Designation: ~~D7144 – 05a (Reapproved 2016)~~ D7144 – 21

Standard Practice for Collection of Surface Dust by Micro-vacuum Sampling for Subsequent ~~Metals Determination~~Determination of Metals and Metalloids[1]

This standard is issued under the fixed designation D7144; 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 the micro-vacuum collection of surface dust for subsequent determination of ~~metals.~~ metals and metalloids. The primary intended application is for sampling from soft, rough, or porous surfaces.

1.2 Micro-vacuum sampling is carried out using a collection nozzle attached to a filter holder (sampling cassette) that is connected to an air sampling pump.

1.3 This practice allows for the subsequent determination of metals and metalloids on a loading basis (mass of ~~metal(s)~~element(s) per unit area sampled), or on a concentration basis (mass of ~~metal(s)~~element(s) per unit mass of sample collected), or both.

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 *Limitations*—Due to a number of physical factors inherent in the micro-vacuum sampling method, analytical results for vacuum dust samples are not likely to reflect the total dust contained within the sampling area prior to sample collection. Indeed, dust collection will generally be biased towards smaller, less dense dust particles. Nevertheless, the use of this standard practice will generate data that are consistent and comparable between operators performing micro-vacuum collection at a variety of sampling locations and sites.[2]

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

1.7 *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.*

[1] This practice is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.04 on Workplace Air Quality.

Current edition approved ~~Oct. 1, 2016~~May 1, 2021. Published ~~October 2016~~May 2021. Originally approved in 2005. Last previous edition approved in ~~2011~~2016 as D7144 – 05a ~~(2011).~~(2016). DOI: ~~10.1520/D7144-05AR16.~~10.1520/D7144-21.

[2] Reynolds, S. J., et al.,"Laboratory Comparison of Vacuum, OSHA, and HUD Sampling Methods for Lead in Household Dust," *American Industrial Hygiene Association Journal*, ~~Vol.~~Vol 58, 1997, pp. 439–446.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres
D3195 Practice for Rotameter Calibration
D4840 Guide for Sample Chain-of-Custody Procedures
D5438 Practice for Collection of Floor Dust for Chemical Analysis
D5337 Practice for Flow Rate Adjustment of Personal Sampling Pumps
D6966 Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Determination of Metals
D7035 Test Method for Determination of Metals and Metalloids in Airborne Particulate Matter by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

~~2.2 *ISO Standard:*[4]~~

~~ISO 15202-1 Workplace air—Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma atomic emission spectrometry—Part 1: Sampling~~

3. Terminology

3.1 *Definitions*—For definitions of terms relating to sampling and analysis of dust not given here, refer to Terminology D1356.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *air sampling ~~pump~~—pump, n—*a portable pump that is used to draw air through a filter holder/collection nozzle assembly for micro-vacuum collection of surface dust. An example would include a personal sampling pump.——————~~D1356~~

3.2.2 *~~batch~~—batch, n—*a group of field or quality control samples, or both, that are collected together in a similar environment and are processed together using the same reagents and equipment.

3.2.3 *collection ~~nozzle~~—nozzle, n—*a piece of flexible plastic tubing cut at a 45° angle at the inlet end, and connected at the outlet end to the inlet orifice of a filter holder (sampling cassette).

3.2.4 *field ~~blank~~—blank, n—*a sample that is handled in exactly the same way that field samples are collected, except that no air is drawn through it.

3.2.5 *filter ~~holder~~—holder, n—*an apparatus that supports and contains the filter medium upon which dust is collected. It is also often referred to as a sampling cassette.

3.2.6 *internal ~~capsule~~—capsule, n—*a device inserted into a filter holder (sampling cassette) that allows complete capture of contaminant within its envelope and prevents deposition of collected material on the internal walls of the sampling cassette. Use of an internal capsule is necessary for gravimetric analysis purposes.

