

Mining Dust Control Technology with Potential Application for the Oil and Gas Industry



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To eliminate mining fatalities, injuries, and illnesses through relevant research and impactful solutions



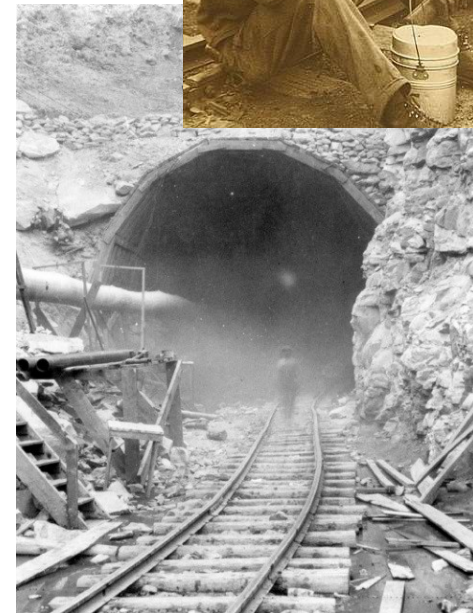
Safe mines — Healthy workers

Outline

- Background
- Filtration and Pressurization Research
- Helmet-CAM
- Clothes Cleaning Booth Technology
- Dust Control Handbook
- Current Potentially Applicable Research

Silicosis Outbreaks

- 1) 1910 to 1913 - 46% (3,700 miners) of Missouri lead miners found to have silicosis
- 2) 1919 - 93% of Vermont granite workers (427 miners) found to have silicosis/1924 - 100% showed early signs silicosis within 4 years.
- 3) 1933 - 476 deaths from Hawk's Nest Tunnel Project: workers died from silicosis drilling this tunnel in West Virginia



Impact of Silicosis



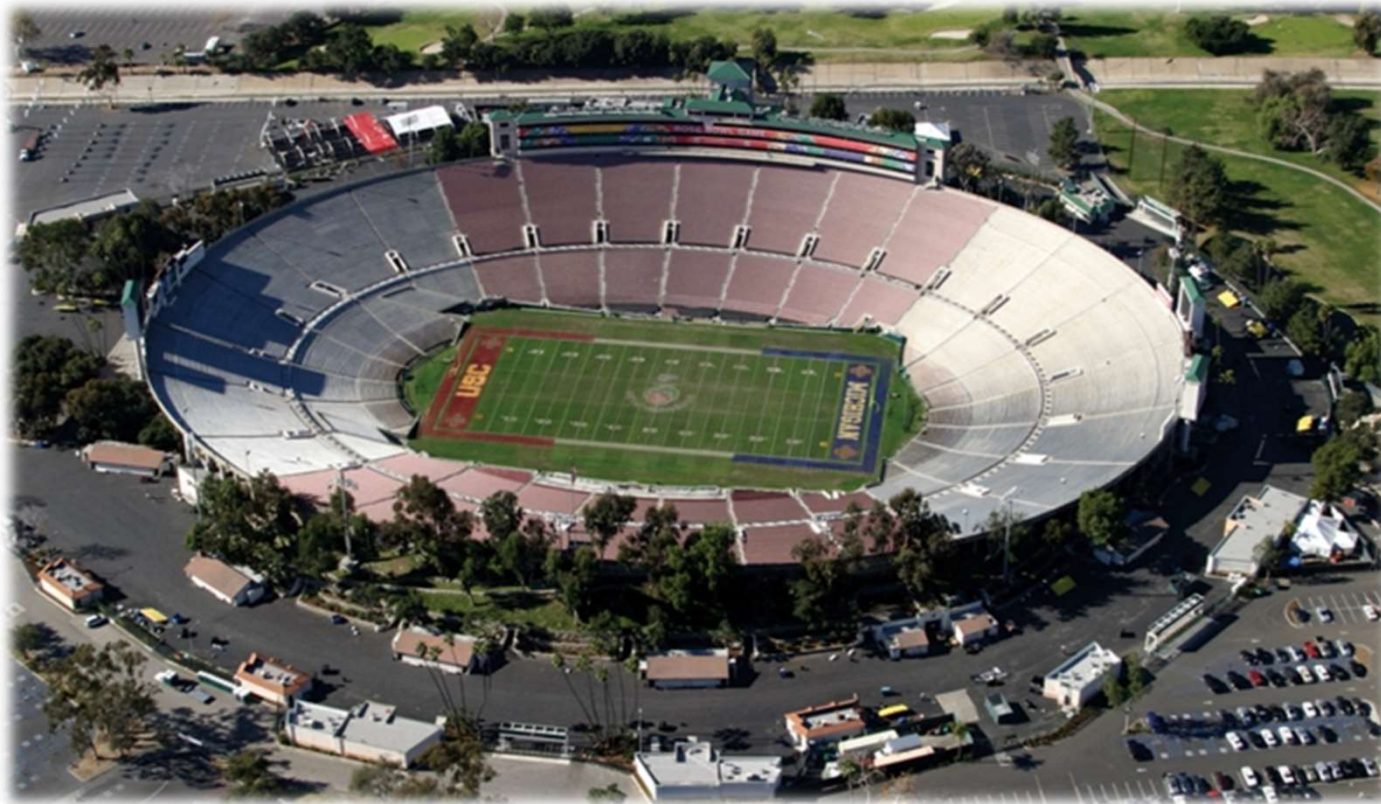
Current Silica Standard: 0.1 mg/m³ or 100 µg/m³

