Designation: D5438 – 23

Standard Practice for Collection of Floor Dust for Chemical Analysis[1]

This standard is issued under the fixed designation D5438; 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 practice covers a procedure for the collection of a sample of dust from carpets and bare floors that can be analyzed for inorganic metals such as lead and organic compounds such as pesticides and other semi-volatile organic compounds (SVOCs).

1.2 This practice is applicable to a variety of carpeted and bare floor surfaces. It has been tested for level loop and plush pile carpets and bare wood floors, specifically. This practice is not applicable to elevated, non-floor surfaces.

1.3 This practice is not intended for the collection and evaluation of dust for the presence of asbestos fibers.

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 practice describes use of a sampling device, the High-Volume Small Surface Sampler (HVS3). Other event-based sampling devices that use commercially available vacuum attachments are not in scope. Composite sampling using whole vacuum cleaner bags is not in scope. Other approaches for floor or non-floor surface sampling (Practices D6966, D6661, D7144) are not within the scope.

1.6 This practice only applies to the HVS3. Other dust sampling methods may or may not be directly comparable. Method evaluation for other dust sampling approaches is encouraged. This could be done by comparison with methods outlined in this standard practice for HVS3 or through independent evaluation using field spikes and certified reference materials.

1.7 This practice provides information on dust loading, chemical dust concentration, and chemical dust loading. Information on the type of floor, the floor surface area sampled, and amount of dust collected is required (see Fig. 2). Cleaning the vacuum attachments in between sampling events is also required (see Section 13).

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *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:*[2]

D422 Test Method for Particle-Size Analysis of Soils (Withdrawn 2016)[3]
D1356 Terminology Relating to Sampling and Analysis of Atmospheres
D6661 Practice for Field Collection of Organic Compounds from Surfaces Using Wipe Sampling
D6966 Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Determination of Metals
D7144 Practice for Collection of Surface Dust by Micro-vacuum Sampling for Subsequent Determination of Metals and Metalloids
E1 Specification for ASTM Liquid-in-Glass Thermometers
E337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)
E1137/E1137M Specification for Industrial Platinum Resistance Thermometers
E1195 Test Method for Determining a Sorption Constant (K_{oc}) for an Organic Chemical in Soil and Sediments (Withdrawn 2013)[3]
E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

[1] This practice 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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

F608 Test Method for Evaluation of Carpet Embedded Dirt Removal Effectiveness of Household/Commercial Vacuum Cleaners

3. Terminology

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

3.1.1 *carpet-embedded dust, n*—soil and other particulate matter, approximately 5 µm equivalent aerodynamic diameter and larger, embedded in carpet pile and normally removable by household vacuum cleaners.

3.1.2 *debris, n*—items (that is, bug parts, plastics, foam, matted hair, gravel, etc.,) that would not pass through a 2 mm sieve and would not be considered surface dust or carpet-embedded dust.

3.1.3 *particle size fraction bins, n*—the mass of surface dust or carpet-embedded dust present between two particle-size values.

3.1.3.1 *Discussion*—While this standard practice refers to 150 µm, other potential particle-size values such as 20 µm, 63 µm, 75 µm, 250 µm, 1 mm, 2 mm, and others could be used to define particle size fraction bins. See Specification E1195 for standard number sieves matched to different particle-sizes.

3.1.4 *surface dust, n*—soil and other particulate matter, approximately 5 µm equivalent aerodynamic diameter and larger, adhering to floor surfaces and normally removable by household vacuum cleaners.

4. Summary of Practice

4.1 The sampling method described in this practice is taken from work published in Roberts et al. (**1-3**),[4] and Stamper et al. (**4**). Appendix F of this published report also contains information on the construction of the HVS3 sampler (**5**).

4.2 Particulate matter is withdrawn from the carpet or bare floor by means of vacuum-induced suction which draws through a sampling nozzle at a specific velocity and flow rate, and the particles are separated mechanically by a cyclone. The cyclone is designed to efficiently separate and collect particles approximately 5 µm mean aerodynamic diameter and larger. However, much smaller particles are also collected at unknown efficiencies. The sampling system allows for height, air flow, and suction adjustments to reproduce systematically a specific air velocity for the removal of particulate matter from carpeted and bare floor surfaces, so that these sampling conditions can be repeated.

NOTE 1—Side-by-side comparison of the HVS3 and a conventional upright vacuum cleaner revealed that both collected particles down to at least 0.2 µm and that the HVS3 was more efficient at collecting particles smaller than 20 µm than conventional vacuum cleaners (**6**). If desired, a fine-particle filter may be added downstream of the cyclone to collect 99.9 % of particles above 0.2 µm aerodynamic mean diameter.