3.2.6.1 *Discussion—*
Such capsules are commercially available.

3.2.7 *sampling device ~~(assembly)~~—(assembly), n—*for micro-vacuum sampling, an apparatus consisting of the collection nozzle, filter holder (containing internal capsule, if necessary), and air sampling pump, used to collect surface dust. The collection nozzle is attached to the inlet end of the filter holder. The filter holder houses the filter, through which air is drawn by using the air sampling pump. The filter holder is attached to the pump by flexible tubing.

3.2.8 *surface ~~dust~~—dust, n—*particulate matter on a given surface which has been transported to its present location by various means, such as settling through the air or tracking from other sources.

4. Summary of Practice

4.1 Samples of surface dust are collected from selected sampling locations into individual filter holders by using a micro-vacuum

[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~~standard's Document Summary page on the ASTM website.

collection technique that employs a personal sampling pump.[4] The sample is then processed for transport and subsequent laboratory analysis for determination of metals and metalloids content.

4.2 The collected sample may include particles which adhere to the internal walls of the filter holder. This material should be rinsed or wiped off and added to the sample meant for subsequent chemical analysis. However, this material cannot be included in gravimetric determination unless an internal capsule that can be accurately weighed is used during sample collection.

5. Significance and Use

5.1 Human exposure to toxic metals and metalloids present in surface dust can result from dermal contact with or ingestion of contaminated dust. Also, inhalation exposure can result from disturbing dust particles from contaminated surfaces. Thus, standardized methods for the collection and analysis of metals and metalloids in surface dust samples are needed in order to evaluate the potential for human exposure to toxic elements.

5.2 This practice involves the use of sampling equipment to collect surface dust samples that may contain toxic ~~metals,~~metals and metalloids, and is intended for use by qualified technical professionals.

5.3 This practice allows for the subsequent determination of collected ~~metals~~elemental concentrations on an area (loading) or mass concentration basis, or both.

5.4 Because particle losses can occur due to collection of dust onto the inner surfaces of the nozzle, the length of the collection nozzle is specified in order that such losses are comparable from one sample to another.

5.5 This practice is suitable for the collection of surface dust samples from, for example: *(a)* soft, porous surfaces such as carpet or upholstery; *(b)* hard, rough surfaces such as concrete or roughened wood; *(c)* confined areas that cannot be easily sampled by other means (such as wipe sampling as described in Practice D6966). A companion sampling technique that may be used for collection of surface dust from hard, smooth surfaces is wipe sampling (Practice D6966). A companion vacuum sampling technique that may be used for sampling carpets is described in Practice D5438.

5.6 Procedures presented in this practice are intended to provide a standardized method for dust collection from surfaces that cannot be reliably sampled using wipe collection methods (for example, Practice D6966). Additionally, the procedure described uses equipment that is readily available and in common use for other environmental and occupational hygiene sampling applications.

5.7 The entire contents of the filter holder, that is, the filter plus collected dust, is targeted for subsequent analysis for metals and metalloids content. An internal capsule is used if gravimetric analysis is necessary.

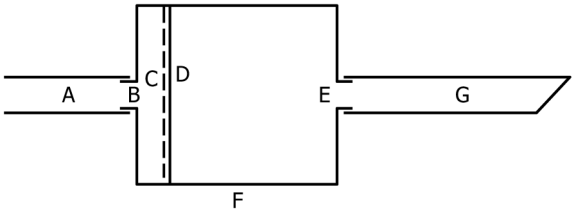
6. Apparatus

6.1 *Dust Sampling Equipment*—The sampling assembly (see Fig. 1) for the micro-vacuum collection of surface dust samples has the following components:

6.1.1 *Filters,* of a diameter suitable for use with the filter holders, and with a collection efficiency of not less than 99.5 % for particles with a diffusion diameter of 0.3 μm, and with a very low metal content (typically less than 0.1 μg of each metal of interest per filter) (see ~~ISO 15202-1).~~Test Method D7035).

