Brownfields2013
SUSTAINABLE COMMUNITIES START HERE

Asbestos in Soil

Ed Cahill – EMSL Analytical

Soil is a Great Hiding Place

- 1% Unconsolidated Chrysotile

- 1% Consolidated Chrysotile

Soil is a Great Hiding Place for Asbestos

Asbestos Contamination

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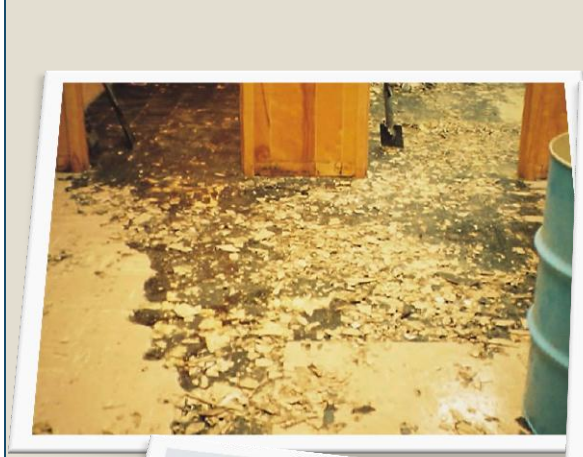


Natural Occurrences of Asbestos (NOA)

Why is Soil so Hard to Analyze?

Non-Homogeneity

Grain size

Scales of Non-Homogeneity

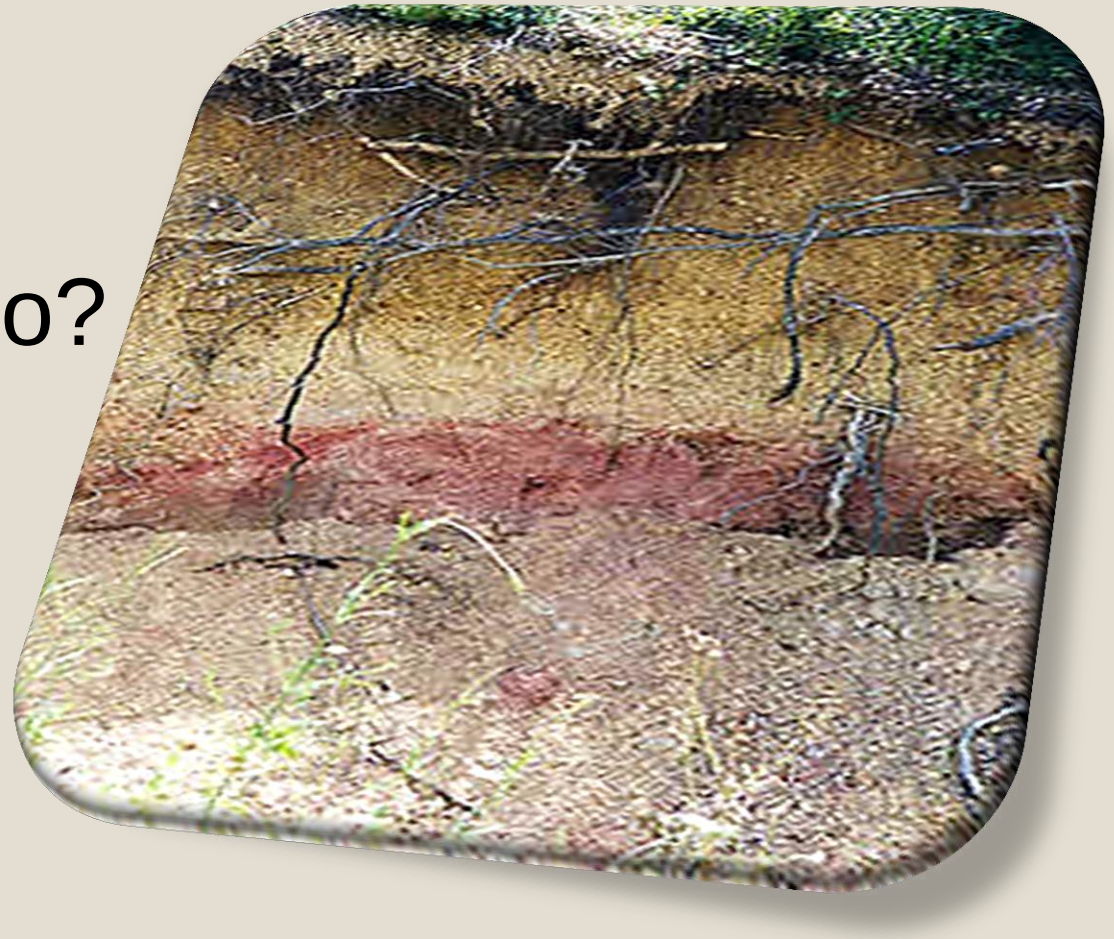
The Big Picture

- Obtaining representative samples in the field can be difficult.
- Samples tend to be very non-homogeneous especially over the large areas that are typical on outdoor sites.
- How many samples for a baseball field or 100 miles of road or rail bed?

Scales on Non-Homogeneity

The Medium Picture

- How deep to go?
- What layers to include?



Scales on Non-Homogeneity

The Fine Picture

Obtaining a representative **sub-sample** in the lab is important.

Scales on Non-Homogeneity

The Very Fine Picture

stereoscopic view of play sand

The presence of even sand sized quartz crystals are a problem.

In Summary

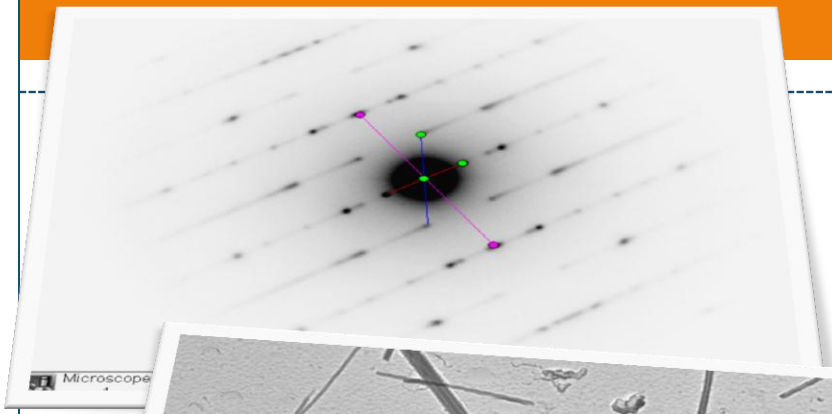
- Soil is a problem matrix for field and lab personnel alike.
- Careful sampling plans are needed to reduce inconsistencies, and help to carefully define …… "What is the sample?"
- The Analytical method used needs to address potential non homogeneity and grain size

