Designation: D7352 – 07 (Reapproved 2012)

Standard Practice for Direct Push Technology for Volatile Contaminant Logging with the Membrane Interface Probe (MIP)[1,2]

This standard is issued under the fixed designation D7352; 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 standard practice describes a method for rapid delineation of volatile organic contaminants (VOC) in the subsurface using a membrane interface probe. Logging with the membrane interface probe is usually performed with direct push equipment.

1.2 This standard practice describes how to obtain a real time vertical log of volatile organic contaminants with depth. The data obtained is indicative of the total volatile organic contaminant concentration in the subsurface at depth.

1.3 Other sensors, such as electrical conductivity, fluorescence detectors, and cone penetration tools may be included to provide additional information. The use of a lithologic logging tool is highly recommended to define hydrostratigraphic conditions, such as migration pathways, and to guide confirmation sampling.

1.4 *Limitations*—The MIP system does not provide specificity of analytes. This tool is to be used as a total volatile organic contaminant-screening tool. Soil and/or water sampling (Guides D6001, D6282, D6724, and Practice D6725) must be performed to identify specific analytes and exact concentrations. Only VOCs are detected by the MIP system in the subsurface. Detection limits are subject to the selectivity of the gas phase detector applied and characteristics of the formation being penetrated (for example, clay and organic carbon content).

1.5 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. 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 the consideration of a project's many unique aspects. The word "standard" in the title means that the document has been approved through the ASTM consensus process.*

1.6 *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:*[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D5299 Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities

D6001 Guide for Direct-Push Groundwater Sampling for Environmental Site Characterization

D6282 Guide for Direct Push Soil Sampling for Environmental Site Characterizations

D6724 Guide for Installation of Direct Push Groundwater Monitoring Wells

D6725 Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers

E355 Practice for Gas Chromatography Terms and Relationships

3. Terminology

3.1 Terminology used within this practice is in accordance with Terminology D653 with the addition of the following:

3.2 *Definitions:*

3.2.1 *carry over*—retention of contaminant in the membrane and trunkline which may result in false positive results or an increased detector baseline at subsequent depth intervals.

---

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

Current edition approved Oct. 15, 2012. Published November 2012. Originally approved in 2007. Last previous edition approved in 2007 as D7352–07. DOI: 10.1520/D7352-07R12.

[2] The Membrane Interface Probe is covered by a patent. Interested parties are invited to submit information regarding the identification of an alternative(s) to this patented item to the ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

[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.

3.2.2 *closed couple flow*—gas flow in the MIP system when a probe is detached and the gas lines are coupled together. The flow is then measured with a gas flow meter on the return tubing before entering the gas phase detectors. Used to verify continuity of gas flow in the MIP system.

3.2.3 *gas dryer*—a selectively permeable membrane tubing (Nafion®) is used to continuously dry the MIP carrier gas stream by removing only water vapor.

3.2.4 *gas phase detectors*—heated laboratory grade detectors used for gas chromatography (Practice E355). Gas effluent from the MIP flows through these detectors for the analysis of VOC compounds. Detectors most often used with the MIP include photoionization detector (PID), flameionization detector (FID), and an electron capture detector (ECD).

3.2.5 *membrane interface probe (MIP)*—a subsurface logging tool for detection of volatile organic compounds (VOCs).

3.2.6 *response test*—a test of the working MIP system performed by placing the MIP probe in an aqueous phase solution with a known contaminant of known concentration. Performed before each MIP log is conducted and one at the end of the working day to validate the MIP system performance. Also used to compare data from individual locations.

3.2.7 *trigger*—mechanical interface between the operator and instrumentation to initiate or terminate data collection.

3.2.8 *trip time*—the time required for a contaminant to penetrate the semi-permeable membrane and travel to the gas phase detectors at the surface through a fixed length of tubing.

3.2.9 *trunkline*—plastic or metal jacketed cord containing electrical wires for the heaters in the probe block, electrical wires for other sensors, and tubing for the transport of carrier gas and the contaminant to the surface and detectors.

3.2.10 *working standard*—a chemical standard used in response testing the MIP system. This standard is a diluted concentration of an analyte stock standard, used for one application and then properly disposed.

4. Summary of Practice

4.1 This practice describes the field method for delineation of volatile organic contaminants with depth via the Membrane Interface Probe (MIP). The MIP is a continuously sampling tool advanced through the soil using a direct push machine for the purpose of logging contaminant and lithologic data in real time (**1, 2**).[4]

4.2 A semipermeable membrane on the probe is heated to a temperature of 100 to 120°C. Clean carrier gas is circulated across the internal surface of the membrane carrying volatile organic contaminants, which have diffused (**3**) through the membrane, to the surface for analysis by gas phase detectors.

5. Significance and Use

5.1 The MIP system provides a timely and cost effective way (**4**) for delineation of volatile organic contaminants (for example, benzene, toluene, solvents, trichloroethylene, tetrachloroethylene) with depth (**5, 6**). Recent investigation (**2**) has found the MIP can be effective in locating zones where dense nonaqueous phase liquids (DNAPL) may be present. MIP provides real-time measurement for optimizing selection of sample locations when using a dynamic work plan. By identifying the depth at which a contaminant is located, a more representative sample of soil or water can be collected.

5.2 Correlation of a series of MIP logs across a site can provide 2-D and 3-D definition of the contaminant plume. When lithologic logs are obtained (EC, CPT, etc.) with the MIP data, contaminant migration pathways may be defined.

5.3 The MIP logs provide a detailed record of contaminant distribution in the saturated and unsaturated formations. A proportion of the chlorinated and non-chlorinated volatile organic contaminants in the sorbed, aqueous, or gaseous phases partition through the membrane for detection up hole.