6.1.1.1 Weight-stable filters ~~or matched-weight filters~~ shall be used if it is desired to determine the mass of collected dust. If the filters are to be weighed in order to determine the mass of dust collected, it is important that they be resistant to moisture retention, so that blank weight changes that can occur as a result of changes in temperature and humidity are as low and repeatable as possible. Also, filters selected for weight stability should not be excessively brittle, since this can introduce weighing errors due to loss of filter material.

[4] ~~Que Hee~~Ashley, ~~S. S.,~~ K., et al., ~~"Evolution of Efficient Methods to Sample Lead Sources, Such as House Dust and Hand Dust, in the Homes of Children." ~~"Evaluation of a Standardized Micro-vacuum Sampling Method for Collection of Surface Dust," ~~*Environmental Research*~~*Journal of Occupational and Environmental Hygiene*, ~~Vol.~~Vol ~~384~~, ~~1985~~2007, pp. ~~77~~215~~–95.~~–223.



A: Flexible tubing connecting the filter holder to the sampling pump (not shown);
B: Outlet of filter holder;
C: Back-up pad/support;
D: Filter;
E: Inlet of filter holder;
F: Housing of filter holder; and
G: Flexible tubing collection nozzle.

FIG. 1 Schematic of Sampling Assembly for Micro-Vacuum Surface Dust Sampling

~~NOTE 1—If the filters are to be weighed in order to determine the mass of dust collected, it is important that they be resistant to moisture retention, so that blank weight changes that can occur as a result of changes in temperature and humidity are as low and repeatable as possible. Also, filters selected for weight stability should not be excessively brittle, since this can introduce weighing errors due to loss of filter material.~~

6.1.2 *Filter holders,* for ~~25-~~25-mm or 37-mm diameter filters.

6.1.3 *Internal ~~capsules, for gravimetric analysis~~—Capsules, For Gravimetric Analysis—*If it is desired to determine the mass of collected dust, internal capsules shall be weighed to the nearest 0.1 mg. If pre-weighed internal capsules and filters are used, it will be necessary to tare the internal capsules, plus backup pads, prior to use. Procedures for accurate weighing of internal capsules are described in detail elsewhere.

~~NOTE 2—If pre-weighed internal capsules and filters are used, it will be necessary to tare the internal capsules, plus backup pads, prior to use. Procedures for accurate weighing of internal capsules are described in detail elsewhere.[6]~~

6.1.4 *Back-up ~~pads, cellulosic; or metallic screen back-up support.~~ Pads, Cellulosic; or Metallic Screen Back-up Support—*

~~NOTE 3—If pre-weighed filters are used, it is not necessary to know the mass of each back-up pad. However, if pre-weighed internal capsules and pre-weighed filters are used, it will be necessary to know the influence of the mass of each back-up pad on the overall mass of the entire sampling assembly (to the nearest 0.1 mg).~~If pre-weighed filters are used, it is not necessary to know the mass of each back-up pad. However, if pre-weighed internal capsules and pre-weighed filters are used, it will be necessary to know the influence of the mass of each back-up pad on the overall mass of the entire sampling assembly (to the nearest 0.1 mg).

6.1.5 *Collection nozzle,* consisting of a piece of flexible polyvinyl chloride (PVC) tubing of length ~~5.5 ± 0.5~~5.5 cm ± 0.5 cm and ~~0.60 ± 0.005~~0.60 cm ± 0.005 cm inside diameter, cut at a 45° (± 1°) angle at the inlet end.

6.1.6 *Tubing, flexible,* inside diameter ~~0.60 ± 0.005~~0.60 cm ± 0.005 cm for connecting the sampling device to the air sampling pump (maximum length 1 m).

