that the document has been approved through the ASTM consensus process.*

1.6.1 This practice does not purport to comprehensively address all of the methods and the issues associated with soil sampling. Users should seek qualified professionals for the decisions as to the proper equipment and methods that would be most successful for their site exploration. Other methods may be available for monitoring soil sampling and qualified professionals should have flexibility to exercise judgement as to possible alternatives not covered in this practice.

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 and health practices. The user must comply with prevalent regulatory codes, such as OSHA (Occupational Health and Safety Administration) guidelines while using this*

[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.

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

practice. For good safety practice, consult applicable OSHA regulations and other safety guides on drilling.[2]

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:*[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils

D1587 Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4220 Practices for Preserving and Transporting Soil Samples

D4546 Test Methods for One-Dimensional Swell or Collapse of Soils

D5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

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

D6026 Practice for Using Significant Digits in Geotechnical Data

D6066 Practice for Determining the Normalized Penetration Resistance of Sands for Evaluation of Liquefaction Potential

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

D6286 Guide for Selection of Drilling Methods for Environmental Site Characterization

3. Terminology

3.1 *Definitions:*

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

4. Significance and Use

4.1 The thick-wall ring lined drive sampler has been used for over 50 years in the arid southwest regions of the U.S. where unsaturated soils are too difficult to sample using the thin-walled tube (Practice D1587). Variations of the sampler include names such as "Dames and Moore, California, Modified California barrels" with outside barrel diameters ranging from 2.5 to 3.5 in. [60-90 mm].[4] In addition to the blow count, these drive samplers have the added benefit of having a ring lined specimens that can be evaluated in the laboratory. Versions of the original Dames and Moore type sampler shown in Fig. 1 are still used, but many now use the Diamond Drill Core Manufacturers Association (DCDMA)[5] specification split barrel drive samplers Fig. 2. The ring lined samplers normally have provisions for a 6-in. [150 mm] waste barrel with or without rings in the top section of the barrel. Drilling in the unsaturated soils is performed almost exclusively with hollow-stem augers (Practice D6151) because it is a dry drilling method. The test can be performed in fluid rotary or other drill holes but use of fluid rotary methods are not recommended in unsaturated soils as the drill fluid may alter the sample properties. Most operators use a 140 lb [75 kg] hammer mass but other hammer masses may be used.

4.2 This practice is used for general soil explorations where samples are required for identification and testing. Disturbed samples can be classified in accordance with Practice D2487 and can be tested for water content, particle size, and Atterberg limits.

4.3 The sampler can be driven with a hammer and the penetration resistance can be recorded. Numerous combinations of hammer size and drop height have been used in practice. Hammer size and drop height should be reported. Users of this practice have derived local correlations of penetration resistance and engineering properties based on local conditions and a particular hammer system and sampler, however, the penetration resistance may differ from Test Method D1586.

4.4 The sampler can be equipped with stacked ring liners, which can be used directly for other laboratory tests. The lab tests are combined with the penetration resistance data, for estimates of soil engineering properties based on engineering experience.

NOTE 1—The most common lab tests are one dimensional consolidation or swell or collapse with wetting, determination of trimmed density, and direct shear testing.

4.4.1 The engineer in charge of the exploration is responsible for evaluating the suitability of the samples for lab testing, evaluating the test result data quality, and for how and what data are to be used in design. If the samples and test

[2] Drilling Safety Guide, National Drilling Association, 6089 Frantz Rd. Suite 101, Dublin, Ohio, 43017.

[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] Problems and Some Solutions in Geotechnical Sampling, H.E. Davis, http://www.quest-ech.biz/Pages/Geotechnical%20Sampling.htm

[5] DCDMA Technical Manual, National Drilling Association, 6089 Frantz Rd. Suite 101, Dublin, Ohio 43017, 1991.

