Sampling to Quantify Respirable Dust Generation

- Current respirable dust standards and sampling requirements established in 1969
- Dust sampling instruments approved for use in underground coal mines
- Sampling methods to quantify dust sources
Respirable dust standard for coal mining

If silica > 5%, reduced standard = \( \frac{10}{\% \text{ silica}} \)

2.0 mg/m\(^3\)
Gravimetric dust sampler

- Provides time-weighted-average respirable dust concentration
- Dorr-Oliver cyclone separates respirable and oversize dust
- Pump operated at 2.0 liters per minute in coal mines
Sampling with gravimetric sampler

• Filter is pre- and post-weighed to determine mass gain and is used to calculate an average dust concentration over sampling period.

• Filter processed using MSHA P7 infrared analytical technique for silica content.

• Sufficient mass must be collected to have confidence in measurement.

• NIOSH typically uses multiple gravimetric samplers and averages data.
Personal DataRAM (pDR)

• Uses light scattering as measurement technology

• Instantaneous readings correlated with time and stored in internal memory

• Relative concentrations impacted by:
  – size distribution of dust
  – composition of dust
  – water mist in air

• PRL adjusts readings with ratio obtained from adjacent gravimetric samplers
pDR field calibration

• Divide average gravimetric concentration by average pDR concentration for same sampling period

• Multiply all individual pDR readings by ratio

• Example:
  gravimetric average = 1.4 mg/m³
  pDR average = 1.1 mg/m³
  grav/pDR ratio = 1.4/1.1 = 1.27
  pDR concentrations * 1.27 = adjusted pDR concentrations
pDR provides time record of dust levels

![Graph showing relative dust concentration over time with two passes: Head to Tail Pass and Tail to Head Pass.](Image)
Personal Dust Monitor (PDM)

- Real-time measurement of respirable dust
- Combines dust sampler and cap lamp into one unit
- Sample inlet is mounted on cap lamp
- Utilizes mass-based measurement to quantify dust concentration (TEOM)
- Dust measurements are displayed on screen and stored internally for later analysis
Principle of operation

- Exchangeable filter cartridge mounted on the end of the tapered element collects particles as sample stream flows through hollow tube.
- Tapered element oscillates at its harmonic frequency -- like a tuning fork.
- Frequency changes in *direct* relation to the mass collected on the filter.
- Measurement principle does *not* respond to other particle characteristics such as size distribution or composition (heated circuit removes moisture).
PDM status:

- Meets NIOSH sampling accuracy requirements (NIOSH RI 9669)
- Equivalency to CMPDSU (gravimetric sampler) published in peer-review journal
- MSHA IS approval granted for use in underground coal mines
- CFR 30, Part 74 modified rule is nearly finalized
- Thermo Scientific began delivery of commercial units in July 2009
- Two ongoing NIOSH research efforts (software and silica)
PDM analytical software

- Compile output from PDM samplers
- Provide user-selected summaries for multiple samplers (foreman, mine superintendent, etc.) or engineering evaluations
- Provide graphing capabilities
PDM filter capsule for maintaining sample integrity for quartz analysis

- Place capsule over PDM filter when TEOM unit removed from PDM
- Use capsule as filter removal tool and to secure dust
- Send to lab, remove finger tab, ash capsule
- Plan to conduct mine surveys to complete side-by-side testing with current silica analysis method
Sampling to isolate a fixed dust source

Continuous miner

Line brattice

Sampling locations

Return

Intake

Check curtain
Sampling to isolate a mobile dust source

U - Upwind location  D - Downwind location
Using real-time data to quantify mobile dust sources

• Evaluate dust levels during truck haulage cycle at an underground gold mine

• Use pDR samplers and time study data to quantify dust generation for different parts of cycle
  – loading
  – hauling full
  – dumping
  – hauling empty

• Two researchers conducting time studies
Time-weighted-average dust contributions

Dump location had highest dust liberation (despite the shortest time)

- Dump: 34%
- Tram Full: 22%
- Tram Empty: 29%
- Loading: 15%
Sampling to isolate an unconfined dust source

A – Ambient sampling location

D – Drill sampling locations

Wind direction
Thank you!

Questions??

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