



Designation: D5314 – 92(Reapproved 2006)

## Standard Guide for Soil Gas Monitoring in the Vadose Zone<sup>1</sup>

This standard is issued under the fixed designation D5314; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This guide covers information pertaining to a broad spectrum of practices and applications of soil atmosphere sampling, including sample recovery and handling, sample analysis, data interpretation, and data reporting. This guide can increase the awareness of soil gas monitoring practitioners concerning important aspects of the behavior of the soil-water-gas-contaminant system in which this monitoring is performed, as well as inform them of the variety of available techniques of each aspect of the practice. Appropriate applications of soil gas monitoring are identified, as are the purposes of the various applications. Emphasis is placed on soil gas contaminant determinations in certain application examples.

1.2 This guide suggests a variety of approaches useful to successfully monitor vadose zone contaminants with instructions that offer direction to those who generate and use soil gas data.

1.3 This guide does not recommend a standard practice to follow in all cases nor does it recommend definite courses of action. The success of any one soil gas monitoring methodology is strongly dependent upon the environment in which it is applied.

1.4 Concerns of practitioner liability or protection from or release from such liability, or both, are not addressed by this guide.

1.5 This guide is organized into the following sections and subsections that address specific segments of the practice of monitoring soil gas:

| Section |                                                                                                                   |
|---------|-------------------------------------------------------------------------------------------------------------------|
| 4       | Summary of Practice                                                                                               |
| 4.1     | Basic principles, including partitioning theory, migration and emplacement processes, and contaminant degradation |
| 4.7     | Summary Procedure                                                                                                 |
| 5       | Significance and Use                                                                                              |
| 6       | Approach and Procedure                                                                                            |
| 6.1     | Sampling Methodology                                                                                              |
| 6.5     | Sample Handling and Transport                                                                                     |
| 6.6     | Analysis of Soil Gas Samples                                                                                      |

<sup>1</sup> This guide 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.

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6.7 Data Interpretation  
7 Reporting

1.6 *This guide does not purport to set standard levels of acceptable risk. Use of this guide for purposes of risk assessment is wholly the responsibility of the user.*

1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 *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.*

1.9 *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:<sup>2</sup>

- D653 Terminology Relating to Soil, Rock, and Contained Fluids
- D1356 Terminology Relating to Sampling and Analysis of Atmospheres
- D1357 Practice for Planning the Sampling of the Ambient Atmosphere
- D1452 Practice for Soil Exploration and Sampling by Auger Borings
- D1605 Practices for Sampling Atmospheres for Analysis of

<sup>2</sup> 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.

Gases and Vapors (Withdrawn 1992)<sup>3</sup>

- D1914 Practice for Conversion Units and Factors Relating to Sampling and Analysis of Atmospheres
- D2652 Terminology Relating to Activated Carbon
- D2820 Test Method for C Through C Hydrocarbons in the Atmosphere by Gas Chromatography (Withdrawn 1993)<sup>3</sup>
- D3249 Practice for General Ambient Air Analyzer Procedures
- D3416 Test Method for Total Hydrocarbons, Methane, and Carbon Monoxide (Gas Chromatographic Method) (Withdrawn 1992)<sup>3</sup>
- D3584 Practice for Indexing Papers and Reports on Soil and Rock for Engineering Purposes (Withdrawn 1996)<sup>3</sup>
- D3614 Guide for Laboratories Engaged in Sampling and Analysis of Atmospheres and Emissions
- D3670 Guide for Determination of Precision and Bias of Methods of Committee D22
- D3686 Practice for Sampling Atmospheres to Collect Organic Compound Vapors (Activated Charcoal Tube Adsorption Method)
- D3687 Practice for Analysis of Organic Compound Vapors Collected by the Activated Charcoal Tube Adsorption Method
- D4220 Practices for Preserving and Transporting Soil Samples
- D4490 Practice for Measuring the Concentration of Toxic Gases or Vapors Using Detector Tubes
- D4597 Practice for Sampling Workplace Atmospheres to Collect Gases or Vapors with Solid Sorbent Diffusive Samplers
- D4696 Guide for Pore-Liquid Sampling from the Vadose Zone
- D4700 Guide for Soil Sampling from the Vadose Zone
- D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
- E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
- E260 Practice for Packed Column Gas Chromatography
- E355 Practice for Gas Chromatography Terms and Relationships
- E594 Practice for Testing Flame Ionization Detectors Used in Gas or Supercritical Fluid Chromatography
- E697 Practice for Use of Electron-Capture Detectors in Gas Chromatography

### 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *capillary fringe*—the basal region of the vadose zone comprising sediments that are saturated, or nearly saturated, near the water table, gradually decreasing in water content with increasing elevation above the water table. Also see Terminology D653.

3.1.2 *contaminant*—substances not normally found in an environment at the observed concentration.

3.1.3 *emplacement*—the establishment of contaminant residence in the vadose zone in a particular phase.

3.1.4 *free product*—liquid phase contaminants released into the environment.

3.1.5 *free vapor phase*—a condition of contaminant residence in which volatilized contaminants occur in porosity that is effective to free and open gaseous flow and exchange, such porosity generally being macroporosity.

3.1.6 *liquid phase*—contaminant residing as a liquid in vadose zone pore space, often referred to as “free product.”

3.1.7 *macroporosity*—large intergranular porosity with large pore throats, including soil cracks, moldic porosity, animal burrows and other significant void space.

3.1.8 *microporosity*—intragranular porosity and microscopic intergranular porosity with submicroscopic pore throats.

3.1.9 *occluded vapor phase*—condition of contaminant residence in which volatilized contaminants occur in porosity that is ineffective to free and open gaseous flow and exchange, such porosity generally being microporosity; frequently termed dead-end pore space.

3.1.10 *partitioning*—the act of movement of contaminants from one soil residence phase to another.

3.1.11 *soil gas*—vadose zone atmosphere.

3.1.12 *solute phase*—a condition of contaminant residence in which contaminants are dissolved in groundwater in either the saturated or the vadose zone.

3.1.13 *sorbed phase*—a condition of contaminant residence in which contaminants are adsorbed onto the surface of soil particles or absorbed by soil organic matter.

3.1.14 *vadose zone*—the hydrogeological region extending from the soil surface to the top of the principal water table.

### 4. Summary of Guide

4.1 Soil gas monitoring in the vadose zone is a method used to directly measure characteristics of the soil atmosphere that are frequently utilized as an indirect indicator of processes occurring in and below a sampling horizon. Soil gas monitoring is used as a method to suggest the presence, composition, and origin of contaminants in and below the vadose zone. Among other applications, this method is also employed in the exploration for natural resources, including petroleum, natural gas and precious metals. Soil gas monitoring is a valuable screening method for detection of volatile organic contaminants, the most abundant analytical group of groundwater contaminant compounds (1).<sup>4</sup>

4.2 *Basic Theoretical Principles*—The processes indicated by the soil gas monitoring method are partitioning, migration, emplacement and degradation. Partitioning represents a group of processes that control contaminant movement from one physical phase to another, these phases being liquid, free vapor (that is, through-flowing air (2)), occluded vapor (that is, locally accessible air and trapped air (2)), solute and sorbed.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> The boldface numbers given in parentheses refer to a list of references at the end of the text.