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Standard Guide for Placement and Use of Diffusion Controlled Passive Monitors for Gaseous Pollutants in Indoor Air[1]

This standard is issued under the fixed designation D6306; 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 the placement and use of diffusion controlled monitors in the indoor atmosphere.

1.2 Diffusion controlled passive monitors within this guide include both area and personal monitors for use in residences, public buildings, offices, and other non-industrial workplaces and dwelling environments. A passive monitor is any air monitor that does not utilize electrical or mechanical power in order to supply air to the sorbent media or chemical reactant within the monitor and sample according to Fick's first law of diffusion.

1.3 The purpose of this guide is to ensure uniformity of sampling within a variety of indoor environments and to facilitate comparison of results.

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

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D1357 Practice for Planning the Sampling of the Ambient Atmosphere

D4597 Practice for Sampling Workplace Atmospheres to Collect Gases or Vapors with Solid Sorbent Diffusive Samplers

D3614 Guide for Laboratories Engaged in Sampling and Analysis of Atmospheres and Emissions

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide refer to Terminology D1356.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *passive monitor*—a diffusion controlled air monitor that does not utilize electrical or mechanical power in order to supply air to the sorbent media or chemical reactant within the monitor. These monitors may be worn by an individual (personal passive monitor) or used as sampling devices within specific locations (area passive monitor).

4. Summary of Guide

4.1 Contaminants in air are sampled by collection with a sorbent or chemically reactive medium in order to undergo subsequent analysis for determination of concentration. Contaminants in air are transported to the sorption medium or reacting chemical through vapor or gas diffusion. During the sampling process, the compounds, in a molecular state, diffuse from the environment adjacent to the sampler through a first region of defined geometric structure and into a second adsorbing region containing the sorbent.

4.2 Guidance is provided for the placement, handling, and use of passive air monitors within an indoor environment.

5. Significance and Use

5.1 The objective of this guide is to provide guidance for the placement and use of passive monitors that when uniformly applied enables the user to eliminate many interferences in the sampling of indoor air. Since the analysis of the indoor environment by passive air monitors is influenced by many factors other than the method of sampling, efforts are made to minimize interfering factors and maintain the air at conditions typical of the measurement location within the vicinity of the passive air monitor. However, when performing diagnostic or special measurements, non-typical indoor air environment conditions may be desirable or required. Thus, the objectives of a sampling study may determine the conditions needed for sampling.

[1] This method is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.05 on Indoor Air.

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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.

5.2 Passive sampling provides for time integrated measurements. Passive monitors are usually placed in an indoor environment over a time period to obtain a cumulative sample; hence, interfering factors should be anticipated and eliminated where possible. Passive monitors often lack the sensitivity to measure short-term peak concentrations.

5.3 With suitable instruction regarding placement of passive monitors, placement and retrieval of the monitors can be performed by unskilled personnel (for example, occupants).

6. General Principles

6.1 The choice of a passive monitor, characteristics of the sampling site, number of sampling points, number of monitors, and number of sampling periods depends on the objectives of the monitoring program.

6.2 Passive monitors rely on air currents within an indoor environment for circulation of a representative sample atmosphere to the vicinity of the monitor. Therefore, it is essential that air circulation in the vicinity of the sampler be sufficient to keep the boundary layer thin enough so that the analyte can diffuse across it, preventing a localized concentration depletion by the monitor. The adequacy of the sampling is directly influenced by the location and subsequent exposure of the monitor to a representative indoor atmosphere.

6.3 The objective of the study may affect the type of monitor selected and the location of placement. In general terms, Practice D1357 will acquaint the user with established overall study considerations.

7. Sampling with Passive Monitors

7.1 Inspect the monitor and package carefully. The monitor or its protective packaging may have been damaged during shipment. The user should not directly contact the monitor with bare skin and, in no case, permit anything to contact the sampling face.

7.2 *Calibration of the Passive Monitor*—Information relating to calibration may be found in Practice D4597. These documents also provide information relating to the determination of the required minimum sampling time.

7.3 The sampling period begins when lid, cover, or protective container of the monitor is removed to permit sampling by the monitor. The starting time of the sampling period should be transcribed to a logbook or appropriate form and on the monitor label. The writing instrument, for example, markers, should not provide the potential of contamination to the monitor. A means of resealing or replacing the monitor lid or cover should be ensured.