4.3 The particulate matter in the air stream is collected in a catch bottle attached to the bottom of the collection cyclone. This catch bottle shall be capped for storage of the sample and transported to the laboratory for analysis.

5. Significance and Use

5.1 This practice may be used to collect dust from carpeted or bare floor surfaces for gravimetric or chemical analysis. The collected sample is substantially unmodified by the sampling procedure.

5.2 This practice provides for a reproducible dust removal rate from level loop and plush carpets, as well as bare floors. It has the ability to achieve relatively constant removal efficiency at different loadings of floor dust.

5.3 This practice also provides for the efficient capture of semivolatile organic chemicals associated with the dust. The test system can be fitted with special canisters downstream of the cyclone for the capture of specific semivolatile organic chemicals that may volatilize from the dust particles during collection.

5.4 This practice does not describe procedures for evaluation of the safety of floor surfaces or the potential human exposure to floor dust. It is the user's responsibility to evaluate the data collected by this practice and make such determinations in the light of other available information.

5.5 This practice provides per-event dust chemical concentration and chemical loading. Advantages and trade-offs of different sampling approaches have been discussed (**7**).

5.6 This practice uses a removable, cleanable dropout jar that facilitates per-event sampling. Other per-event vacuum attachments are commercially available. These are not directly comparable with composite sampling done using whole vacuum cleaner bags.

6. Interferences

6.1 There are no known interferences to the determination of dust loadings covered by this practice.

7. Apparatus

7.1 *Sampling Apparatus,* which may be constructed from commercially available vacuum cleaners and attachments (as shown in Fig. 1):

7.1.1 The dimensions of the sampling apparatus (nozzle size, cyclone diameter, cyclone inlet diameter, etc.) are interdependent. The flow rate must produce a sufficient velocity both at the sampled surface and in the cyclone. The cyclone must have a cut diameter of 5 µm at the same velocity that will provide a horizontal velocity of 40 cm/s at 10 mm from the nozzle in the carpet material, or 5 mm from the nozzle on bare floors. The fundamental principles of this device have been discussed in detail in Roberts et al. (**1-3**).

7.1.2 *Nozzle*—The edges and corners of the sampling nozzle shall be rounded to prevent catching the carpet material. The nozzle must be constructed to allow for sufficient suction to separate loose particles from the carpet or bare floor and carry them to the cyclone. It must have an adjustment mechanism to establish the nozzle lip parallel to the surface and to achieve the proper suction velocity and pressure drop across the nozzle. A

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

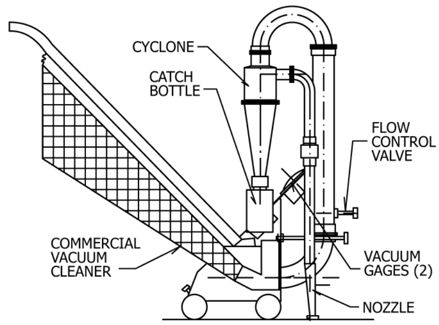

FIG. 1 Floor Dust Sampler Using a Commercial Vacuum Cleaner as the Suction Source

nozzle 12.4 cm long and 1 cm wide, with a 13 mm flange and tapered to the nozzle tubing at no more than 30°, will yield the appropriate velocities when operated as specified in Section 11.

7.1.3 *Gaskets*—Gaskets in joints should be of a material appropriate to avoid sample contamination.

7.1.4 *Cyclone*—The cyclone shall be of a specific size such that a given air flow allows for separation of the particles 5 µm mean aerodynamic diameter and larger. The cyclone must be made of aluminum or stainless steel, and the catch bottle must be made of clear glass or fluorinated ethylene propylene (FEP) to avoid contamination and allow the operator to see the sample.

7.1.5 *Flow Control System*—The flow control system shall allow for substantial volume adjustment. The suction source must be capable of drawing 12 L/s through the system with no restrictions other than the nozzle, cyclone, and flow control system connected. An upright commercial vacuum cleaner with a seven amp or greater motor capable of pulling a vacuum of 6.5 kPa may be used for this purpose.

7.1.6 *Flow Measuring and Suction Gauges*—Two vacuum gauges are required: one with a range of 0 kPa to 3.7 kPa is used for setting flow rate and another with a range of 0 kPa to 2.5 kPa is used to set the pressure drop across the vacuum nozzle.