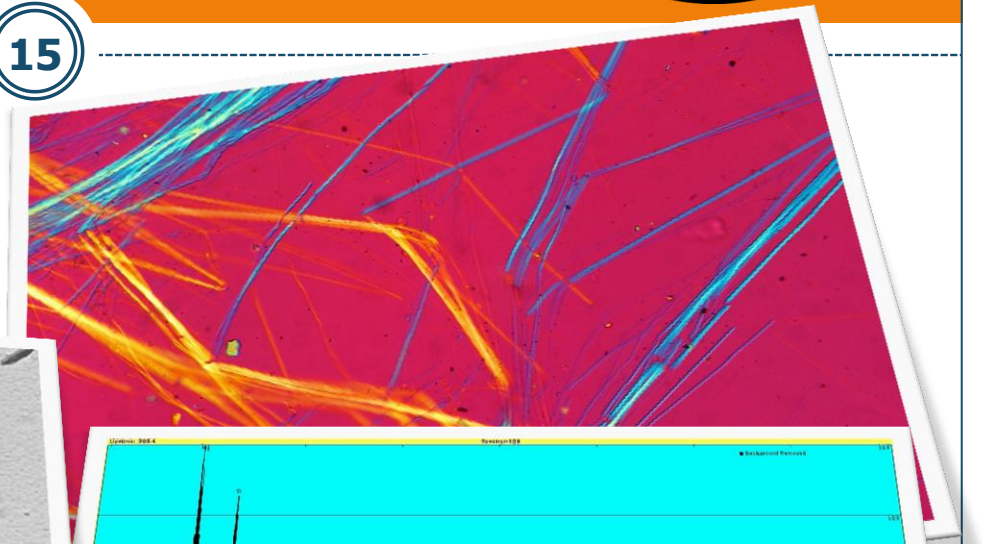
Good Luck!

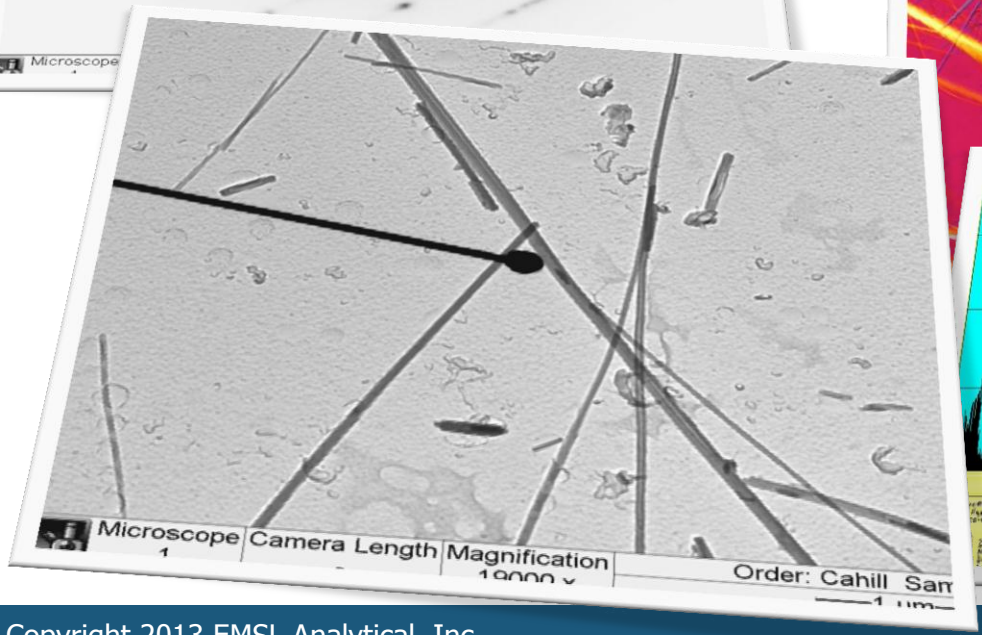
One way to help homogenize the samples either in the field or after submittal to the lab

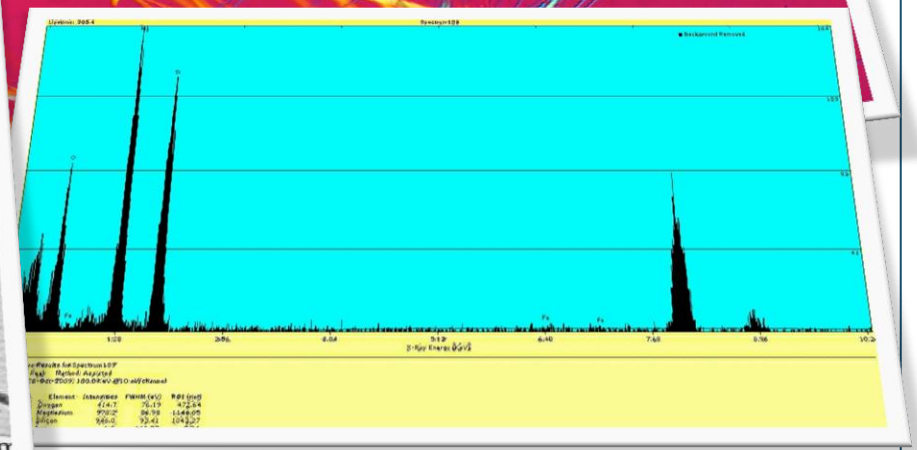
Riffle Splitting

Analytical Choices
What Method to Choose









Limitations of "Standard" PLM

EPA PLM Method (EPA/600/R-93/116)

Method for the Determination of Asbestos in Bulk ***Building Materials***

- This method is designed for relatively homogenous bulk building materials, not soil.
- The final version of this method is flexible though and matrix modification prior to analysis is described

