



Designation: D 7144 – 05

Standard Practice for Collection of Surface Dust by Micro-vacuum Sampling for Subsequent Metals Determination¹

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1. Scope

1.1 This practice covers the micro-vacuum collection of surface dust for subsequent determination of metals. 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), which is in turn connected to an air sampling pump.

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

1.4 The values stated in SI units are to be regarded as the 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:³

D 1356 Terminology Relating to Sampling and Analysis of Atmospheres

D 3195 Practice for Rotameter Calibration

D 4840 Guide for Sampling Chain of Custody Procedures

D 5438 Practice for Collection of Floor Dust for Chemical Analysis

D 6966 Practice for Collection of Dust Wipe Samples for Subsequent Metals Determination

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 D 1356.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *air sampling pump*—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 (D 1365).

3.2.2 *batch*—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*—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*—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*—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*—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.

NOTE 1—Such capsules are commercially available.

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 Atmospheres. Current edition approved May 1, 2005. Published May 2005.

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. 58, pp. 439-446 (1997).

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.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

3.2.7 *sampling device (assembly)*—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*—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 collection technique that employs a personal sampling pump.⁵ The sample is then processed for transport and subsequent laboratory analysis for determination of metals 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 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 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, and is intended for use by qualified technical professionals.

5.3 This practice allows for the subsequent determination of collected metals 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 D 6966). A companion sampling technique that may be used for collection of surface dust from hard, smooth surfaces is wipe sampling (Practice D 6966). A companion

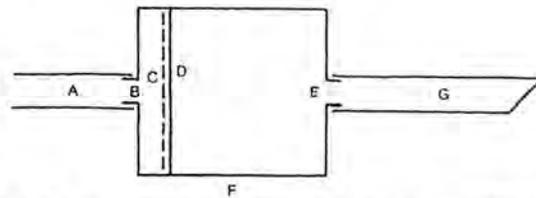


FIG. 1 Schematic of Sampling Assembly for Micro-Vacuum Surface Dust Sampling
 A: Flexible tubing connecting the filter holder to the sampling pump (not shown); B: Outlet of filter holder; C: Back-up pad/support; D: Filter; E: Inlet of filter holder; F: Housing of filter holder; G: Flexible tubing collection nozzle

vacuum sampling technique that may be used for sampling carpets is described in Practice D 5438.

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 D 6966). 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 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).

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.

NOTE 2—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- or 37-mm diameter filters.

6.1.3 *Internal 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.

NOTE 3—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

⁵ Que Hee, S. S., et al., "Evolution of efficient methods to sample lead sources, such as house dust and hand dust, in the homes of children." *Environmental Research*, Vol. 38, pp. 77-95 (1985).

⁶ *NIOSH Manual of Analytical Methods*, 4th ed.: Methods 0500 and 0600. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Cincinnati, Ohio, 1994.

6.1.4 Back-up pads, cellulosic; or metallic screen back-up support.

NOTE 4—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 cm and 0.60 ± 0.005 cm inside diameter, cut at a 45° angle at the inlet end.

6.1.6 Tubing, flexible, inside diameter 0.60 ± 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/min. The pump shall be calibrated with a representative sampling assembly in line so that the volume of air sampled can be measured to an accuracy of $\pm 5\%$ or better.

6.1.8 Calibration device, for air sampling pumps; soap bubble meter or equivalent, as specified in Practice D 3195.

6.1.9 Rotameter, calibrated, as specified in Practice D 3195.

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 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.⁶

NOTE 5—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:

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 device (for example, a calibrated rotameter; see Practice D 3195), set the flow rate of the air sampling pump, with a sampling assembly in the line, to 2.5 ± 0.1 L/min.

NOTE 6—While soap bubble meters are useful for applications in the laboratory and in the field, calibrated rotameters are especially convenient for on-site calibrations and calibration checks.

7.2.3 Calibration of sampling pumps shall be checked prior to and following use.

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 sampling pump via 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 7—Areas where template-assisted sampling may not be possible include, for example, locations where: (a) the surface to be sampled is confined or otherwise not easily accessible; (b) the surface to be sampled is smaller (in at least one dimension) than the template; (c) the surface to be sampled is curved (not flat); and so forth.

7.3.4 Activate the sampling pump and allow for a suitable warm-up period. To ensure that the specified flow rate is obtained, sufficient pump warm-up shall be determined by using a calibration check device (that is, soap bubble meter or rotameter).

