M435 Implementation Guidance Document

Topics

- Introduction
- Applicability
- Sampling Practices
- Sample Processing Practices
- Laboratory Sample Analysis
- Quality Control

Introduction

Background

- 1990 ARB Asbestos Airborne Toxic Control Measure (ATCM) for Surfacing Applications.
- 2001 ARB Asbestos ATCM for Construction, Grading, Quarrying, and Surface Mining Operations.
- 2007 ARB M435 Interlaboratory Study (ILS).
  - Sample processing/analytical procedures varied.
  - Can affect reported asbestos content.

Purpose

- Assist asbestos stakeholders in the application and performance of M435.
- Clarify procedures and recommend good field sampling and laboratory practices.
- Result in more accurate and repeatable M435 asbestos content measurements.
Applicability of M435

• Surfacing ATCM - M435 is the **required test method** to determine the asbestos content of surfacing aggregate materials.
• Construction ATCM - M435 is referenced as a **laboratory test method** to determine the asbestos content of bulk samples.
• M435 random sampling plan is not applicable for asbestos ATCM exemption requirements.

Sampling Practices for Aggregate Materials

**Sources and Sampling Design**

- Test Method 418
- Storage Piles
- Conveyor Belts
- Roads
- Aggregate-covered Surfaces
- Areas
- Road Shoulders

- Minimum of 3 random grab samples per 1000 tons
- Minimum of 3 random grab samples per 1 mile road
- Minimum of 3 random grab samples per acre
- Minimum of 3 random grab samples per 2 miles or 2 acres

**Equipment and Procedures**

- Storage piles - sloughing effect.
  - Sampling tubes, round point shovels, front loaders.
- Conveyor belts – less sloughing.
  - Automated or manual sampling using templates.
- Aggregate-covered surfaces.
  - Manual or automated augers, shovel, or other suitable equipment.

**Sample Documentation**

- Complete sample description per M435.
- Sample acceptance criteria.
- Chain of custody documentation.
- Laboratory information management system.
Laboratory Sample Processing Practices

M435 Sample Processing

Aggregate Sample → Dry, crush to <3/8-inch nominal diameter, reduce to 1 pint aliquot → Pulverize majority to <75 µm diameter (<200 Tyler mesh) → Analyze using Polarized Light Microscopy (PLM) → 400-point count rules Determine % Asbestos

Drying

• Purpose of drying: to remove moisture that would hinder complete pulverization.
• Recommend standardization of laboratory drying procedures (e.g., temperature, time).

Crushing

• Sample must be crushed to a nominal size of <3/8 inch (~0.95 centimeter).
• Recommend use of jaw crushers:
  – Reliable.
  – Timely.
• Not recommended:
  – Use of hammers.
  – Restricting rock sample sizes.
  – Discarding large rock samples.

Sequence of Post-crushing Procedures

• Post-crushing processing procedures:
  a) Sample size reduction.
  b) Homogenization.
  c) Pulverization.
• The sequence of these procedures affects the representativeness of the powder analyzed.
• The sequence also depends on what equipment are present in the laboratory.
Laboratory Sample Processing Practices

**Sequences of Post-crushing Procedures**

<table>
<thead>
<tr>
<th>Available Post-crushing Equipment</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Braun Mill + Mixer (Sequence 1)</td>
<td>Pulverize entire crushed sample</td>
<td>Use mortar to homogenize entire powdered sample</td>
<td>Manually take 1 pint for analysis</td>
</tr>
<tr>
<td>Braun Mill + Mixer (Sequence 2)</td>
<td>Pulverize entire crushed sample</td>
<td>Manually homogenize powdered sample</td>
<td>Manually take 1 pint for analysis</td>
</tr>
<tr>
<td>Shatterbox (SB), Ball Mill (BM), or Freyter Mill (FM) + Mixer (Sequence 3)</td>
<td>Use mixer to homogenize entire crushed sample</td>
<td>Manually take 1 pint crushed sample for pulverization</td>
<td>Pulverize 1 pint crushed sample for analysis</td>
</tr>
<tr>
<td>SB, BM, or FM + Mixer (Sequence 4)</td>
<td>Split entire crushed sample and take 1 pint aliquot</td>
<td>Pulverize 1 pint crushed sample</td>
<td>Manually homogenize powdered sample for analysis</td>
</tr>
<tr>
<td>M435 Braun Mill or Equivalent (no Mixer)</td>
<td>Split entire crushed sample and take 1 pint aliquot</td>
<td>Pulverize 1 pint crushed sample</td>
<td>Manually homogenize powdered sample for analysis</td>
</tr>
</tbody>
</table>

Test Method 435

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**Laboratory Sample Processing Practices**

**Pulverization**

- Recommend the use of the Braun Mill for pulverization.
- ILS results - Braun Mill produced powder with:
  - No leftover chunks.
  - Not over-pulverized.
  - Majority of particles: <75µm diameter.

