Standardized Surface Sampling Methods for Metals

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Overview

Background
- Reasons for surface sampling
- Comparison to action levels or background

Surface sampling techniques
- Wipe, dermal, vacuum, etc.
- Attributes & limitations
- Available research & data gaps

Discussion & summary
- Performance data available (presented later)
- Examples of standardized methods
- Recommendations / improvements
Introduction

Why Surface Sampling? Examples:

- Evidence of skin sensitization by exposure to beryllium particles
- Ingestion of lead from surface particles on hands
- Take-home exposures to metals in dust
  - Prevent exposure to metals on surfaces through exposure monitoring
Surface Action Levels for Pb, Be

Few metals have surface action levels established by regulatory agencies.

Lead and Beryllium are two elements having surface dust loading limits in the US.

Pb: EPA; Be: DOE
Beryllium surface compliance levels (DOE: 10 CFR 850)

Equipment release:
0.2 μg Be/100 cm²

Housekeeping:
3.0 μg Be/100 cm²

(But no information on sampling methodology)

“Analysis by AIHA-accredited lab or equivalent”
Surface action levels for lead
[40 CFR 745 (EPA 403 Rule), 2001]

Definition of dust-lead hazard (§745.6)
- floors (bare or carpeted): 40 μg/ft²
- window sills (interior): 250 μg/ft²

Clearance levels (§745.227)
- floors (bare or carpeted): 40 μg/ft²
- window sills (interior): 250 μg/ft²
- window troughs: 400 μg/ft²
EPA 403 Rule Pb Samples:

Samples of settled dust for risk assessment or clearance shall be collected:

- from horizontal surfaces underneath friction surfaces
- from floors (bare & carpeted)
- from interior window sills
- from window troughs (clearance only)
- *using wipes that meet ASTM E1792*
Definition of Wipe Sample (40 CFR Part 745, §745.63):

**Wipe Sample** means a sample collected by wiping a representative surface of known area, as determined by ASTM E1728 [sample collection standard practice], or equivalent method, with an acceptable wipe material as defined in ASTM E1792 [Pb wipe specification].
EPA 403 Pb samples, cont’d.

All samples shall be analyzed by a laboratory recognized under the National Lead Laboratory Accreditation Program (NLLAP).

[40 CFR 745.227(f)(2)]
Surface sampling of metals

Consider:

Wipe samples (wet, usually)
Vacuum samples (various techniques)
Swab sampling (rare for metals)
Tape samples
Rinsates
Surface sampling of metals, cont’d

- Hard / smooth / nonporous surfaces
- Soft / rough / porous substrates
- Fragile substrates
- Oily / grossly contaminated surfaces
- Dermal sampling
- Bulk sampling
Surface Sampling Techniques

- **Wipe sampling**
  Wet: consider wetting agent
  Dry: consider sampling medium

- **Vacuum sampling**
  Alternative to wipe sampling
  Consider substrate to be sampled
Dermal & Bulk Sampling

- **Dermal sampling**
  Wipe, patch, tape & rinse methods

- **Bulk sampling**
  Use if there is gross dust buildup
  Soils / sediments
National Technology Transfer and Advancement Act of 1995 (NTTAA)

Public Law 104-113 (enacted 1996); directs federal agencies to:

(A) Use voluntary consensus standards in lieu of in-house procedures

(B) Participate in the development of relevant voluntary consensus standards
Advantages of the consensus standards development process

- Brings together people with a diversity of backgrounds, expertise, and knowledge
- Provides a balanced representation of interests at the standards-writing table (users, producers, general interest)
- Quality is enhanced by strict balloting and due process procedures, and requirements for method precision and bias / uncertainty statements
- Working group format promotes open discussion
ASTM International wipe sampling standard for metals

ASTM D6966, Standard Practice for Collection of Settled Dust using Wipe Sampling Methods for Subsequent Determination of Metals

(Note: Established by voluntary consensus)
ASTM D6966 Requirements

- Individually packaged wipes; non-interfering materials; minimal metals background
- >75% collection efficiency (RTI, 1990s)
- Sampling scheme (100-cm² minimum sampling area):