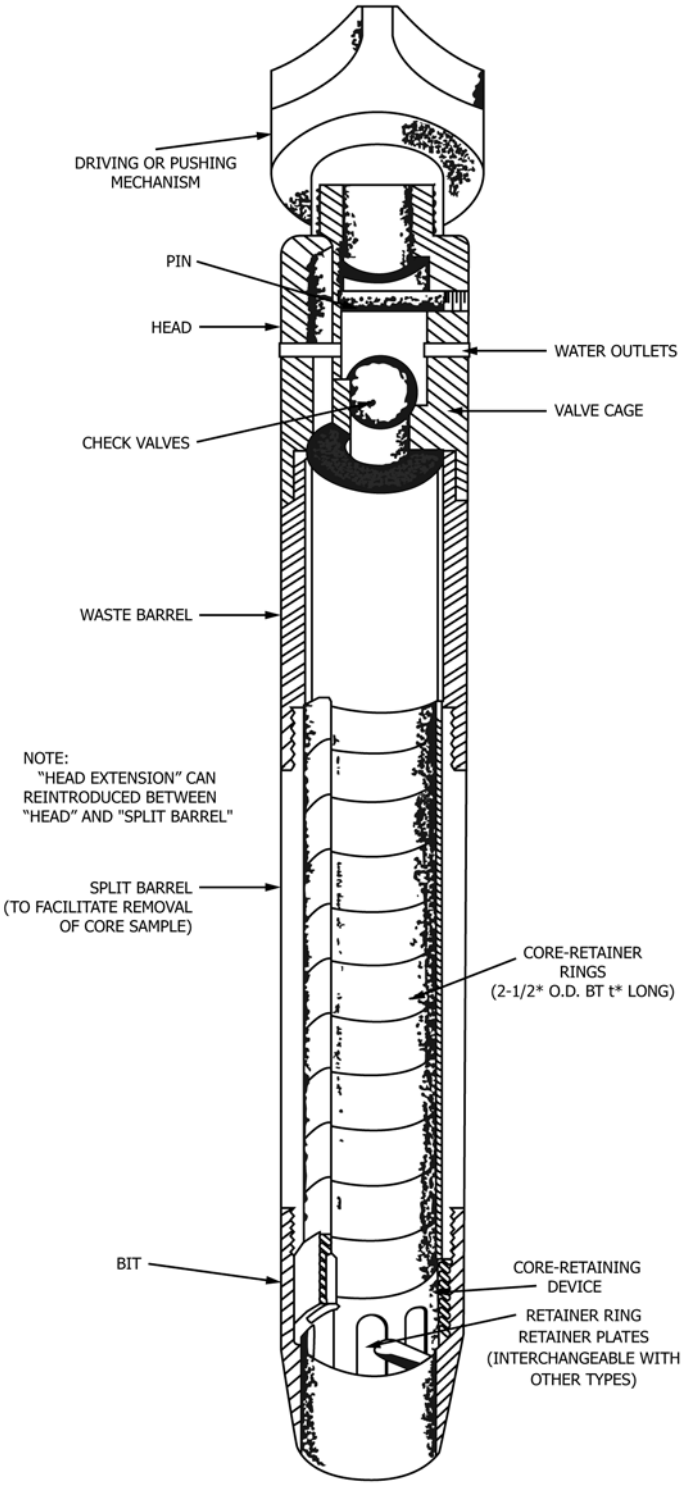

FIG. 1 Original "Dames and Moore" Type Ring Lined Drive Sampler

results are not suitable, the user should specify other methods to obtain soil samples such Thin-wall Tubes (Practice D1587) for soft soils or rotary soil core barrels (Guide D6169) or hollow-stem auger soil cores (Practice D6151) for harder soils.

4.5 This standard addresses sampling in drill holes with drilling equipment. The sampler can be hand driven or driven in test pits without drilling equipment. If these special driving methods are used the sampling process should be reported.

NOTE 2—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. Users of this practice are cautioned that compliance with Practice D3740 does not in itself assure 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 should 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.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment may be used that provides a reasonably clean hole before insertion of the sampler and that does not disturb the soil to be sampled (Guide D6286). The most common method for testing in unsaturated soils is to use top head drive rotary hollow-stem auger dry drilling methods (Practice D6151). If fluid rotary methods are used, bottom discharge bits should be avoided as they could disturb the sampling interval and side-discharge bits are preferable.

5.2 *Drive Weight Assembly*—Any drive weight assembly that will provide penetration in the range from 1 to 100 blows per foot [0.30 m] may be used. In soft soils, if the sample is desired for laboratory testing, the sample may be pushed to reduce disturbance.

5.3 *Ring-Lined Barrel Sampling Assembly*—This shall consist of a shoe, sample barrel, and waste barrel (extension), and head with check valve, vents, and threaded connector (Head) for drill rod, as shown in Fig. 2. Typical outside diameters of the barrel range from 2.0 to 3.5 in. [50 to 90 mm]. Fig. 2 is reproduced from the DCDMA manual[5] to illustrate typical dimensions. Other sampler designs can be used as long as the sampler dimensions have similar proportions and are reported on the boring log. The total sampler assembly length is typically 2 ft [0.6 m]. The length should be two digits or a whole number such as 2 ft [0.6 m] such that it is easy to record sampling depth intervals to the nearest 0.1 ft [50 mm] or better.