5.4 The data obtained from application of this practice may be used to guide soil (Guide D6282) and groundwater sampling (Guide D6001) or placement of long-term monitoring wells (Guide D6724).

5.5 MIP data can be used to optimize site remediation by knowing the depth distribution of volatile organic contaminants. For example, materials injected for remediation are placed at correct depths in the formation.

5.6 This practice also may be used as a means of evaluating remediation performance. MIP can provide a cost-effective way to monitor the progress of remediation. When properly performed at suitable sites, logging locations can be compared from the initial investigation to the monitoring of the contaminant under remediation conditions.

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. Practitioners that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard 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 testing and/or inspection of soils and rock. As such, it is not totally applicable to agencies performing this practice. However, users 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.

6. Apparatus

6.1 *General*—The following discussion provides descriptions and details for the Membrane Interface Probe and system components (Fig. 1). Additional details on the MIP system are available in the Geoprobe MIP SOP (**1**).

6.1.1 *The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

6.2 *Membrane Interface Probe*—The MIP is the interface between the bulk formation and the gas phase detectors up

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

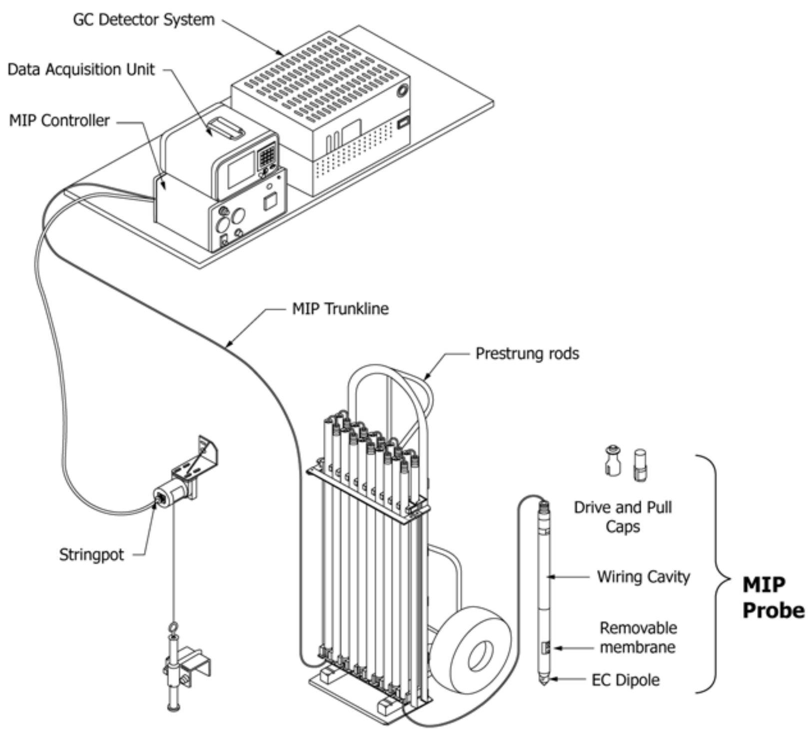

FIG. 1 The Primary Components of the Membrane Interface System

hole. Volatile compounds outside the probe diffuse across the membrane and are swept up hole via an inert carrier gas (Fig. 2).

6.2.1 The membrane is set in a removable insert. It is constructed of a polymer coating impregnated into stainless steel wire mesh.

6.2.2 The membrane is inserted into a heater block. The elevated temperature of the heater block is used to speed the diffusion of contaminants out of the bulk formation and through the membrane. This heater block has a regulated temperature typically set at 100 to 120°C.

6.2.3 Tubing is used to supply carrier gas to the membrane. Two tubes are used: a supply tube running from the carrier gas source to the membrane and a return tube running from the membrane to the gas phase detectors at ground surface.

6.2.4 The MIP system may be configured with a soil electrical conductivity dipole for simultaneous collection of general lithologic data.

6.2.5 The MIP probe may be coupled to a CPT probe at its lower end for simultaneous collection of CPT data (Fig. 3).

6.3 *MIP Trunkline*—This cable consists of electrical wires for heating the MIP heater block and supplying voltage to additional sensors. The trunkline also contains gas lines for the transport of VOCs from the probe to detectors up-hole. This trunkline is packaged in a durable, protective jacketing to be prestrung through steel drive rods prior to logging (Fig. 2).

6.4 *MIP Controller*—The MIP controller is used to control the flow delivered to the membrane and the voltage delivered to the heater block and electrical conductivity dipole electrode. The primary features of the MIP controller include:

6.4.1 Primary pressure regulator to control the pressure of carrier gas to the flow regulation circuit of the MIP controller.

6.4.2 A mass flow controller is used to regulate the flow of carrier gas through the MIP system. Typical flow rates of 20 to 60 mL/min are used in the operation of the membrane interface probe.

6.4.3 Temperature controller regulates the voltage supplied to the heater block to maintain an elevated temperature in the subsurface. The temperature controller has two outputs on an LCD. The top output is the temperature of the membrane in the heater block. The bottom output is the set temperature of the controller; the manufacturer sets this temperature at 121°C.

6.4.4 Analog signal input from the detector system. The analog outputs from the gas phase detectors are connected to the controller to be transferred to the data acquisition system.

6.5 *Data Acquisition System*—The primary purpose of this system is to save and graph data collected from the MIP probe and detector system in real time. The data saved by the acquisition system are: depth; soil electrical conductivity; rate of probe penetration into the subsurface; temperature of the probe; pressure of the carrier gas supply at the flow controller; and four possible gas phase detector inputs. The primary components of the data acquisition system include:

6.5.1 Alpha/numeric keypad for entry of site location information,

6.5.2 Internal and/or external data storage device for transfer of data from acquisition system to desktop or laptop computers, and