6.1.7 *Air sampling pump, portable,* capable of sampling at a flow rate of ~~2.5 ± 0.5 L~~2.5 L/min~~/min.~~ ± 0.5 L/min. The pump flow rate shall be ~~calibrated~~ adjusted and set with a representative sampling assembly in line so that the volume of air sampled can be measured to an accuracy of ±5 % or better.

6.1.8 *Calibration device,* for air sampling pumps; soap bubble meter or equivalent, as specified in Practice D3195.

6.1.9 *Rotameter, calibrated,* as specified in Practice D3195.

6.1.10 *Sampling templates,* minimum dimensions 10 cm by 10 cm, maximum dimensions 30 cm by 30 cm; reusable metallic or plastic; or disposable plastic or cardboard.

6.1.11 *Gloves, powderless, latex-free,* for handling of filters, back-up pads/supports, samplers, tubing, collection nozzles, and other sample collection components.

6.1.12 *Tape, adhesive,* for immobilization of sampling templates; and for delineation of sampling areas where the use of templates is impractical.

6.1.13 *Tape measure or ruler, metric,* for measurement of sampling areas when the use of templates is impractical, and for measurement of tubing, collection nozzles, and so forth.

6.1.14 *Tweezers,* plastic or plastic-tipped metallic, for handling of filters.

6.1.15 *Sealable plastic bags, or boxes, or other airtight containers, or a combination of the three,* for transporting collected samples.

7. Procedure

7.1 *Assembly of ~~Micro-Vacuum~~Micro-vacuum Sampling Device*—The following shall be carried out in an uncontaminated area while wearing clean gloves:

7.1.1 Assemble the filter in the filter holder, with the filter supported on a back-up pad or metallic screen. To prevent contamination, the filter should be handled only with tweezers.

7.1.2 If pre-weighed filters and internal capsules are used, record their masses to the nearest 0.1 mg using established acceptance criteria.

NOTE 1—If desired, pre-loaded filter holders and capsules with pre-weighed filters and internal capsules may be purchased, already assembled, from the manufacturer.

7.1.3 Close and seal the sampling device to prevent leakage of air around the filter or into/out of the sampler. Label the sampler with a unique sample identifier.

7.1.4 Attach the outlet end of the collection nozzle to the inlet end of the filter holder, and secure tightly.

7.2 ~~Calibration of sampling train for micro-vacuum sampling:~~*Flow Adjustment Sampling Train for Micro-vacuum Sampling:*

7.2.1 Ensure that sampling pumps, if battery-powered, are sufficiently charged prior to use.

7.2.2 Using a ~~soap bubble meter or equivalent calibration~~ calibrated and traceable flow measurement device (for example, a calibrated ~~rotameter;~~ rotameter or soap bubble meter; see Practice D3195), set the flow rate of the air sampling pump, with a sampling assembly in the line, to 2.5 ± 0.1 L/min.

NOTE 2—While soap bubble meters are useful for applications in the laboratory and in the field, calibrated and traceable rotameters are especially convenient for on-site ~~calibrations and calibration~~ flow rate checks.

7.2.3 ~~Calibration~~ The flow of sampling pumps shall be checked prior to and following ~~use.~~use in accordance with Practices D3195 and D5337.

7.3 *Preparation for Sampling*—The following shall be carried out while wearing clean gloves:

7.3.1 Attach the sample collection device (that is, the assembly with the collection nozzle attached to filter holder) to the ~~calibrated~~ flow adjusted sampling pump by means of a piece of flexible tubing.

7.3.2 Using indelible ink, uniquely label the sampling cassette of each sample collection assembly.

7.3.3 If possible, demarcate the area of the surface to be sampled (for example, 10 cm by 10 cm) using a template, and secure the outside edges of the template with tape. If it is not practical to use a template, carefully measure the area (in cm by cm) to be sampled using a tape measure or ruler, and delineate the sampling area with tape.

NOTE 3—Areas where template-assisted sampling may not be possible include, for example, locations where: *(a)* the surface to be sampled is confined