5.4 *Ring-Lined Sampler*—Test specimens shall be obtained using a suitable split barrel or solid barrel lined on the inside with removable rings or liners. These rings or liners shall be thin-walled and shall conform to the size requirements of the particular laboratory test determinations employed. They shall fit snugly inside the sampler with no discernible free play in any direction. Rings are often brass, steel, or stainless steel, but can be made of any material of adequate strength and resistance to corrosion. The sampler may be sectionalized to allow end-to-end make-up of sections as necessary. Each section shall be designed so that addition or removal of sections will not loosen, permit movement, or otherwise adversely affect retention of the rings within the sampler. The sampler and rings shall be free of bumps, dents, scratches, rust, dirt, and corrosion.

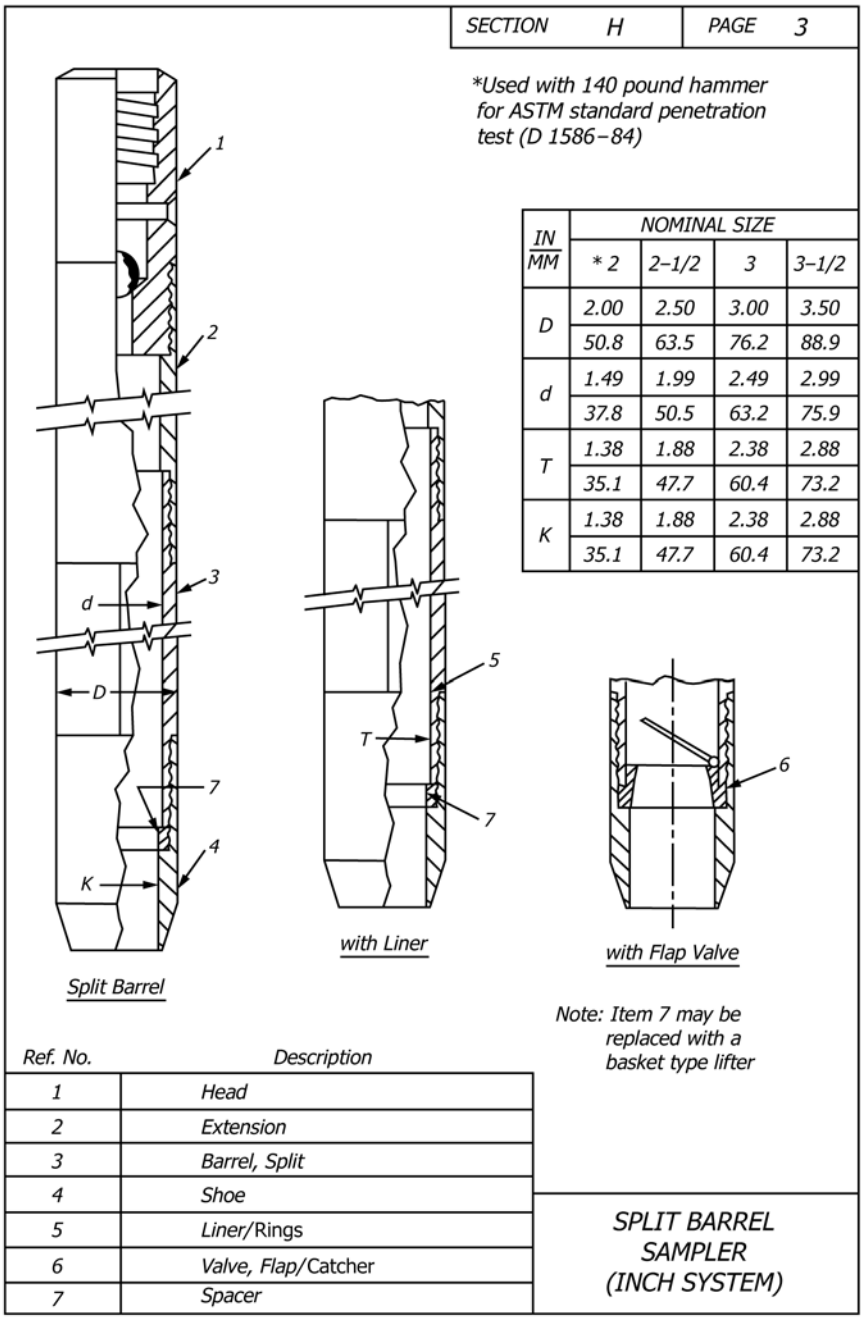

FIG. 2 Ring-Lined Barrel Sampling Assembly

NOTE 3—It is recommended that the sampler contain at least four to twelve rings or one to two liners in order to provide samples for a variety of tests. The ring height should be equal to or less than its inside diameter.