7.1.7 Optional filter holder assembly with appropriate fine particle filter, such as a 25 cm micro-quartz-fibre, binderless, acid-washed filter.[5]

7.2 *Other Equipment:*

7.2.1 *Stopwatch.*

7.2.2 *Masking Tape and Marking Pen,* for outlining sections for sampling.

7.2.3 *Clean Aluminum Foil and Clean Glass or FEP Jars,* for the collection and storage of samples.

7.2.4 *Thermometer* (see Specifications E1, E1137/E1137M, or E2251).

7.2.5 *Relative Humidity Meter* (see Test Method E337, Method A, which allows use of alternative thermometers).

7.2.6 *Shaker Sieve,* as specified in Test Method D422, with 100 mesh-screen above the pan to separate the fine dust below 150 µm.

[5] A filter holder for circular 25 cm particle filters and flow control valve assembly which replaces the normal flow control assembly is available from the manufacturer of the floor vacuum device.

7.2.7 *Analytical Balance,* sensitive to at least 0.1 mg and having a weighing range from 0.1 mg to 1000 g.

8. Reagents and Materials

8.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available (**8**).

8.2 Methanol is required for sampling train cleaning after sample collection.

9. Sampling Strategy

9.1 The overall sampling strategy should be designed to address the goals of the study. Users should consider factors such as foot traffic volume, types of activities, proximity to potential sources, etc. The sampling strategy should be described in the sampling report so it can be taken into consideration when readers are comparing loadings or concentrations, or both, to those obtained from other studies. The ideal sampling location(s) for the beginning of the test procedure are an area that conforms with the protocol for the user's overall sampling strategy. For example, when sampling in a home for child exposure assessment, protocol may require the selection of a carpeted area for sampling where small children play or are likely to play.

10. Pretest Preparation and Calibration

10.1 *Calibration*—The sampling system described in this practice does not have any calibrated flow devices other than the cyclone and the Magnehelic gauges. The cyclone used for the separation of the particles must be designed to give proper separation at varying flow rates throughout the sampling range of the system. The pressure gauges and any other devices (that is, temperature gauge) used for testing purposes should be calibrated against a primary standard.

10.1.1 *Pressure Gauges*—Pressure gauges shall be calibrated against an inclined manometer or other primary standard prior to any field test. One means of checking a Magnehelic gauge is to set a flow rate through the sampling system with a manometer and then switch to the Magnehelic gauge. If the difference in the readings is more than 3 %, the gauge is leaking or is in need of repair or calibration. This should be done at two different flow rates when checking the gauge.

SAMPLE DATA SHEET

Operator ______________________ Date __________ Sample ID # ____________

Sampling site ____

Type of Carpet: ______ Plush ________ Level Loop _______ Multilevel ________ Shag ________

Upright ______ Canister _____ Other _______

Type of Bare Floor: ___ Wood _______ Vinyl ______ Laminate _____ Concrete ____ Other ___

Last Vacuumed Date ____________ Temp. _________ Humidity ________ %

Location of Area Sampled (Room): __________________ Surface Area Sampled ________ m^2

Sketch of Area Sampled:

Leak Check: Yes ___ No ____ 20 second cleaning @ end: Yes ____ No ______

Total Sample Time: ____ minutes ___ seconds Flow ^P ______ Nozzle ^ P ______

Bottle final weight: ______ g | Tare Weight: ______ g | Net Weight: ______ g

Pan and Sample weight _____ g | Pan Tare Weight: ____ g |Net Weight: _____ g

Total Dust Loading: ________ grams/m^2 | Fine Dust Loading: grams/m^2

Cyclone Sample # ____________________ | Lab Sample # ____________________

Comments: ____

FIG. 2 Sample Data Sheet for Sampling for Floor Dust

10.1.2 The cyclone flow measurement is calibrated with a laminar flow element, spirometer, or roots meter. See the appendix for cyclone calibration with a laminar flow element.

10.2 *Pretest Preparation:*

10.2.1 Each catch bottle to be used shall be clean and inspected for any contamination. The bottles should be marked with masking tape and a marking pen for identification of the test site, time, and date.

10.2.2 The sampling train shall be inspected to ensure that it has been cleaned and assembled properly.

10.2.3 The sampling train shall be leak-checked prior to sampling. This can be accomplished by placing a mailing envelope or a piece of cardboard beneath the nozzle and switching on the suction source. The flow Magnehelic gauge should read 5 Pa (0.02 in. H_2O) or less to ensure that the system is leak free. If any leakage is detected, the system shall be inspected for the cause and corrected before use.

11. Sampling

11.1 *Sampling a Carpeted Floor:*