Two Approaches to Soil

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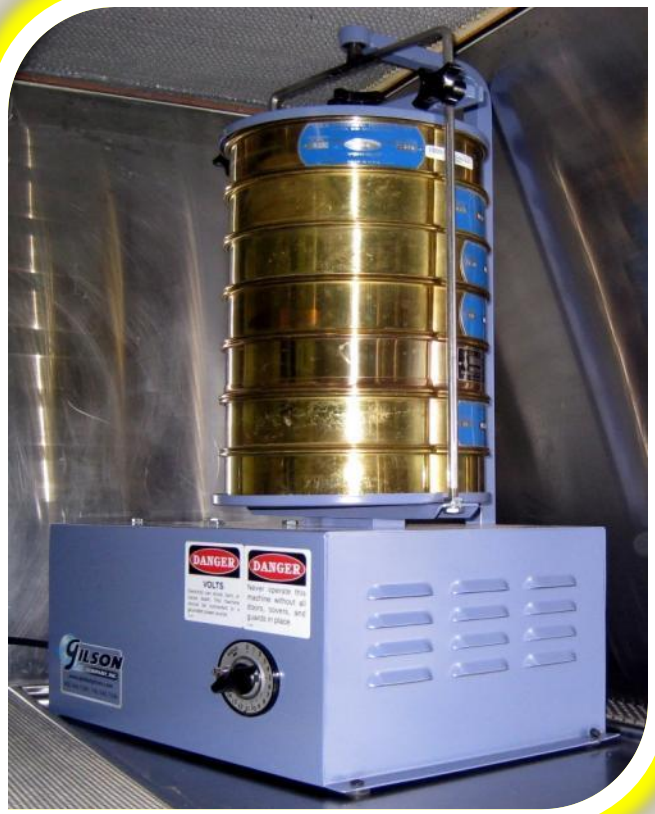
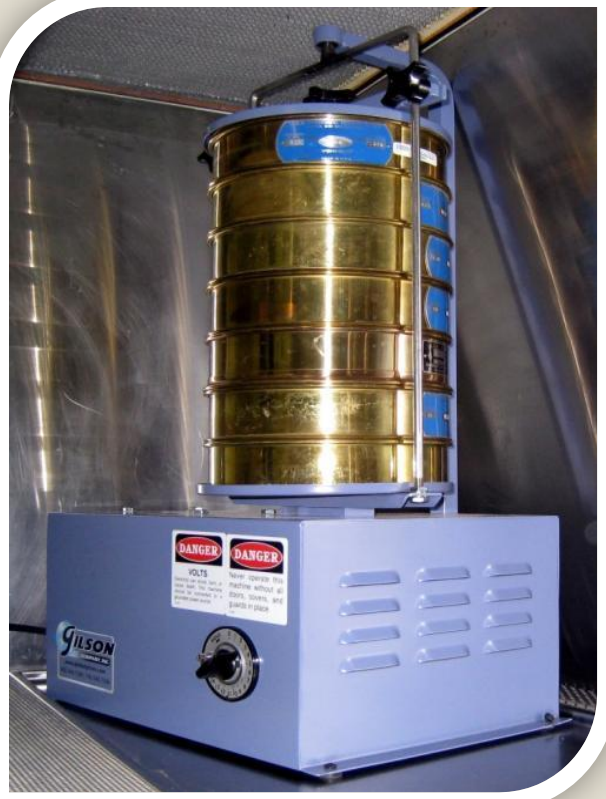
Sieving



Milling

ASTM D7521 - 13

Sieving



Designation: D7521 – 13

Standard Test Method for Determination of Asbestos in Soil[1]

This standard is issued under the fixed designation D7521; 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 test method covers a procedure to: (*1*) identify asbestos in soil, (*2*) provide an estimate of the concentration of asbestos in the sampled soil (dried), and (*3*) optionally to provide a concentration of asbestos reported as the number of asbestos structures per gram of sample.

1.2 In this test method, results are produced that may be used for evaluation of sites contaminated by construction, mine and manufacturing wastes, deposits of natural occurrences of asbestos (NOA), and other sources of interest to the investigator.

1.3 This test method describes the gravimetric, sieve, and other laboratory procedures for preparing the soil for analysis as well as the identification and quantification of any asbestos detected. Pieces of collected soil and material embedded therein that pass through a 19-mm sieve will become part of the sample that is analyzed and for which results are reported.

1.3.1 Asbestos is identified and quantified by polarized light microscopy (PLM) techniques including analysis of morphology and optical properties. Optional transmission electron microscopy (TEM) identification and quantification of asbestos is based on morphology, selected area electron diffraction (SAED), and energy dispersive X-ray analysis (EDXA). Some information about fiber size may also be determined. The PLM and TEM methods use different definitions and size criteria for fibers and structures. Separate data sets may be produced.

1.4 This test method has an analytical sensitivity of 0.25 % by weight with optional procedures to allow for an analytical sensitivity of 0.1 % by weight.

1.7 *Hazards*—Asbestos fibers are acknowledged carcinogens. Breathing asbestos fibers can result in disease of the lungs including asbestosis, lung cancer, and mesothelioma. Precautions should be taken to avoid creating and breathing airborne asbestos particles when sampling and analyzing materials suspected of containing asbestos.

1.8 *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:*

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates

D1193 Specification for Reagent Water

D3670 Guide for Determination of Precision and Bias of Methods of Committee D22

D6281 Test Method for Airborne Asbestos Concentration in Ambient and Indoor Atmospheres as Determined by Transmission Electron Microscopy Direct Transfer (TEM)

D6620 Practice for Asbestos Detection Limit Based on Counts

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

2.2 *EPA Standards:*

EPA 600/R-93/116 Method for the Determination of [illegible] tos in Bulk Building Materials[2]

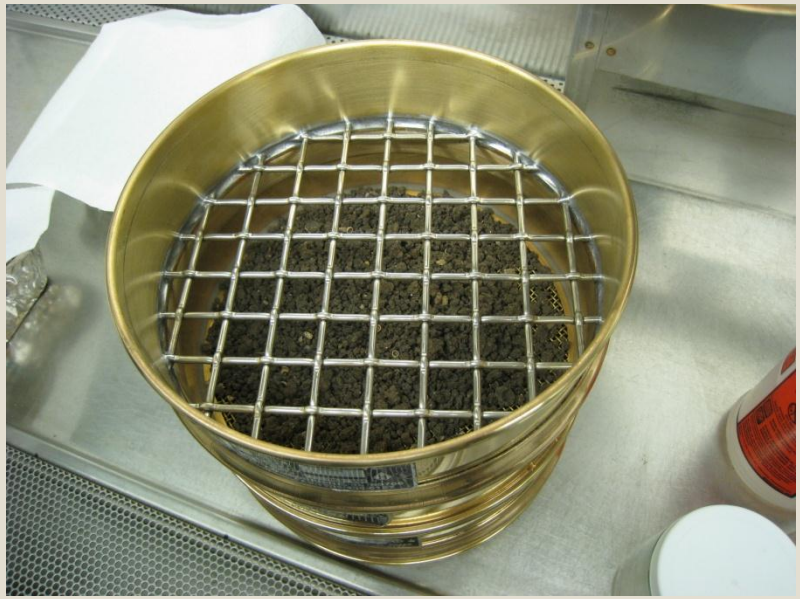
2.3 *ISO Standards:*[3]