5.5 *Waste Barrel*—A waste barrel that can be removed from the sampler in the field shall be provided to contain space for disturbed soil originally at the bottom of the hole. The length of the waste barrel shall be at least three times its interior diameter, and the inside diameter shall be the same, or slightly larger than, the inside diameter of the rings. The waste barrel may also contain rings or liners for containment of the disturbed soil.

5.5.1 An attachment, check valve, and one or more vents is required.

5.6 *Shoe*—A shoe similar in design to that used in Test Method D1586 is shown on Fig. 1. Fig. 1 shows typical sizes as specified by the DCDMA[5]. The inside of the assembled shoe and ring-lined sampler shall be smooth, straight, and uniform. Use of a hardened steel shoe improves resistance to damage. Dented or distorted shoes should not be used.

5.6.1 In North American practice, the area ratio and cutting edge bevel have been varied. In general, it is desirable to maintain proportions similar to those in D1586. Most commercial suppliers offer an ASTM D1586 "sharp" shoe and a "blunt" shoe for hard driving conditions. The cutting angle of the shoe influences the sample quality and sharper shoes generally result in higher sample quality. The cutting shoe of the Dames and Moore type sampler (Fig. 1) is sharper than the ASTM shoe.

5.7 *Retainer*—Various types of retainers may be required to aid in recovery. These are located in spacer area 7 shown on Fig. 2. If a retainer is used, the type used should be reported.

5.8 *Sample Extractor*—Specimen-filled rings shall be removed from the sampler by pressing them out or alternatively by the use of a split barrel. The extractor disk shall be at least 0.5 in. [10 mm] thick and shall bear solidly against the sample rings at all points. It shall slide easily inside the sampler barrel without jamming and without free play.

5.9 *Containers for Specimen-Filled Rings*—These shall be snug fitting, tightly sealed (watertight), rigid containers or caps that will not permit movement of the specimen-filled rings inside. They shall be noncorrosive.

5.10 *Miscellaneous Equipment*—This includes a pipe vise, pipe wrenches, spatulas, cleaning brushes, buckets, rags, data sheets, transporting boxes, knife for cutting sampler, indelible markers, wire brushes, etc. Water must be available for cleaning the equipment.

6. Procedure

6.1 Clean the hole to sampling elevation using whatever method is preferred that will ensure that the material to be sampled is not disturbed. In saturated sands and silts, withdraw the drill bit slowly to prevent loosening of the soil around the hole. When casing is used, it shall not be driven below sampling elevation. When drilling below the groundwater level the water or drilling liquid within the boring must be maintained at all times at or above the natural groundwater level. It is preferable to keep the hole filled.

6.2 Keep a careful record of drill penetration and sampler depth to the nearest 0.1 ft [50 mm] or better to ensure that the soil being sampled is the original soil at the bottom of the hole and is not contaminated by soil falling down from the sides of the hole. Hollow-stem auger drilling is the preferred method in unsaturated soils because it is a dry drilling method. Hollow-stem augers provide for continuous protected casing when drilling. When using other drilling methods, if there is any significant tendency for soil to fall from the sides of the hole to the bottom, use water, drilling mud, hollow-stem auger, or casing, as necessary, in order to prevent this from happening. When using casing or hollow-stem augers be sure the soil does not squeeze or flow up into the cased hole as may happen in loose sand below the water table by maintaining fluid balance in the hole. The process of jetting through an open-tube sampler, or jetting heaved sand out of a casing, and then sampling when the desired depth is reached shall not be permitted. The use of bottom-discharge bits is not preferred.

6.3 Assemble and lower the sampling assembly it carefully into the hole. With the cutting edge of the shoe resting on the bottom of the hole and the water level in the boring at or above the groundwater level, record the sampling start depth to the nearest 0.1 ft [50 mm] or better. Then drive or push the sampling assembly into the soil. Drive or push the assembly in far enough so that all cuttings, sludge, and soil disturbed by drilling are in the waste barrel; however, in no case drive or push the assembly farther than the total length of the shoe, sampler, and waste barrel. Take care that none of the sample is lost due to improper operation of the check valve. Record the depth of advancement to the nearest 0.1 ft [50 mm] or better.

6.4 When using a driving hammer to drive the sampling assembly, record the penetration resistance in depth increments required by the testing program. Typical practice is to drive the sampler in three 0.5 ft [150 mm] increments as used in Test Method D1587. In such a case, record the hammer weight, height of drop, and number of blows, and the depth intervals penetrated to the nearest 0.1 ft [50 mm] or better.

