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Standard Guide for Use of Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices[1]

This standard is issued under the fixed designation D 5872; 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 guide covers how casing-advancement drilling and sampling procedures may be used for geoenvironmental exploration and installation of subsurface water-quality monitoring devices.

1.2 Different methods exist to advance casing for geoenvironmental exploration. Selection of a particular method should be made on the basis of geologic conditions at the site. This guide does not include procedures for wireline rotary casing advancer systems which are addressed in Guide D 5786.

1.3 The values stated in inch-pound or SI units are to be regarded separately as the standard. The values given in parentheses are for information only.

1.4 Casing-advancement drilling methods for geoenvironmental exploration and monitoring-device installations will often involve safety planning, administration and documentation. This guide does not purport to specifically address exploration and site safety.

1.5 *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.*

1.6 *This guide 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 judgment. Not all aspects of this guide 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.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 2113 Practice for Rock Core Drilling and Sampling of Rock for Site Investigation

D 4428/D 4428M Test Methods for Crosshole Seismic Testing

D 5088 Practices for Decontamination of Field Equipment Used at Waste Sites

D 5092 Practice for Design and Installation of Ground Water Monitoring Wells

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

D 5521 Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers

D 5782 Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D 5786 Practice for (Field Procedure) for Constant Drawdown Tests in Flowing Wells for Determining Hydraulic Properties of Aquifer Systems

3. Terminology

3.1 Terminology used within this guide is in accordance with Terminology D 653 with the addition of the following:

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bentonite*—the common name for drilling fluid additives and well-construction products consisting mostly of naturally occurring montmorillonite. Some bentonite products have chemical additives that may affect water-quality analyses.

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[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.

3.2.2 *bentonite granules and chips*—irregularly-shaped particles of bentonite (free from additives) that have been dried and separated into a specific size range.

3.2.3 *bentonite pellets*—roughly spherical- or disc-shaped units of compressed bentonite powder (some pellet manufacturers coat the bentonite with chemicals that may affect the water-quality analysis).

3.2.4 *cleanout depth*—the depth to which the end of the drill string (bit or core barrel cutting end) has reached after an interval of cutting. The cleanout depth (or drilled depth as it is referred to after cleaning out of any sloughed material in the bottom of the borehole) is usually recorded to the nearest 0.1 ft (0.03 m).

3.2.5 *coefficient of uniformity*— C_u (D), the ratio D_{60}/D_{10}, where D_{60} is the particle diameter corresponding to 60 % finer on the cumulative particle-size distribution curve, and D_{10} is the particle diameter corresponding to 10 % finer on the cumulative particle-size distribution curve.

3.2.6 *drawworks*—a power-driven winch, or several winches, usually equipped with a clutch and brake system(s) for hoisting or lowering a drilling string.

3.2.7 *drill hole*—a cylindrical hole advanced into the subsurface by mechanical means. Also known as a borehole or boring.

3.2.8 *drill string*—the complete rotary drilling assembly under rotation including bit, sampler/core barrel, drill rods and connector assemblies (subs). The total length of this assembly is used to determine drilling depth by referencing the position of the top of the string to a datum near the ground surface.

3.2.9 *filter pack*—also known as a gravel pack or primary filter pack in the practice of monitoring-well installations. The gravel pack is usually granular material, having selected grain-size characteristics, that is placed between a monitoring device and the borehole wall. The basic purpose of the filter pack or gravel envelope is to act as: a non-clogging filter when the aquifer is not suited to natural development or, act as a formation stabilizer when the aquifer is suitable for natural development.

3.2.9.1 *Discussion*—Under most circumstances a clean, quartz sand or gravel should be used. In some cases a pre-packed screen may be used.

3.2.10 *hoisting line—or drilling line*, is wire rope used on the drawworks to hoist and lower the drill string.

3.2.11 *in-situ testing devices*—sensors or probes, used for obtaining mechanical- or chemical-test data, that are typically pushed, rotated or driven below the bottom of a borehole following completion of an increment of drilling. However, some *in-situ testing devices* (such as electronic pressure transducers, gas-lift samplers, tensiometers, and so forth) may require lowering and setting of the device(s) in pre-existing boreholes by means of a suspension line or a string of lowering rods or pipes. Centralizers may be required to correctly position the device(s) in the borehole.