![Sampling schemes](image-url)
ASTM E1792
Wipe Specifications

- Minimal background lead
- Ruggedness testing
- Uniform moisture content
- Individually packaged
- Dimensions & thickness
- Pb collection efficiency/ recoverability tests
Dry sampling methods

Vacuum cleaner method (carpets)
  • ASTM D5438

Micro-vacuum sampling (rough / fragile / inaccessible surfaces)
  • ASTM D7144

Dry wipe sampling (special cases)
  • ASTM D7296

Bulk sampling
  • ASTM & EPA methods
Vacuum sampling: Consensus standards

ASTM D7144

ASTM D5438
Dry wipe sampling

- ASTM D7296, Standard Practice for Collection of Settled Dust Samples using Dry Wipe Sampling Methods for Subsequent Determination of Beryllium and Compounds
- Use *only* if wet wipe sampling or vacuum sampling inappropriate
  [Also may be applicable to sampling radioactive elements]
Dermal sampling methods

1. Wet wipe
2. Patch sampling
3. Tape sampling
4. Skin rinsates

(Photo by Dr. A. L. Sussell)
## Surface sampling stds for metals (gov’t & consensus)

<table>
<thead>
<tr>
<th>Method</th>
<th>Media / device</th>
<th>Surfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA ID-125G &amp; ID-206</td>
<td>Wet or dry filter or wipe</td>
<td>Smooth / Hard; Dermal</td>
</tr>
<tr>
<td>NIOSH 9100, 9102</td>
<td>Wet wipe</td>
<td>Smooth; Dermal</td>
</tr>
<tr>
<td>ASTM D6966</td>
<td>Wet wipe</td>
<td>Smooth / Hard</td>
</tr>
<tr>
<td>ASTM E1216</td>
<td>Adhesive tape</td>
<td>Smooth</td>
</tr>
<tr>
<td>OSHA &amp; NIOSH (several)</td>
<td>Patch or Rinse</td>
<td>Dermal samples</td>
</tr>
<tr>
<td>ASTM D5438</td>
<td>Vacuum cleaner</td>
<td>Carpets</td>
</tr>
<tr>
<td>ASTM D7144</td>
<td>Micro-vacuum</td>
<td>Rough or fragile</td>
</tr>
<tr>
<td>ASTM D7296</td>
<td>Dry wipe</td>
<td>Oily or fragile</td>
</tr>
</tbody>
</table>
ASTM D5438 – High-volume vacuum sampler (HVS3)

Dust sample collected in catch bottle (part #3)

(Figure courtesy of Dr. R. G. Lewis)
ASTM D7144 Micro-vacuum sampler evaluation (Ashley et al., JOEH 2007)

Main sampler components:

- Collection nozzle
- Cassette (& filter)
Dermal sampling: Need for voluntary consensus standards

- Recent review articles demonstrate lack of harmonization & consequent difficulty in data comparisons between different dermal exposure studies.
- New working groups in ISO TC 146 / SC 2 and ASTM International D22.04 will develop standardized procedures for dermal sampling.
Bulk sampling methods

- Many published ASTM standard procedures: Scooping, coring; penetrometers, augers, etc. (www.astm.org)

  See, e.g.:
  
  (a) J.H. Morgan, Ed., Sampling Environmental Media; ASTM STP 1282 (1996)

- Sample surface vs. subsurface: Distinguish anthropogenic vs. natural sources of elements.
Surface sampling of nonmetals

Recognize that other surface sampling methods for non-metals have been published by gov’t and consensus standards groups; Examples:

- Drugs / pharmaceuticals
- Pesticides
- Biological agents
Summary

Focus here has been on available governmental and voluntary consensus standards for sampling of metals on surfaces, esp. wipe & vacuum collection methods.

- Performance data support some of the consensus standards (to be presented later).
- Bulk sampling methods are available (ASTM International; EPA) & well standardized.
- Identified need for standardization of dermal sampling methods (ISO, ASTM).
Acknowledgments

ASTM International Subcommittee D22.04 on Workplace Air Quality

ASTM International Subcommittee E06.23 on Mitigation of Lead Hazards

Beryllium Health and Safety Committee, Sampling and Analysis Subcommittee