6.5 After the sampler has been advanced extract the sampler. Using hollow-stem augers, the sampler is often over-cored prior to sampler extraction and, in many cases, the hollow-stem is advanced to the next sampling interval. In some cases it might be beneficial to let the sampler rest before extraction. The barrel can also be rotated to shear the base of the sample. Withdraw the sampler at a rate that will preserve the sample. If there is excessive fluid pressure in the rods above, provide vent ports to relieve fluid pressure. If sample recovery is difficult, consider use of retainers (5.7).

6.6 Carefully disassemble the sampling assembly in such a manner as to minimize soil disturbance as much as possible. Disturbed samples may be placed in any suitable container such as plastic bags or sealed jars. Label the sample container(s) in a suitable manner. Discard samples that appear to be contaminated or questionable.

6.7 If rings or liners are used, trim the soil flush with the ends of the sampling rings or liner, and cap both ends. If the specimens in rings, or liners, are to be stored for more than 72 hours, the liner or ring cap should be taped. Be certain that there is no movement of the soil inside the specimen-filled rings and that the specimen was not disturbed while being removed from the barrel. If the soil in the bottom end ring does not protrude from the ring after removing the shoe, do not use the soil in the bottom ring for tests other than soil classification and water content. If the top ring or rings contain voids, depressions, or any material other than the soil that is being sampled, do not use the soil in this ring (or rings) for any purpose whatsoever. The filling of depressions in the end rings with additional soil shall not be permitted.

6.8 Classify the soil sample (Practice D2488) and examine the material for structure, consistency, color, and condition. Record these observations and include them in the report (see 7.3.8).

6.9 Describe the moisture condition of the sample (Practice D2488). If required, determine the water content of a specimen taken from the shoe or bottom ring in accordance with Test Method D2216.

6.10 Preserve and transport the sample in accordance with Practices D4220.

7. Report

7.1 The methodology used to specify how data are recorded, as given below, is covered in 1.5.

7.2 Record as a minimum the following general information (data):

7.3 Data obtained in each boring shall be recorded in accordance with the Subsurface Logging Guide D5434 as required by the exploration program. In addition, the following information shall be reported;

7.3.1 Name and location of job,

7.3.2 Date of boring and times of start and finish,

7.3.3 Boring number and location,

7.3.4 Surface elevation, if available,

7.3.5 Sample number and depth,

7.3.6 Method of advancing sampler, hammer weight, drop height, penetration resistance, and push pressures,

7.3.7 Description and size of sampler, outside diameter, shoe type, inside diameter of shoe, rings, or split barrel. Report length of drive barrel assembly. Report type of retainer used, if any,

7.3.8 Description of soil (see Practice D2488) and any other laboratory test results performed,

7.3.9 Describe water contents or results of water content determinations (Test Method D2216), if performed.

7.3.10 Size of casing, depth of cased hole,

7.3.11 Type of drilling equipment—description,

7.3.12 Names of personnel: crewman, field engineer, technician, etc.,

7.3.13 Weather conditions, and

7.3.14 General remarks.

7.4 Record as a minimum the following sampling data as follows:

7.4.1 Record all depths, elevations, and drilling and sample intervals to the nearest 0.1 ft. [50 mm] or better.

7.4.2 Depth interval of layer sampled, drive interval, length of sample recovered, and recovery expressed as percent.

7.4.3 Depth to water table or depth of overlying water and time of reading, level of fluid inside borehole, if any, to the nearest 0.1 ft. [50 mm] or better.

8. Precision and Bias

8.1 This practice does not produce numerical or repeatable data and therefore a precision and bias statement is not applicable.

9. Keywords

9.1 penetration resistance; ring lined; soil drive sampler; soil sampling; split barrel

SUMMARY OF CHANGES

In accordance with Committee D18 policy this section identifies the location of changes to this standard since the 01 (2007) edition that may impact the use of this standard. (April 1, 2017)

(1) Scope section was revised to emphasize the possible disturbance effects using a thick wall drive sampler.

(2) The significance and use section was revised to address concerns about laboratory testing of ring specimens. It was stressed that the user is responsible for evaluating the sample quality and test result and use.

(3) An historical section was added recognizing the use of Dames and Moore and California type samplers that are still in use.

(4) The procedure section was revised to reflect the predominant use of hollow-stem augers in unsaturated soils being sampled.

(5) The practice was changed to dual units in-lb primary with rationalized SI units in brackets. D18 editorial requirements were made, including the report section.