M435 Implementation Guidance Document
Topics

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

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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.

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Introduction
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.

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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.

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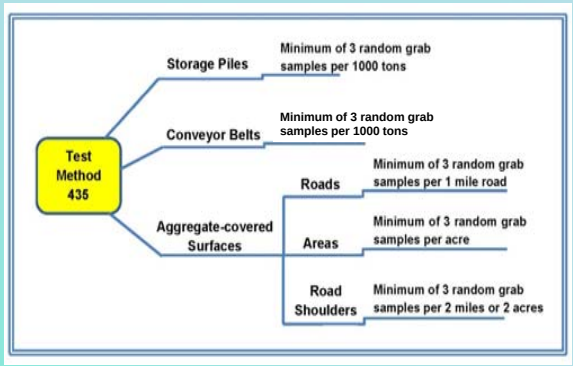
Sampling Practices for Aggregate Materials
Sources and Sampling Design



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Sampling Practices for Aggregate Materials
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.

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Sampling Practices for Aggregate Materials
Sample Documentation

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

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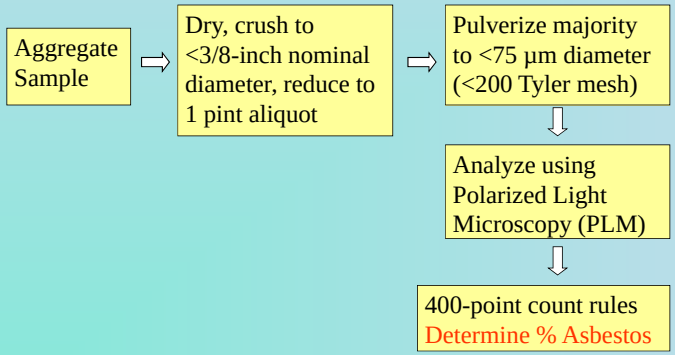
Laboratory Sample Processing Practices
M435 Sample Processing



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Laboratory Sample Processing Practices
Drying

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

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Laboratory Sample Processing Practices
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.

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Laboratory Sample Processing Practices
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.

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Laboratory Sample Processing Practices
Sequences of Post-crushing Procedures

Test Method 435

Available Post-crushing Equipment	Step 1	Step 2	Step 3
Braun Mill + Mixer (Sequence 1)	Pulverize entire crushed sample.	Use mixer to homogenize entire powdered sample.	Manually take 1 pint for analysis.
Braun Mill (no Mixer) (Sequence 2)	Pulverize entire crushed sample.	Manually homogenize powdered sample.	Manually take 1 pint for analysis.
Shatterbox (SB), Ball Mill (BM), or Freezer Mill (FM) + Mixer (Sequence 3)	Use mixer to homogenize entire crushed sample.	Manually take 1 pint crushed sample for pulverization.	Pulverize 1 pint crushed sample for analysis.
SB, BM, or FM (no Mixer) (Sequence 4)	Riffle split entire crushed sample and take 1 pint aliquot.	Pulverize 1 pint crushed sample.	Manually homogenize powdered sample for analysis.
M435: Braun Mill or Equivalent (no Mixer)	Riffle split entire crushed sample and take 1 pint aliquot.	Pulverize 1 pint crushed sample for analysis.	

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Laboratory Sample Processing Practices
Sequences of Post-crushing Procedures

Recommended

Test Method 435

Available Post-crushing Equipment	Step 1	Step 2	Step 3
Braun Mill + Mixer (Sequence 1)	Pulverize entire crushed sample.	Use mixer to homogenize entire powdered sample.	Manually take 1 pint for analysis.
Braun Mill (no Mixer) (Sequence 2)	Pulverize entire crushed sample.	Manually homogenize powdered sample.	Manually take 1 pint for analysis.
Shatterbox (SB), Ball Mill (BM), or Freezer Mill (FM) + Mixer (Sequence 3)	Use mixer to homogenize entire crushed sample.	Manually take 1 pint crushed sample for pulverization.	Pulverize 1 pint crushed sample for analysis.
SB, BM, or FM (no Mixer) (Sequence 4)	Riffle split entire crushed sample and take 1 pint aliquot.	Pulverize 1 pint crushed sample.	Manually homogenize powdered sample for analysis.
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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.

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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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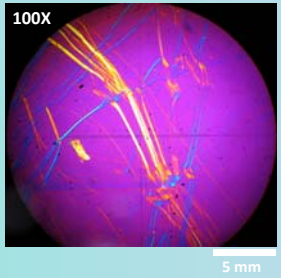
Laboratory Sample Analysis Procedures

Principles of M435 Asbestos Identification

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



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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.

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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.

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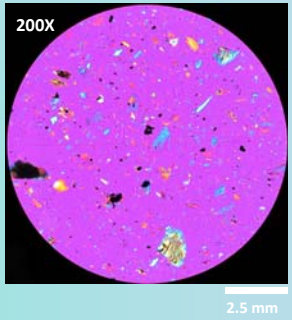
Laboratory Sample Analysis Procedures

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.



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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.

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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.

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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.

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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.

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California Environmental Protection Agency
Air Resources Board

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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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