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**Laboratory Sampling Processing Practices**

**Pulverization**

- Equivalency of other pulverizers to the Braun Mill.
- M435-specific pulverization protocol for this equipment.
- Acceptable particle size distribution and equivalent size characteristics.
Laboratory Sample Processing Practices

**Pulverization**

The recommended PSD:

- ≥98% of the powder passes through the 250-µm mesh sieve.
- 75- to 250-µm size fraction is 40 to 50% of the total mass of sample processed.
- <75-µm size fraction is 50 to 60% of the initial sample mass.

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**Laboratory Sample Processing Practices**

**Homogenization**

- Increases powder homogeneity.
- Increases the likelihood that a representative aliquot of the field sample is analyzed.
- Increases accuracy and repeatability.
- Recommend:
  - use of a 3-dimensional mixer.

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**Laboratory Sample Processing Practices**

**Sample Size Reduction of Crushed Sample**

- Even number of equal width chutes.
- At least 8 chutes for coarse aggregate, or 12 chutes for fine aggregate.
- Minimum width of the individual chutes should be about 50% larger than the largest particles in the sample.

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**Laboratory Sample Analysis Procedures**

**Principles of M435 Asbestos Identification**

- Morphology requirements.
- Optical characteristics determination by polarized light microscopy (M435 Table 3).
Laboratory Sample Analysis Procedures

PLM Limits of Resolution

- Fine particles and fibers ≤2µm in length and ≤0.15µm in thickness.
- Smaller asbestos fibers may still be present.
- Other analytical techniques are not part of M435:
  - X-ray diffractometry (XRD).
  - Scanning electron microscopy (SEM).
  - Transmission Electron Microscopy (TEM).
- The Department of Toxic Substances Control uses a tiered analytical approach of PLM followed by TEM.

Laboratory Sample Analysis Procedures

Asbestos Quantification

- Required testing volume:
  - 1 pint powdered aliquot.
- Recommended powder mass:
  - 5 mg per PLM slide, particle loading of ~30%.
- Fiber identification requirements:
  - Length-to-width aspect ratio of ≥ 3:1 and
  - Asbestos optical properties (M435 Table 3).
  - Only asbestos characteristics, as described in M435 Table 3, should be used for asbestos identification.

Laboratory Sample Analysis Procedures

Asbestos Quantification

- Recommended point-count reticle:
  - Standard crosshair reticle.
- Additional objective lens recommended:
  - 20X PLM objective to verify optical properties.
- Increase in points counted:
  - Multiples of 400 (e.g., 800, 1,200, 1,600, etc.).
  - Additional points counted may increase false negative errors.

Laboratory Sample Analysis Procedures

Exceptions for Point-counting

- Exception I – sample contains no asbestos.
  - No asbestos fibers in 10 fields of view (FOVs) in each of 3 PLM slides (30 FOVs total).
  - Report no asbestos was found by visual technique.
- Exception II – sample contains >10% asbestos.
  - Asbestos content exceeds 10% from 3 PLM slides.
  - Report asbestos content exceeds 10% by visual technique.
Quality Control

Sampling

- Sampling equipment cleanliness.
- Equipment cleaning protocol.
- Integrity of field samples.
- Protection of sample identity.
- Field log of M435 samples, including sampling details.

Quality Control

Processing

- Sample chain of custody.
- Laboratory information management system.
- Written SOP specific for M435.
- Processing blanks alongside regular field samples.
- Calibration of processing equipment.
- Particle size calibration check.

Quality Control

Analysis

- Microscope alignment.
- Refractive index liquid calibration.
- Asbestos proficiency training.
- Blind analytical replicates.
- Instrument cross checks.
- M435 laboratory protocol validation.
- Performance evaluation slides.
- Documentation of results.

For questions and comments, please contact:

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Visit the Test Method 435 website and join the Asbestos List Serve:

http://www.arb.ca.gov/toxics/asbestos/tm435/tm435.htm

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