NIOSH REL /Pending OSHA Standard: 50 µg/m³

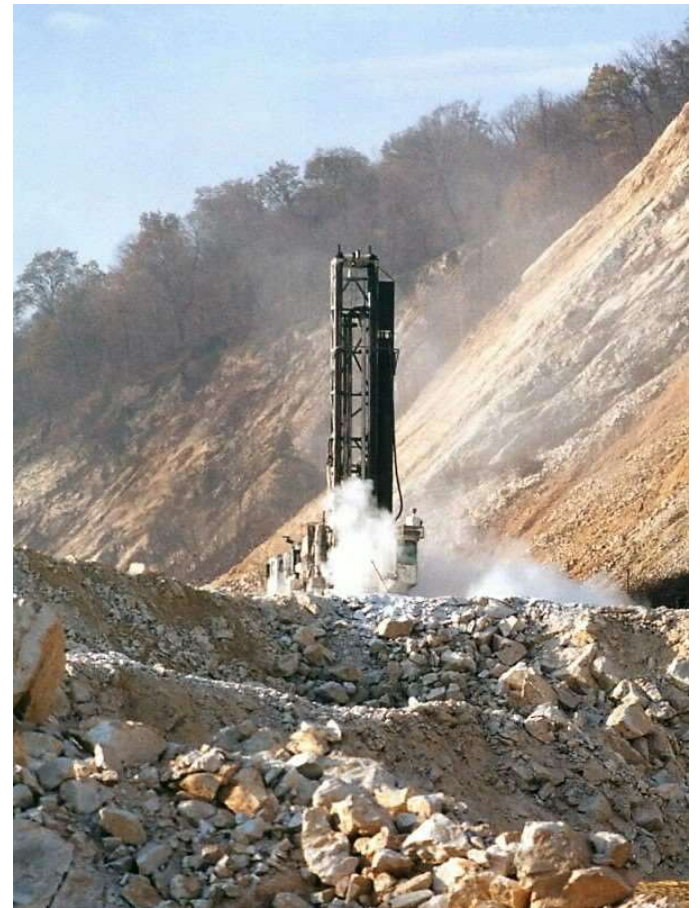
**Quarter weights:
5.6 grams**



Evenly distribute 5.6 grams respirable silica dust in air volume in the Rose Bowl stadium – would cause a worker breathing this air over 8 hrs. to be over-exposed