ASTM Sieve Method

Sample Size 250 cc or less

Sieve Stack

- 19 mm (3/4”)
- 2 mm
- 106 micron



Anything larger than 19 mm is not considered part of the sample

ASTM Sieve Method

1) Sample is dried
2) Weighed
3) Dry Sieved (wet sieving is optional) on sieve shaker for 5 minutes

ASTM Sieve Method

4) Weigh each fraction
5) Analyze each fraction

Coarse and Medium Fractions still too large for straight PLM

ASTM Sieve Method

The fine fraction is fine enough and homogenous enough for a PLM slide prep and analysis

Wet or Dry?

Pros

- Washes the suspect ACM making for easier detection
- Breaks down matrix to its smallest components

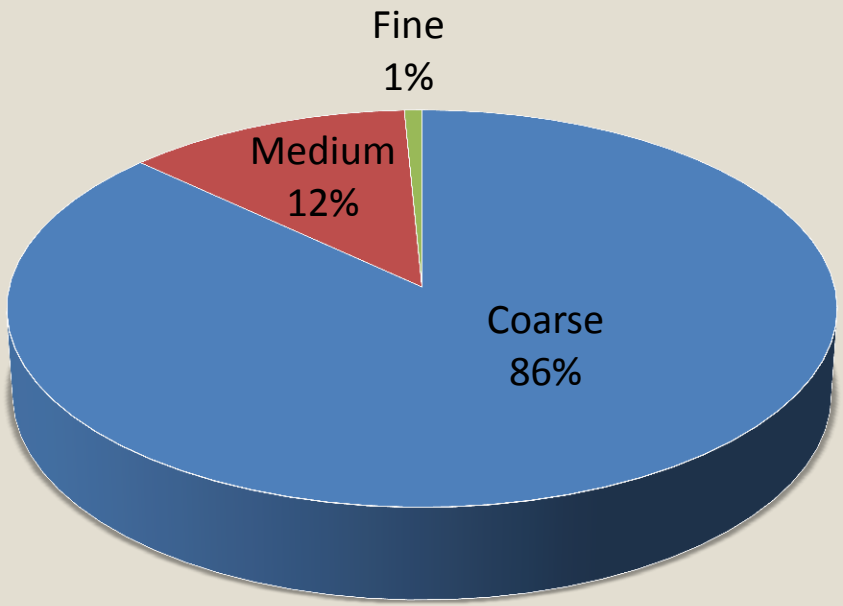
Wet Sieving Can Be Better for Some Soils

Cons

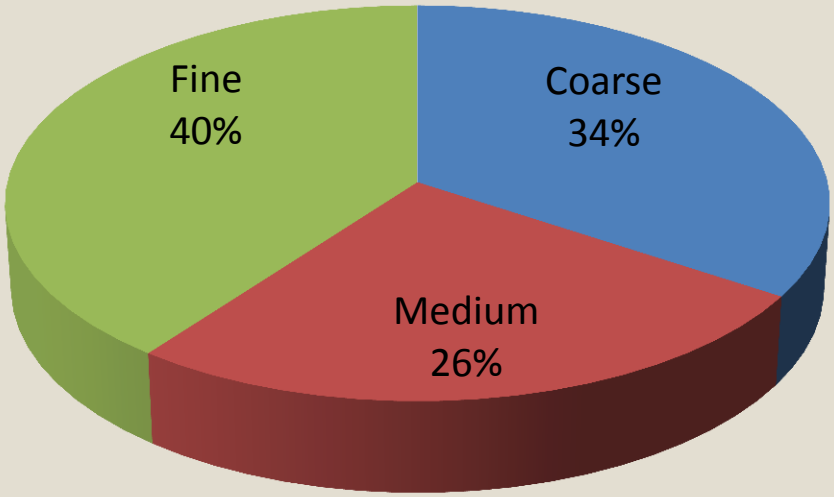
- More labor intensive
- More time (drying)
- Even more time and possible fiber loss as fine fraction needs to be sedimented
- Water disposal an issue

The Same Sample !

Dry Sieving



Wet Sieving



Visual and Stereomicroscopic Analysis

HAND PICKING SUSPECT ACM OUT OF COARSE AND MEDIUM FRACTIONS.

ASTM Analysis

THE ASBESTOS % FOR EACH TYPE OF ACM IS DETERMINED. THE PERCENT ASBESTOS IS EXTRAPOLATED TO THAT FRACTION, AND THEN TO THE ENTIRE SAMPLE.

13. Calculation

13.1 *PLM Analysis*

13.1.1 Total calculated asbestos content of the soil (the coarse (>2-mm), medium (<2-mm and >106-µm), and fine (<106-µm) fractions) in the soil sample using PLM analysis is determined using the following formula:

$$\text{Total Asbestos (\%)} = \frac{[\%_F \text{ PLM PC} * W_F] + [\%_M \text{ PLM} * W_M] + [\%_C \text{ PLM} * W_C]}{W_F + W_M + W_C} \quad (1)$$

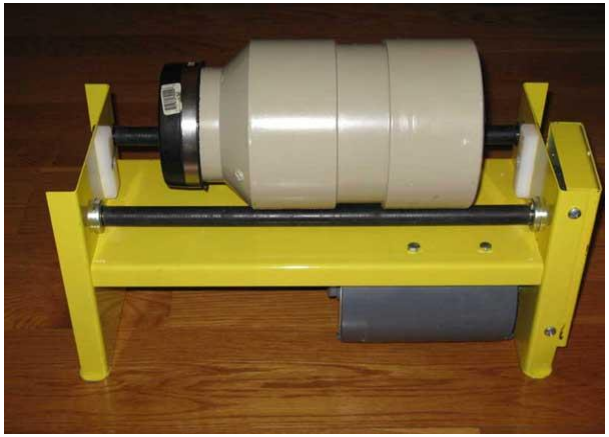
ASTM Sieve Method

- If all three fractions are non detect by PLM a TEM analysis is performed.
- Optional drop mount Qualitative only (detect/non detect).
- If drop mount is positive then gravimetric reduction followed by Quantitative TEM analysis (structures/µg)

TEM Quantitative Analysis

- 100 to 250 mg of the material from the fine fraction is gravimetrically reduced via muffle furnace and acid treatment.
- Filtered onto a 0.2µm PC or 0.22µm MCE filter
- TEM examination using a direct method consistent with Test Method D6281.
- Results reported in Structures per microgram
- Is that a useful number?