7.4 The monitor should have a permanently attached identification code or serial number that should be transcribed to a logbook or an appropriate form. The logbook should include information describing the location of the monitor and pertinent information regarding the building and deployment area, such as construction, type of heating system, insulation, occupancy number and patterns, and major appliance location. A room deployment should additionally list location within the room: activities, general location of furnishings, possible sinks/sources, vents, and other relevant features. Include a diagram of the sampling location and building, depicting the information listed in this subsection. If the occupant deploys the monitor, sufficient instructions should be included regarding proper location and sampling procedures. A form should be included for easy collection of occupant information necessary for logbook entries.

7.5 If the monitor is deployed for other than a screening measurement, the monitor should be placed by an experienced professional familiar with the monitor used. For specific diagnostic measurements, a deviation from the guidelines in this document is permissible.

7.6 *Recovery of the Passive Monitor:*

7.6.1 The sampling period is terminated when the monitor is sealed and removed from the sampling environment.

7.6.2 Record the time and date for measurement termination in a logbook or on any appropriate form and on the monitor label. Any damage to the monitor or variation in the monitor placement since deployment should be noted in the logbook or on any appropriate form.

7.6.3 Adequate information should be entered into the logbook to permit interpretation of results and comparison to similar measurements. Any variation in the sampling location, building structure, or building systems should be noted.

7.6.4 The monitor should be analyzed within time specifications of the specific monitor used.

8. Procedure

8.1 *Factors Affecting Use of Passive Monitors:*

8.1.1 *Detection Limit*—The detection limit for the passive monitor may preclude obtaining useful results if the concentration in the test area is insufficient to exceed the detection limit during the minimum sampling duration.

8.1.1.1 *Minimum Sampling Duration*—The duration of sampling can affect the results obtained. If the concentration in the air is low, a short sampling time may not produce an acceptable mass of sampled material on the monitor. Monitors may require a minimum sampling duration to achieve representative results.

8.1.2 *Accuracy*—The accuracy of the monitor selected should be appropriate for the testing purpose. The duration of sampling and the exposure concentration may affect the technically claimed accuracy (see 10.2).

8.1.3 *Precision*—Precision of all monitors should be determined for each use through the application of field blank samples, duplicates, and laboratory controls. Five percent of the monitors should be held for blanks and 10 % used as duplicates (see 10.2).

8.1.4 *Selectivity*—The monitor chosen should be as selective as possible for the contaminant species and concentration range of interest to avoid problems of interference.

8.1.5 *Interferences*—Some passive monitors will measure multiple contaminants as a single integrated result, that is, poor selectivity. The concentration of the interfering species may or may not significantly affect the results of the intended species of interest. Any interfering species should be investigated for concentration and deleterious effect upon the results of the species of interest.

8.1.6 *Sampling Rate Air Velocity*—Most passive monitors operate on the principle of diffusion; hence, either excessive airflow that modifies calibrated diffusion or lack of airflow causing a starvation effect will impact adversely on the resulting measurement through altering the sampling rate.

8.1.7 *Performance Factors*—The monitor may not be 100 % efficient as a means of capture, adhesion, absorption, reaction, and so forth. The required performance must be considered for monitor selection with regards to detection limits and final results likely to be encountered.

8.1.7.1 *Temperature*—Monitors should only be deployed under the suggested range of operating temperatures.

8.1.7.2 *Humidity*—Monitors should be deployed only under the suggested range of operating humidities. Humidity may interfere with the operation of some monitors.

8.1.8 *Proximity of Sources*—Deployment of the monitor near a source of the species of interest or of an interfering species may result in non-representative results. Where known sources exist, efforts should be made to deploy the monitor in a more representative location unless sampling in the vicinity of that source/sink forms an integral part of the sampling strategy. Known sources should be listed in a logbook or on an appropriate form.

8.2 *Deployment:*

8.2.1 The monitors should be deployed as early as possible within limitations of any known or indicated storage life.

8.2.2 Collocated monitors should be deployed at the same time, either as duplicates or concurrent samples, depending upon the objectives of the measurements.

9. Selection of Monitoring Locations

9.1 *Passive Air Monitors*—Personal.

9.1.1 *Breathing Zone*—The location in the atmosphere at which persons breathe. This measurement location is intended to represent the air actually inhaled by the study subject. However, exhaled air will also be sampled at this location. Therefore, exhaled gases may be detected that were not initially present in the atmosphere surrounding the subject.

9.1.2 *Other Locations*—These locations are generally selected for the sake of convenience or comfort for the subject. The selected location must conform to the needs of the study and be free of potential obstruction to the sampling environment and the subject.