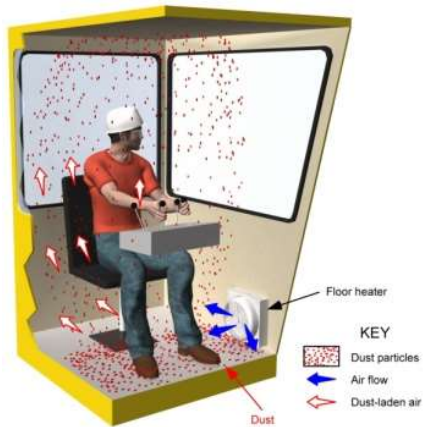
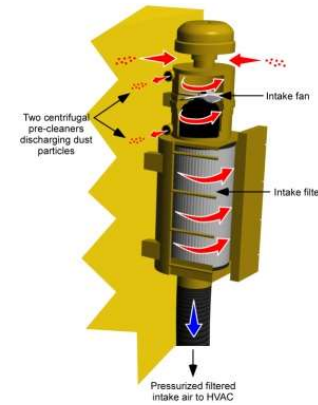
PROBLEM: Miners are exposed to elevated dust (respirable crystalline silica) in enclosed cabs and environmental enclosures



Research Goal: Optimizing filtration and pressurization efficiency to enclosed cabs/environmental enclosures to minimize respirable (silica) dust exposure and provide maximum air quality



Key Components for Effective Cab Filtration and Pressurization Systems



- 1. Effective Filtration**
- 2. Cab Integrity**
- 3. Monitoring and Maintenance**



Effective Filtration

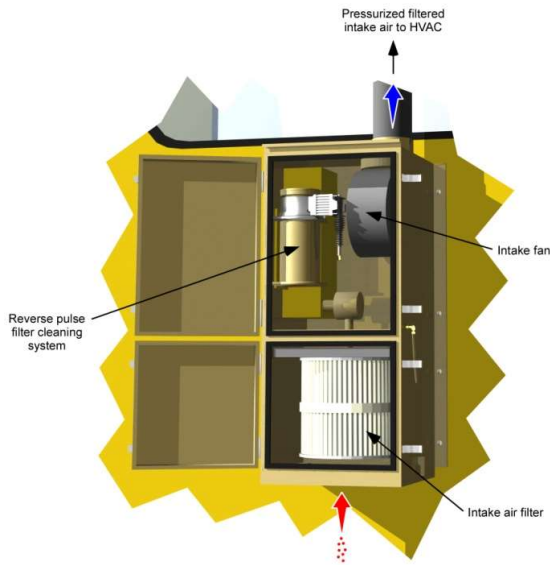
1. Pressurized Intake/Outside Air
2. Recirculated Cab Air



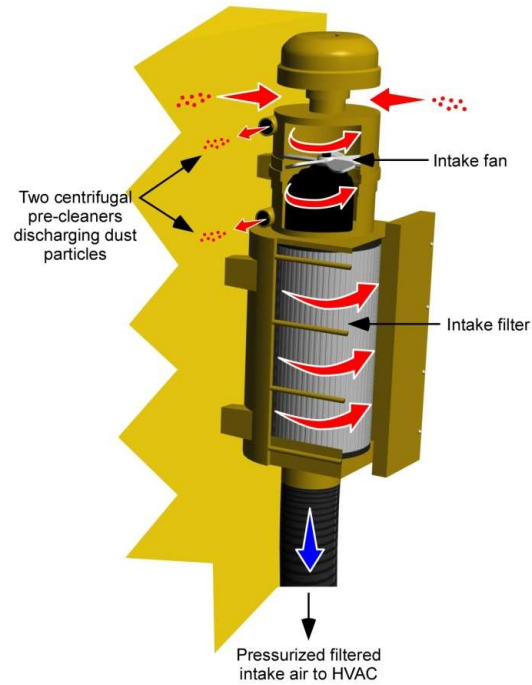
Powered Unit: Self-cleaning or centrifugal design