The MILLING Approach



Disk pulverizer/plate grinder
Cross Beater Mill
Freezer mill
Ball mill, etc……

CA Air Resources Board (CARB) Method 435

Determination of Asbestos Content of Serpentine Aggregate

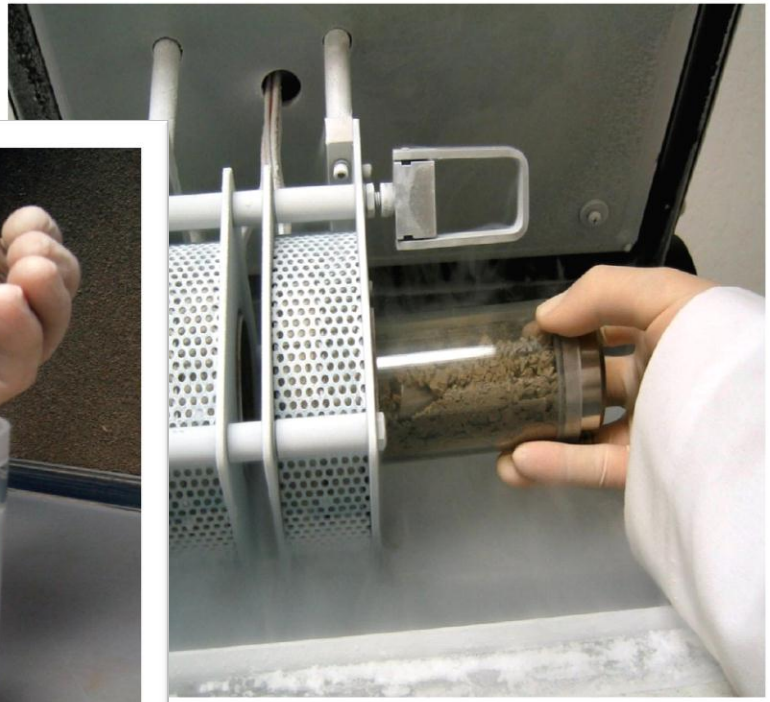
This is the current de facto standard for milling methods.

1. One pint (473cc) sample
2. milled to 200 mesh (74 microns)
3. PLM

CARB 435 Method

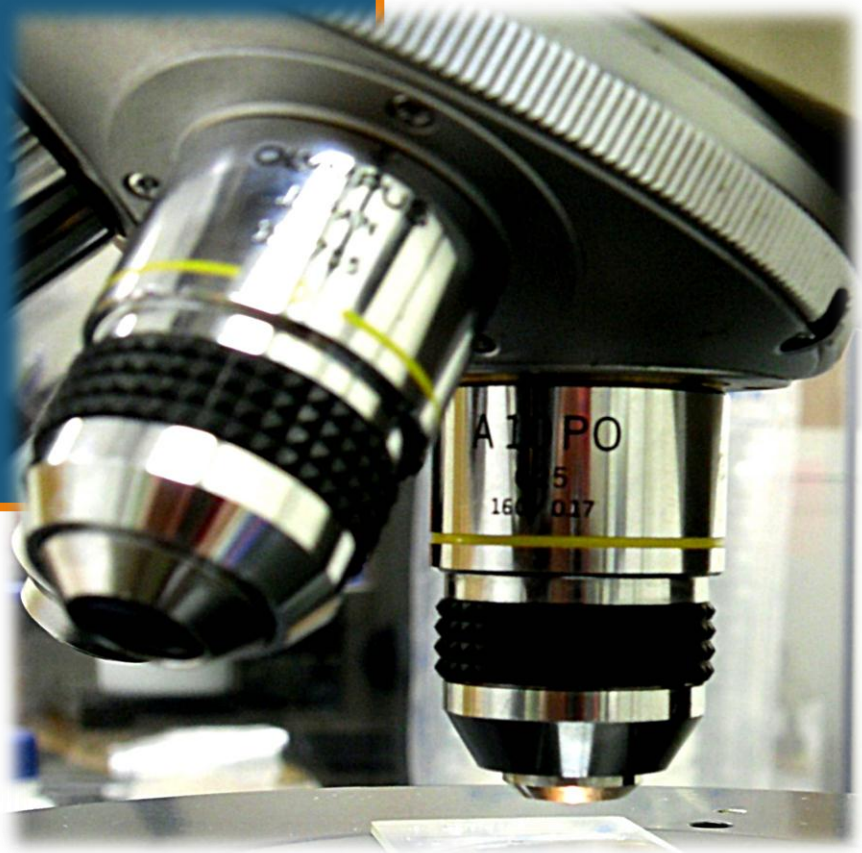
The sample is dried in a drying oven and material >3/8" is removed by sieving