3.2.12 *mast*—or derrick, on a drilling rig is used for supporting the crown block, top drive, pulldown chains, hoisting lines, etc. It must be constructed to safely carry the expected loads encountered in drilling and completion of wells of the diameter and depth for which the rig manufacturer specifies the equipment.

3.2.12.1 *Discussion*—To allow for contingencies, it is recommended that the rated capacity of the mast should be at least twice the anticipated weight load or normal pulling load.

3.2.13 *piezometer*—an instrument placed below ground surface to measure hydraulic head at a point.

3.2.14 *subsurface water-quality monitoring device*— an instrument placed below ground surface to obtain a sample for analyses of the chemical, biological, or radiological characteristics of subsurface pore water or to make in-situ measurements.

4. Significance and Use

4.1 Casing advancement may be used in support of geoenvironmental exploration and for installation of subsurface water-quality monitoring devices in both unconsolidated and consolidated materials. Casing-advancement systems and procedures used for geoenvironmental exploration and instrumentation installations consist of direct air-rotary drilling utilizing conventional rotary bits or a down-the-hole hammer drill with underreaming capability, in combination with a drill-through casing driver.

NOTE 1—Direct air-rotary drilling uses pressured air for circulation of drill cuttings. In some instances, water or foam additives, or both, may be injected into the air stream to improve cuttings-lifting capacity and cuttings return. The use of air under high pressures may cause fracturing of the formation materials or extreme erosion of the borehole if drilling pressures and techniques are not carefully maintained and monitored. If borehole damage becomes apparent, consideration to other drilling method(s) should be given.

4.1.1 Casing-advancement methods allow for installation of subsurface water-quality monitoring devices and collection of water-quality samples at any depth(s) during drilling.

4.1.2 Other advantages of casing-advancement drilling methods include: the capability of drilling without the introduction of any drilling fluid(s) to the subsurface; maintenance of hole stability for sampling purposes and monitor-well installation/construction in poorly-indurated to unconsolidated materials.

4.1.3 The user of casing-advancement drilling for geoenvironmental exploration and monitoring-device installations should be cognizant of both the physical (temperature and airborne particles) and chemical (compressor lubricants and possible fluid additives) qualities of compressed air that may be used as the circulating medium.

4.2 The application of casing-advancement drilling to geoenvironmental exploration may involve soil or rock sampling, or in-situ soil, rock, or pore-fluid testing. The user may install a monitoring device within the same borehole wherein sampling, in-situ or pore-fluid testing, or coring was performed.

4.3 The subsurface water-quality monitoring devices that are addressed in this guide consist generally of a screened- or porous-intake device and riser pipe(s) that are usually installed with a filter pack to enhance the longevity of the intake unit, and with isolation seals and low-permeability backfill to deter the movement of fluids or infiltration of surface water between hydrologic units penetrated by the borehole (see Practice

D 5092). Inasmuch as a piezometer is primarily a device used for measuring subsurface hydraulic heads, the conversion of a piezometer to a water-quality monitoring device should be made only after consideration of the overall quality and integrity of the installation to include the quality of materials that will contact sampled water or gas. Both water-quality monitoring devices and piezometers should have adequate casing seals, annular isolation seals and backfills to deter communication of contaminants between hydrologic units.

5. Apparatus

5.1 Casing-advancement systems and procedures used for geoenvironmental exploration and instrumentation installations include: direct air rotary in combination with a drill-through casing driver, and conventional rotary bits or down-the-hole hammer drill with or without underreaming capability. Each of these methods requires a specific type of drill rig and tools.

NOTE 2—In North America, the sizes of casings bits, drill rods and core barrels are standardized by American Petroleum Institute (API)[3] and the Diamond Core Drill Manufacturers Association (DCDMA). Refer to the DCDMA Technical Manual[4] and to published materials of API for available sizes and capacities of drilling tools equipment.

5.1.1 Direct air-rotary drill rigs equipped with drill-through casing drivers have a mast-mounted, percussion driver that is used to set casing while simultaneously utilizing a top-head rotary-drive unit. The drill string is generally advanced with bit being slightly ahead of the casing. Fig. 1 shows the various components of the drill-through casing driver system. Other mechanical components include casings, drill rods, drill bits, air compressors, pressure lines, swivels, dust collectors, and air-cleaning device (cyclone separator).

