Implementation of a field-based respirable dust and crystalline silica monitoring program

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Traditional exposure monitoring

Challenges

• Changing conditions can move faster than results are available

• Much of the process is outside direct control

• Additional samples → additional costs
“direct-reading”

vs.

“field-based”
Helmet-CAM: overview

Real-time exposure monitoring

Video recording of surroundings and activities

Connection between exposure source and exposure level
Helmet-CAM components

wearable camera

dust monitor (housed in backpack)

cyclone
Helmet-CAM options (not an exhaustive list)

- Housing
  - Backpack
  - Miner’s Safety Belts
  - Safety Vest

- Video

- Dust monitoring
NIOSH’s EVADE software simplifies Helmet-CAM analysis

With the interactive and intuitive interface:

Point to location of video and exposure concentration

Merge data by time (automatically)

Identify peak exposures easily from visual display

https://www.cdc.gov/niosh/mining/Works/coversheet1867.html
Helmet-CAM allows for fast evaluation of engineering controls
Field-based silica monitoring: overview

- Respirable dust samples are collected
- Sample data used for decision making
- Raw data and sample metadata are entered in FAST
- 30 seconds: Raw data is processed and exported
- 60 seconds: Sample cassette is inserted in instrument and analyzed
- 120 seconds: Sample data used for decision making
- 30 seconds: Raw data is processed and exported
- 60 seconds: Sample cassette is inserted in instrument and analyzed
- 120 seconds: Sample data used for decision making
Field-based silica monitoring components

- respirable cyclone
- compatible cassette / cradle
- portable FTIR instrument
- computer
The science behind field-based silica monitoring

- FTIR already used in the U.S. to measure quartz in samples from coal mines
- Sample analysis produces a broad spectrum; a specific region is used to quantify quartz
Field-based silica monitoring options *(not an exhaustive list)*

- **Instruments**
- **Samplers** & more samplers to be added in coming FAST updates!
- **Cassette**
facilitates the field-based analysis process

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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RAW OUTPUT FROM FTIR (EXAMPLE DATA)

**Translate** the raw output from the FTIR software, using information that you provide to calculate mass and concentration

**Store** data in a database which can be shared or synced

**Organize** data by sampling event ... and more
## FAST: Data out

### Sample Data

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Worker</th>
<th>Silica Concentration (μg/m³)</th>
<th>Respirable Dust Mass (mg)</th>
<th>Dust Concentration (mg/m³)</th>
<th>Event</th>
<th>Sample Location</th>
<th>Warnings</th>
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</table>
FAST: Data out

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<tr>
<td>40.49</td>
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<tr>
<td>47.13</td>
<td></td>
</tr>
<tr>
<td>14.34</td>
<td>1) Estimate: more information is required for a more accurate quantification</td>
</tr>
<tr>
<td>32.52</td>
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<td>33.47</td>
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<td>122.7</td>
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<td>45.01</td>
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Case-study: Helmet-CAM / field-based monitoring combined

Two workers experience the same respirable dust concentration

Worker 1

Total sampling time: 2 hours 44 minutes

Average silica concentration: 0.053 mg/m³ (FTIR estimate)

Silica content of sample: 16.9% (FTIR estimate)

Spikes attributed to:
• marking rib with aerosol can
• changing bits
• work outside the cab
Case-study: Helmet-CAM / field-based monitoring combined

Two workers experience the same respirable dust concentration

Worker 2

Total sampling time:
2 hours 24 minutes

Average silica concentration:
0.095 mg/m³ (FTIR estimate) x 2

Silica content of sample:
26.5% (FTIR estimate)

Spikes attributed to:
Not attributed to specific events
What does this comparison tell us?

Silica content (% silica) is variable throughout the mine – 16.9% vs. 26.5%

Specific sources can be addressed to reduce Worker 1’s exposure
• Worker 1 can modify how he performs those three tasks
  • to move his breathing zone away from the source
  • to produce less dust as he performs the tasks
  • to spend less time in those areas
• Worker 1 may want to wear a respirator, and this data will show him where that will be most beneficial

No specific sources are associated with Worker 2’s overall exposure
• More generalized control strategies may reduce his exposure
• Can the roadways be watered more often?
• Can ventilation in this area be increased or optimized?
• Can Worker 2 reduce the amount of time he needs to spend in this area?
Integrating what is learned through Helmet-CAM / field-based monitoring into company health and safety management systems

NIOSH dissemination and mine implementation of information
During Helmet-CAM interventions managers and workers talked about what occurs [or not] on mine sites to promote health and safety processes and practices.

56 managers – various levels of mine

48 workers – all hourly employees
Results showed conflicting information about leaders’ communication

- Visibility of organizational support
- Consistency of supervisor support and communication
- Worker engagement to obtain consensus

NIOSH studied the progress of management’s H&S practices through the use of Helmet-CAM.
Visibility

Management action is critical

- What management says versus what they do
- Quality of responses and follow up
- Site-specific messages about critical hazards

Supervisor support * Compliance
Besides encouraging protective practices, management should be willing to engage in small pilot studies to determine what may help reduce exposure.

Did you know?

Starting with a forceful stream of water during housekeeping (e.g., hosing down equipment, walls, beams, and the floor) can elevate dust exposure.

During housekeeping, begin with a wide spray to wet everything down. Then use a narrow, forceful stream.

Findings based on NIOSH field studies. To learn more, visit go.usa.gov/xxG59.
Consistency

Balancing positive and negative reinforcements and maintaining the same consequences

What, why, and how messages are communicated
How mistakes are used and responded to among the workforce – can mistakes be made?
How accomplishments are used and responded to among the workforce
Consistent rules for everyone to follow

Supervisor Communication * Risk Tolerance
To help maintenance of a new behavior, management must encourage and provide positive consequences for health protective practices.
Consensus

Engaging workers in HSMS implementation

Methods to encourage joint decision making (peer to peer interventions, committees, etc.)

Methods to enhance worker responsibility and accountability

Engagement * Performance
Using this information to improve the entire system, not just the use of one technology or program.

**Did you know?**

Using clothes cleaning technology throughout the workday can reduce your exposure to respirable dust by up to 88%.

Launder clothes post-shift, including sweatshirts and coats, and use leather (not cloth) gloves to avoid dust buildup.

**System:** Engineering is integrated within risk management and clothes cleaning technology becomes recognized as a H&S process in mining.

**Leadership:** Organizations provide health protective technology and support its use.

**Culture:** Workers buy into and use the technology to protect their health as a part of their normal, daily work practices.
But does this have an impact on worker perceptions and performance?
Worker perceptions and performance:
• Pre assessment survey
• “You can bring up issues but no changes are made. The chain of command makes it difficult to implement any changes.”

Manager perceptions and performance:
• You need things to be visible to them. Take action. I’m pretty sure the guys respect me, I try to be visible on site, talk to them.

Observable changes (Y)
Worker change in perception – increase in supervisor support:
• After learning how much the dust booth helps us they [mgmt.] moved it in the shack so even in 30 degree below weather you can use it – so the booth was moved and we have less hassle.

Worker change in behavior:
• use of clothes cleaning booth @ 6 weeks and 6 months.

What management says versus what they do directly impacts workers’ perceptions of H&S priorities and their subsequent actions

Initial HSMS assessment (X)

Intervention Activities

Activity₁:
Dust data vantage points, feedback, and interviews

Activity₂:
Management Communication Practices, Support, and Engagement
Acknowledgment: The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. Mention of any company or product does not constitute endorsement by NIOSH, CDC. In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.

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