Milled to reduce the nominal particle size to 75 microns

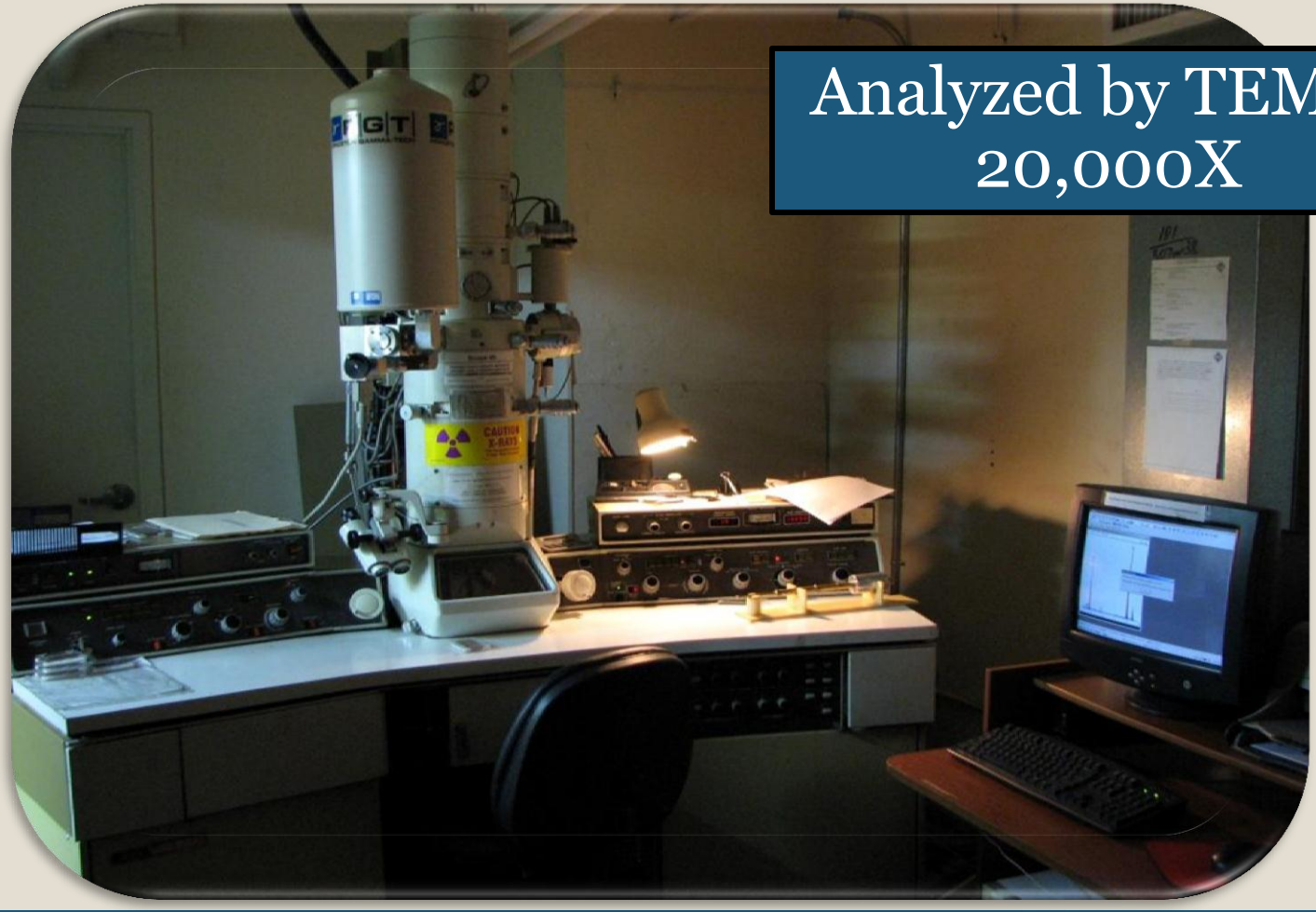


CARB 435

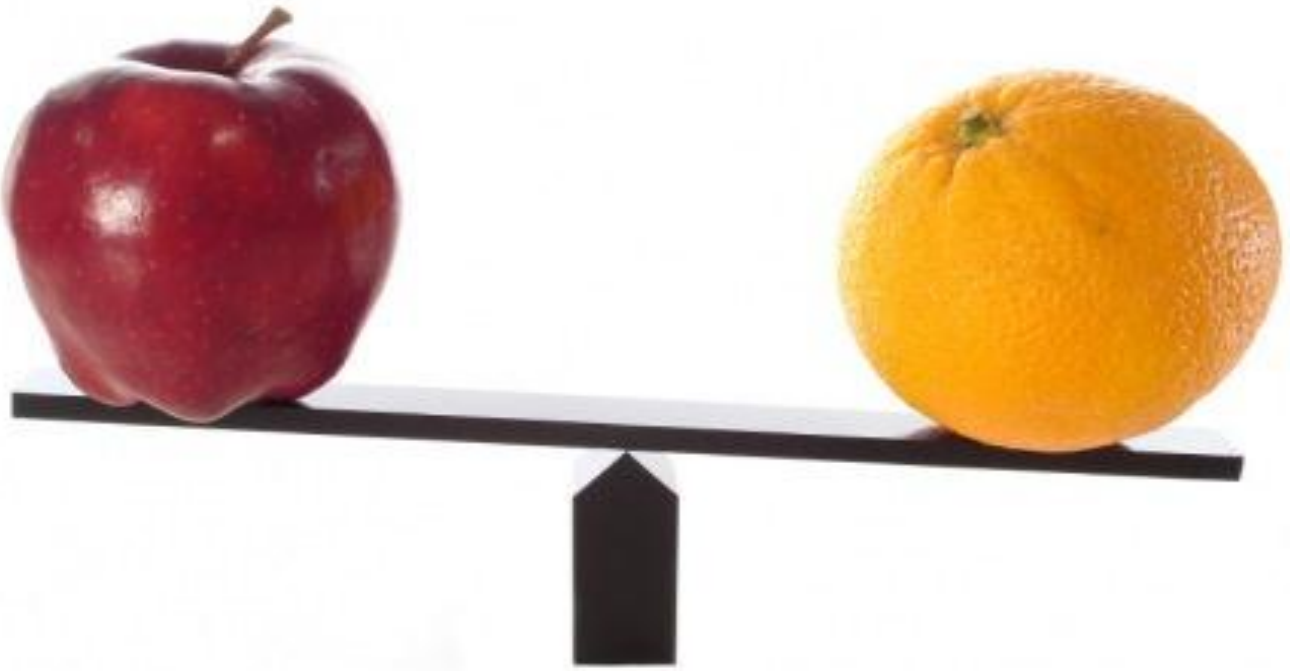
After milling, the sample is analyzed by a PLM 400 or 1000 point count (0.25% or 0.1%)



TEM CARB Method



How Do They Compare?



Summing Up

ASTM Sieve Method

Pros

- Specifically designed for soil so defensible ("fit for use")
- Allows for a forensic analysis as it does not alter the asbestos or ACM as it exists in the sample
- TEM follow up on NAD circumvents the 0.25 micron width limitation

Cons

- Most time consuming
- potential cross contamination due to sieves (difficult to clean)
- cost
- Course and medium fraction still not amenable to PLM