9.2 *Passive Monitors*—Area.

9.2.1 *Building Measurements*—For a complete building, monitors should be placed at representative locations considering each floor, room, activity area, and zone of the HVAC system. No single measurement can provide adequate information regarding concentration for an entire building.

9.2.1.1 *Locations*—The location of placement for a passive monitor must consider the space served by each HVAC system, the type and the level of activity, and occupant traffic occurring within the placement zone. The purpose of testing will determine whether and where additional monitors should be placed separately. The location may be selected to compare health concerns (case versus control) or with varying proximity.

9.2.1.2 *Indoor Atmospheric Conditions:*

(a) The monitor should be placed in a central location that is both unobstructed and representative of the actual used area of the room. The location should not interfere with normal occupant activities.

(b) Humidity—Locations near water basins, tubs, showers, stoves, washers, driers, humidifiers/dehumidifiers, or other known sources/sinks of humidity should be avoided.

(c) Temperature—Locations near furnaces, vents, sinks, tubs, showers, electric lights, air conditioners, or other devices that may directly or indirectly generate heat/cold should be avoided.

(d) Meteorologic—Locations in direct sunlight or near seasonal or short-term variations from weather should be avoided, for example, near windows, drafty openings, and intake/exhaust vents.

(e) Airflow—Locations in direct airflow, such as near HVAC vents, appliance fan vents, and computer cooling fans, should be avoided. Areas with a known air-flow due to pressure differentials between rooms should be avoided. Air with insufficient circulation to provide a representative atmosphere to the monitor should be avoided.

9.2.1.3 *Spatial Considerations*—The monitors should be placed in open and unobstructed positions where typical air circulation will be adequate. The monitor should be placed at least 20 cm below the ceiling (but not near lighting or air vents), 50 cm above the floor, and 15 cm from a wall. Locations near outside walls should be avoided, if possible. Suspension by thread from the ceiling may be suitable. Placement on shelves or in corners is undesirable. The motion experienced by thread suspension of monitors may help prevent air starvation of the monitor (see 6.2). The passive monitor should be located where air circulation will provide at least the required minimum air velocity required for diffusion.

9.2.1.4 *Occupant and Activity Considerations*—The monitor should be placed out of reach of small children and pets; the location should not hinder typical occupant activities. The monitor should not be placed near suspected sources/sinks unless sampling in the vicinity of that source/sink forms an integral part of the sampling strategy. The monitor should be placed in a location that is agreeable to the occupant(s).

10. Quality Assurance

10.1 A quality assurance program should include all of the activities necessary to provide measurement data at requisite precision and accuracy. Airflow measurements should be made at the sampling locations to be sure that the conditions are acceptable for the monitors to be used.

10.2 Guidelines for a quality assurance program are outlined in Guide D3614.

10.2.1 Under ideal circumstances, a number of replicate measurements should be obtained at each measurement site. Practically, a sufficient number of replicates should be obtained to ensure the requisite precision needed. At least one duplicate/collocated sample or 10 % of the field samples should be collocated. Only one passive monitor may be sufficient if screening is the study objective.

10.2.2 A field blank (unexposed monitor) should be deployed and retrieved concurrent with the exposed air monitors.

At least one field blank or a number equivalent to 10 % of the field samples, whichever is larger, should be shipped and analyzed with each group of samples.

10.2.3 A reference blank from each lot of monitors should be retained in a non-contaminated laboratory atmosphere. The field blank data and reference blank data should be in agreement.

10.2.4 Data collection and recording procedures should be specified to identify responsibility for record keeping, analysis of recorder chart records, conversion to computer format, and method and frequency of reporting. Specifications should be included for safe-guarding equipment, samples, and records. Maintain the chain of evidence and custody within records in case data are required for legal purposes.

10.2.5 Sample shipment and storage procedures should be documented, especially if the methods used impose any limits on time delay prior to analysis, refrigeration, or other storage conditions/precautions in sample handling.

10.2.6 Methods of computation after analysis or of automatic data recording should be specified, including data validation procedures used to minimize errors in computation or record keeping.

10.2.7 Independent audits of the entire measurement program by an outside agency are helpful. During the audit, parallel sampling and analysis are conducted independently to verify the precision and accuracy of the final results. Simultaneous independent analysis of ambient atmospheres can be used as well as independent measurements using cylinder gases or other calibration standards.

11. Keywords

11.1 diffusion; indoor air; monitor; passive sampling; sampler