5.1.1.1 *Mast-Mounted Casing Driver*, using a piston activated by air pressure to create driving force. Casing drivers are devised to principally drive casing down while drilling but they can also be used to drive the casing upward for casing removal.

5.1.1.2 *Standard Casings*, driven with the casing driver. The bottom of the casing is equipped with a forged or cast alloy drive shoe. The top of the casing fits into the casing driver by means of an anvil. In hard formations casings may be welded at connections for added stability. The casing size is usually selected to provide a drill hole of sufficient diameter for the required sampling or testing or for insertion of instrumentation device components such as the screened intake and filter pack and installation devices such as a tremie pipe.

5.1.1.3 Other considerations for selection of casing size are borehole depth and formation type. The casing size should allow for adequate annulus between the casing and the drill rod for upward discharge of cuttings. Also, consideration should be made when difficult formations are expected to require telescoping from larger to smaller casing diameters.

5.1.1.4 *Drill Rods*, used inside the casing for rotary air drilling. The rods extend through the casing driver and are connected to a top-head drive motor for rotation and transfer of rotational force from the drill rig to the bit or core barrel. Drill rod and casing are usually assembled as a unit and raised into position on the mast. Individual drill rods should be straight so they do not contribute to excessive vibrations or "whipping" of the drill-rod column. All threaded connections should be in good repair and not leak significantly at the internal air pressure required for drilling. Drill rods should be made up securely by wrench tightening at the threaded joint(s) at all times to prevent rod damage. Drill pipes usually require lubricants on the threads to allow easy unthreading (breaking) of the connecting joints. Some lubricants have organic or metallic constituents, or both, that could be interpreted as contaminants if detected in a sample. Various lubricants are available that have components of known chemistry. The effect of pipe-thread lubricants on chemical analyses of samples should be considered and documented when using casing-advancement drilling. The same consideration and documentation should be given to lubricants used with water swivels, hoisting swivels, or other devices used near the drilling axis.

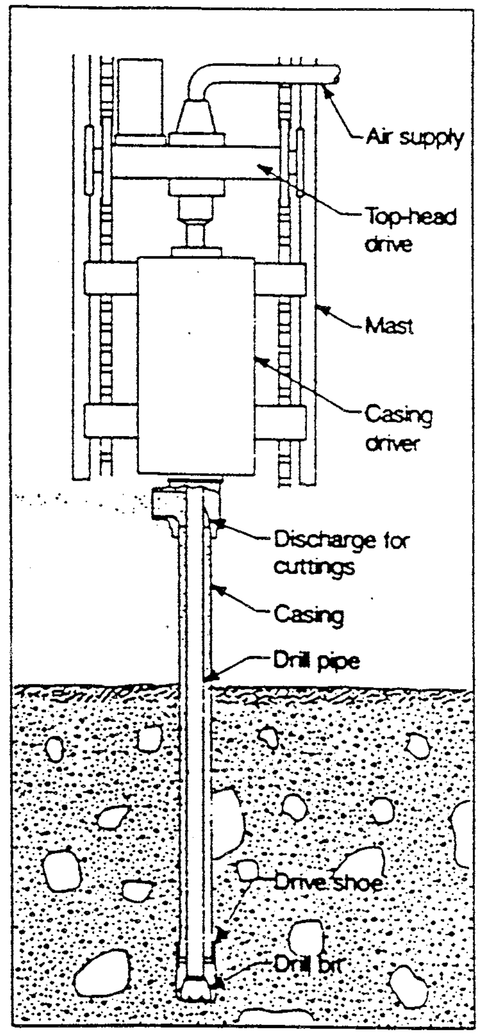

FIG. 1 Casing Drivers can be Fitted to Top-Head Drive Rotary Rigs to Simultaneously Drill and Drive Casing

[3] American Petroleum Institute, "API Specifications for Casing, Tubing, and Drill Pipe," *API Spec 5A*, (API), 1220 L. St., NW, Washington, DC 20005.

[4] *DCDMA Technical Manual*, Drilling Equipment Manufacturers Association, 3008 Millwood Avenue, Columbia, SC 29205, 1991.