Summing Up

CARB 435

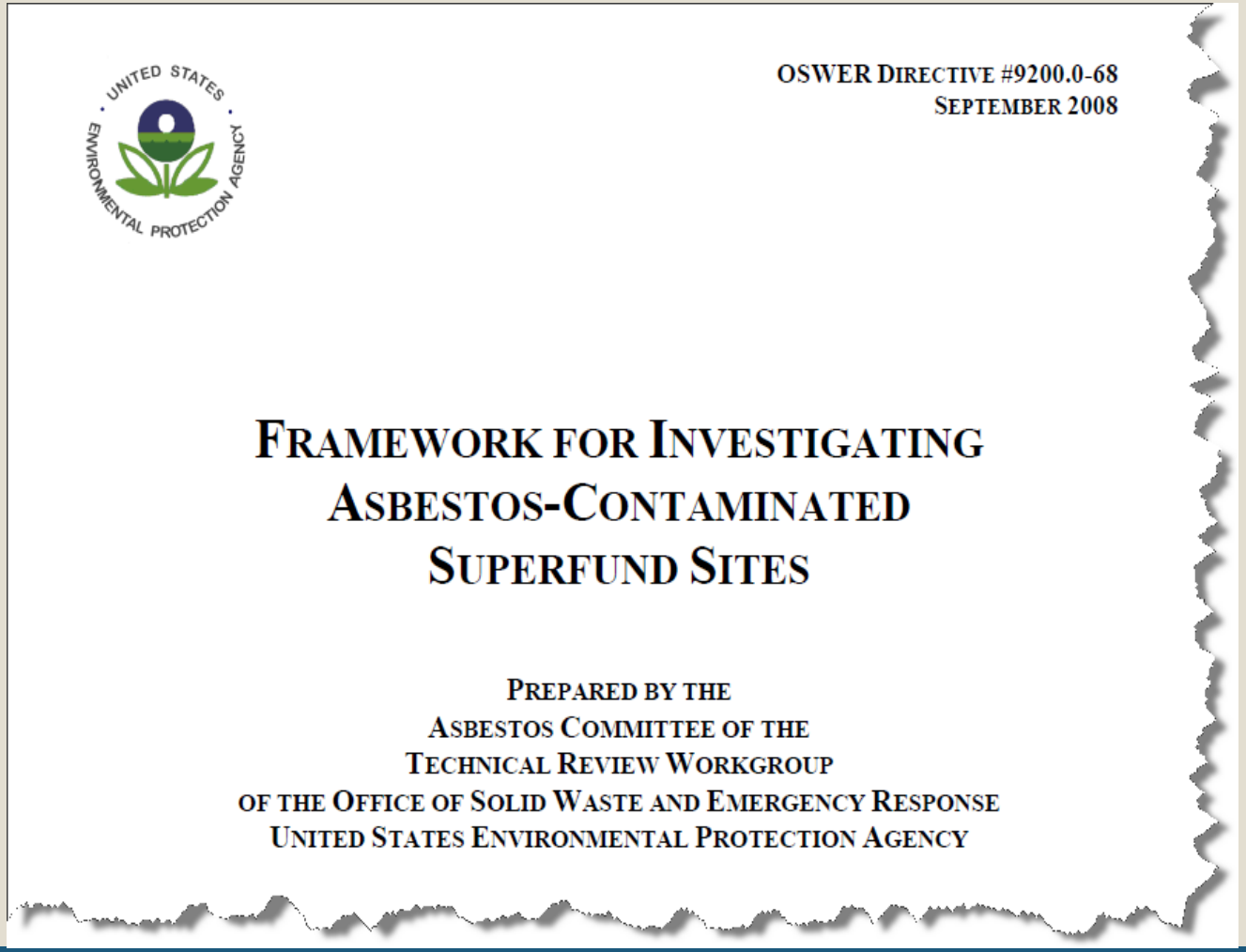
Pros

- Homogenizes the entire sample prior to analysis. (better quant?)
- Reduces grain size of entire sample
- Less labor intensive than sieving
- Mentioned in the EPA framework document
- Options for better DL 0.25 , 0.1 or even lower
- Milled sample is also amenable to TEM analysis

Cons

- Potential to create fibers (cleavage fragments with large aspect ratios) from non asbestiform minerals.
- Alters fiber sizes dimensions

- **CARB 435 mentioned**
- **1% is not an appropriate action level for asbestos in soil**



OSWER DIRECTIVE #9200.0-68
SEPTEMBER 2008

FRAMEWORK FOR INVESTIGATING ASBESTOS-CONTAMINATED SUPERFUND SITES

PREPARED BY THE
ASBESTOS COMMITTEE OF THE
TECHNICAL REVIEW WORKGROUP
OF THE OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Another Approach Fiber Releasability

- Determining the percentage of asbestos in soil is useful for knowing that there is a potential for exposure.
- But it does not give us a clue as to what the risk actually is.
- 1% is not an acceptable action level to use for asbestos in soil

The Elutriator Method

The Elutriator Method

- With this method a soil sample is gravimetrically tracked through sieving into course and fine fractions
- The fine fraction is then tumbled in a closed chamber and any respirable dust generated is collected on air cassettes
- Analysis is performed by ISO 10312

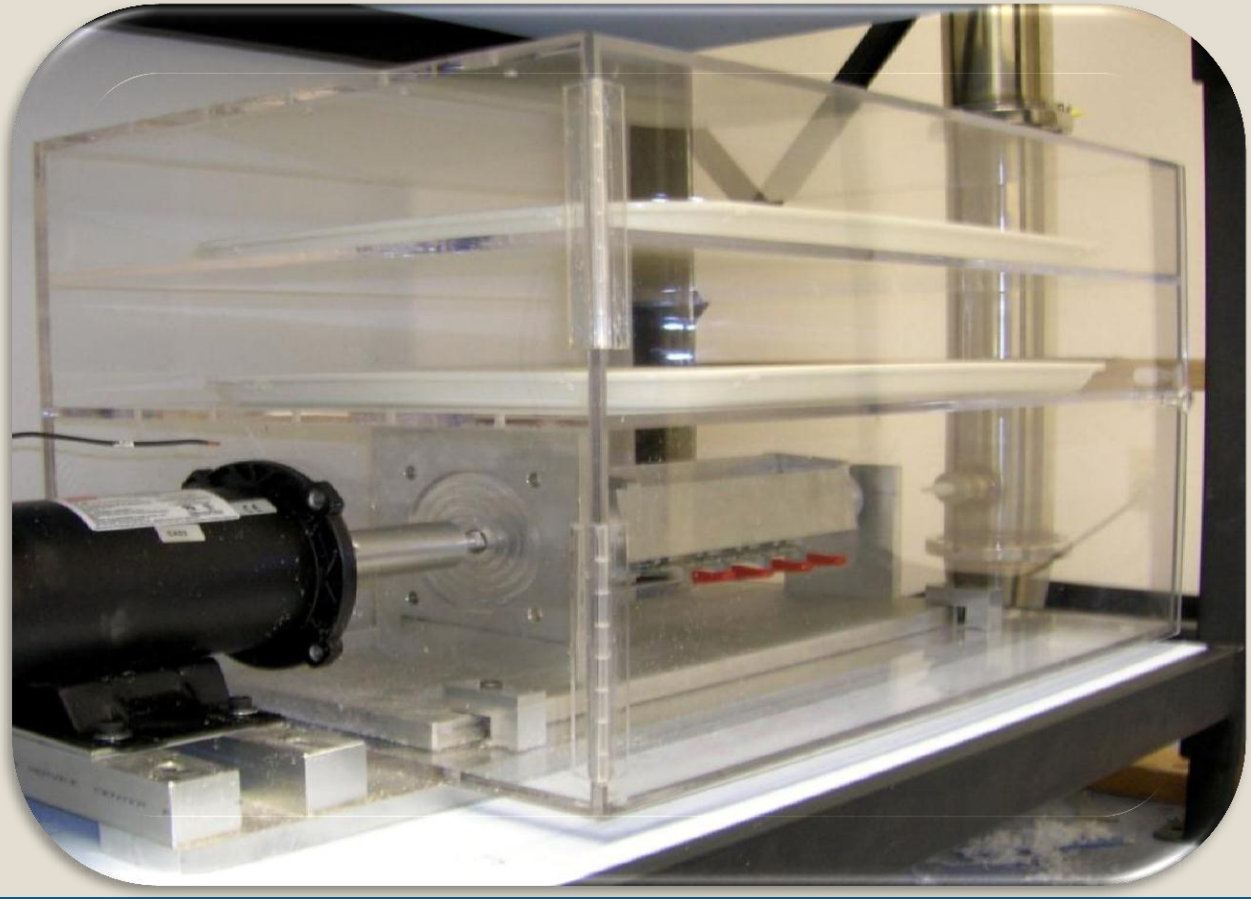
This method is (arguably) acceptable for risk assessment studies