NOTE 8—Warm-up times may differ for sampling pumps of different manufacture and age. A 5-min warm-up period is usually sufficient.

7.4 Sample collection—The following shall be carried out while wearing clean gloves:

7.4.1 Hold the collection nozzle immediately above the surface being sampled, but avoid contacting the surface with the nozzle. The inlet of the nozzle (cut at a 45° angle) should be approximately parallel to the surface being sampled. Endeavor to keep the nozzle within ~ 1 -5 mm above the surface; do not press the nozzle against the surface being sampled.

7.4.2 Move the collection nozzle from one side of the sampling area to the other. The rate of movement of the nozzle across the surface shall be no more than 1 sec/10 cm. Repeat this sweeping motion in the same direction until the entire sampling area has been “vacuumed” with the collection nozzle. If the nozzle becomes clogged during sampling, dislodge the obstruction using a clean knife or other suitable tool.

7.4.3 Repeat the procedure described in 7.4.2 in a direction 90° from the initial sampling direction. Be sure to cover the entire sampling area.

7.4.4 Continue sample collection (use various sampling directions, if desired) until a total of 1 min sampling time per 100 cm² area is reached.

Note 9—Larger sampling areas will require longer sampling times.

7.4.5 Avoid excessive overloading of the filter; this problem can be identified by a >10 % drop in the measured flow rate. If overloading becomes evident, reduce the sampling area; alternatively, use additional sample collection assemblies to sample the defined area. Record this information.

7.4.6 Use a separate, clean collection nozzle and filter holder (with clean filter) for each micro-vacuum sample.

Note 10—Use of a separate collection nozzle for each sample is essential for prevention of cross-contamination.

7.4.7 Prepare field blanks at the same time that sampling is carried out; these shall represent no less than 5 % of the total number of samples, or at least one per batch minimum. Field blanks shall be handled in the same fashion as field samples, but no air is drawn through the filters.

Note 11—Some laboratories also require that media blanks are submitted along with field blanks and samples.

7.4.8 Following collection of a surface dust sample, disconnect the sampling assembly from the sampling pump and collection nozzle, and then turn off the sampling pump. When disconnecting and capping the filter holder, hold it upright to ensure that no loose dust is lost from the sampling assembly. After removing the connecting tubes, cap the inlet and outlet ends of the filter holder with plugs.

7.4.9 Place the filter holder in a suitable container for transport, such as a sealable plastic bag or box.

7.5 *Sample Transport*—Samples shall be transported to the laboratory in sample containers. This shall be done in such a manner that the filter holders or internal capsules containing collected dust vacuum samples are neither disturbed nor contaminated. Sample transporting shall be carried out and documented so that a chain of custody is established (in accordance with Guide D 4840).

7.6 *Records*—Record the following information in a bound notebook (with numbered pages) or on data sampling forms, or both. Record pertinent sampling data for each sample, for example:

- 7.6.1 sample location,
- 7.6.2 sampling site,
- 7.6.3 date and time,
- 7.6.4 sampling flow rates,
- 7.6.5 calibration data,
- 7.6.6 pre-sampling filter/sampler mass (if pre-weighed filters and internal capsules are used),
- 7.6.7 surface type sampled,
- 7.6.8 filter type,
- 7.6.9 personal identifier,
- 7.6.10 pump type and identifier,
- 7.6.11 sampling rate,
- 7.6.12 air volume sampled, and
- 7.6.13 surface area sampled.

8. Report

8.1 Parameters to be reported include items and information such as:

- 8.1.1 flow rate used,
- 8.1.2 number of samples and field blanks,
- 8.1.3 air sampling pumps used,
- 8.1.4 pump settings,
- 8.1.5 calibration data and equipment used for calibration,
- 8.1.6 sampling areas,
- 8.1.7 type/description of collection nozzle used,
- 8.1.8 date and time,
- 8.1.9 sampling site and locations
- 8.1.10 personal identifier(s) of individual(s) who carried out sampling,
- 8.1.11 sample identifiers,
- 8.1.12 pertinent information (that is, masses) on pre-weighed filters/internal capsules, if used, and
- 8.1.13 type of sampler/filter used.

9. Keywords

- 9.1 dust; metals; surfaces; vacuum sampling

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