The Elutriator Method

Tumbler apparatus filled with soil

The Elutriator Method

Tumbler inside enclosed humidity chamber



The Elutriator Method

Isokinetic sampling at top of elutriator stack to catch only the respirable fraction of fibers released from the soil.

ISO 10312 Analysis Results in structures/g

Field Alternatives to the Elutriator

There are other techniques in the field that also collect and measure releasable fibers from soil.

- **Activity Based air Sampling (ABS)**
- **Releasable Asbestos Field (RAF) Unit**
- **Fluidized Bed Asbestos Segregator(FBAS)**

Activity Based Air Sampling

Activity Based Air Sampling

Personnel (and sometimes area) monitoring is performed while samplers mimic likely activity for that location.

RAF Unit

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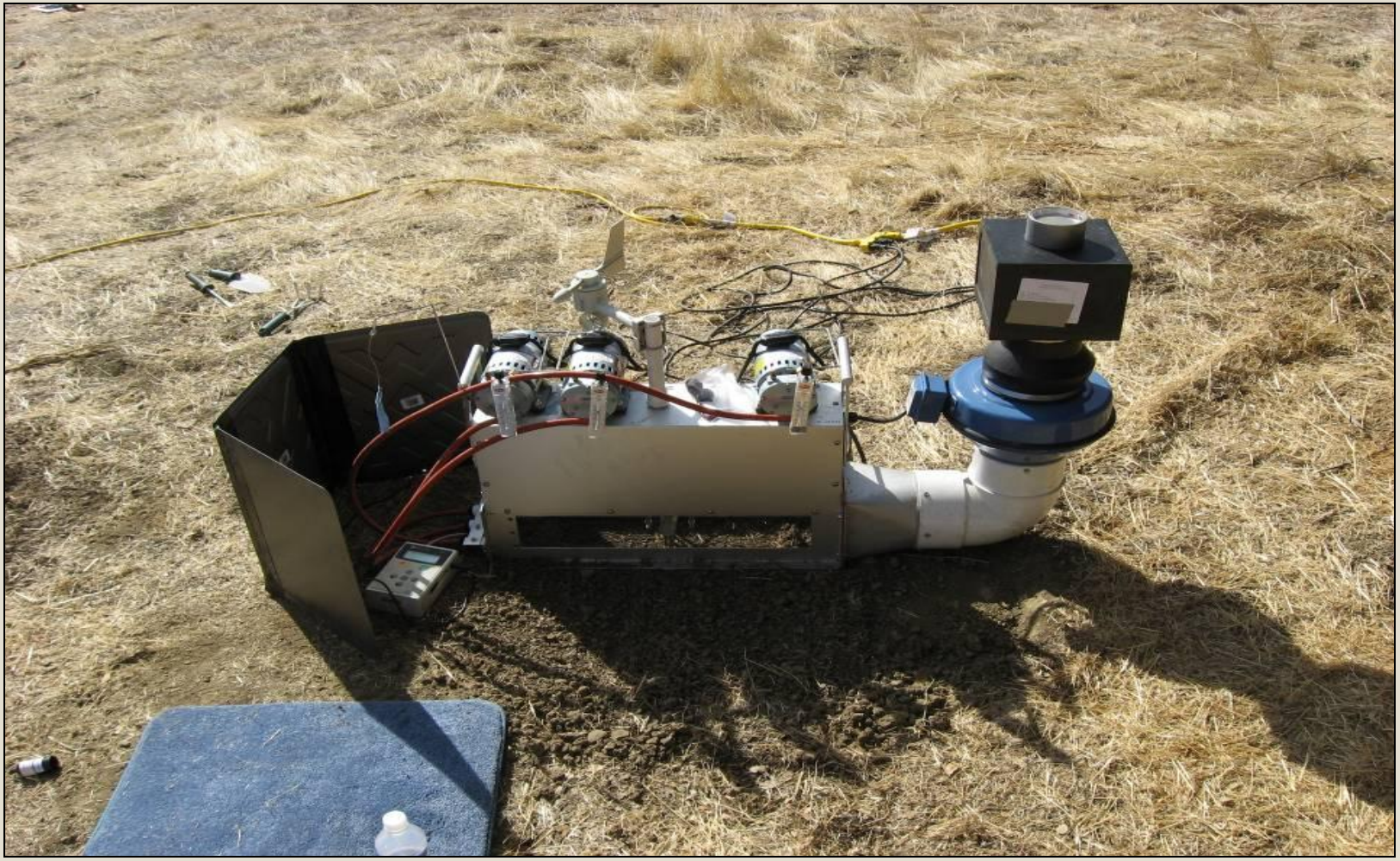

RAF Unit

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Fluidized Bed

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