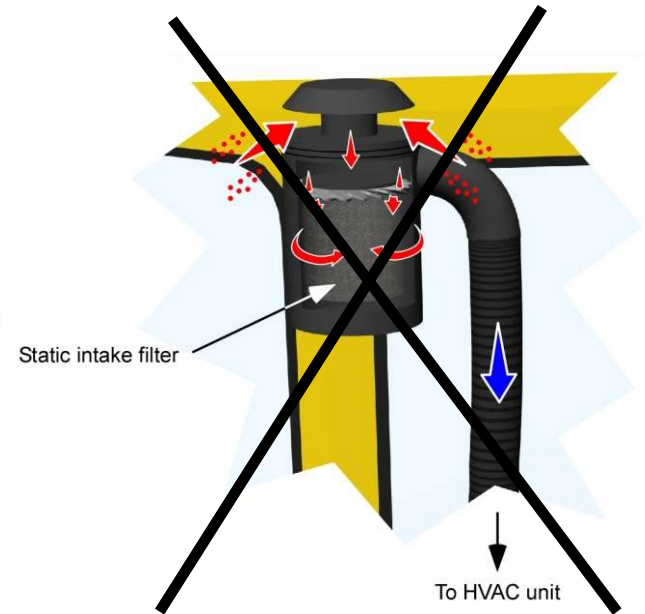
Self-cleaning



Centrifugal

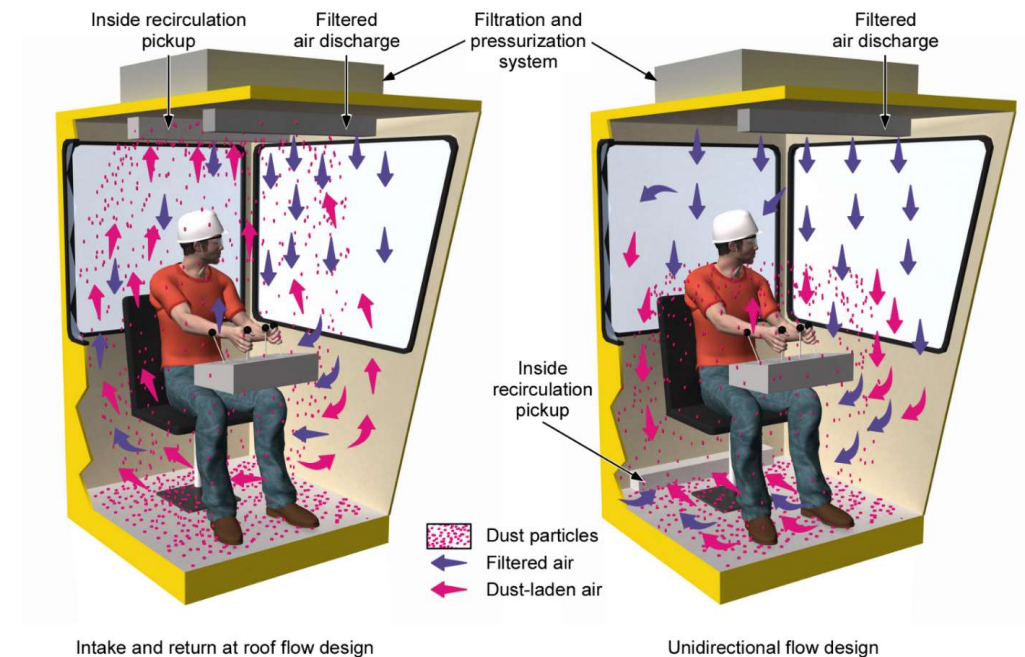


Static

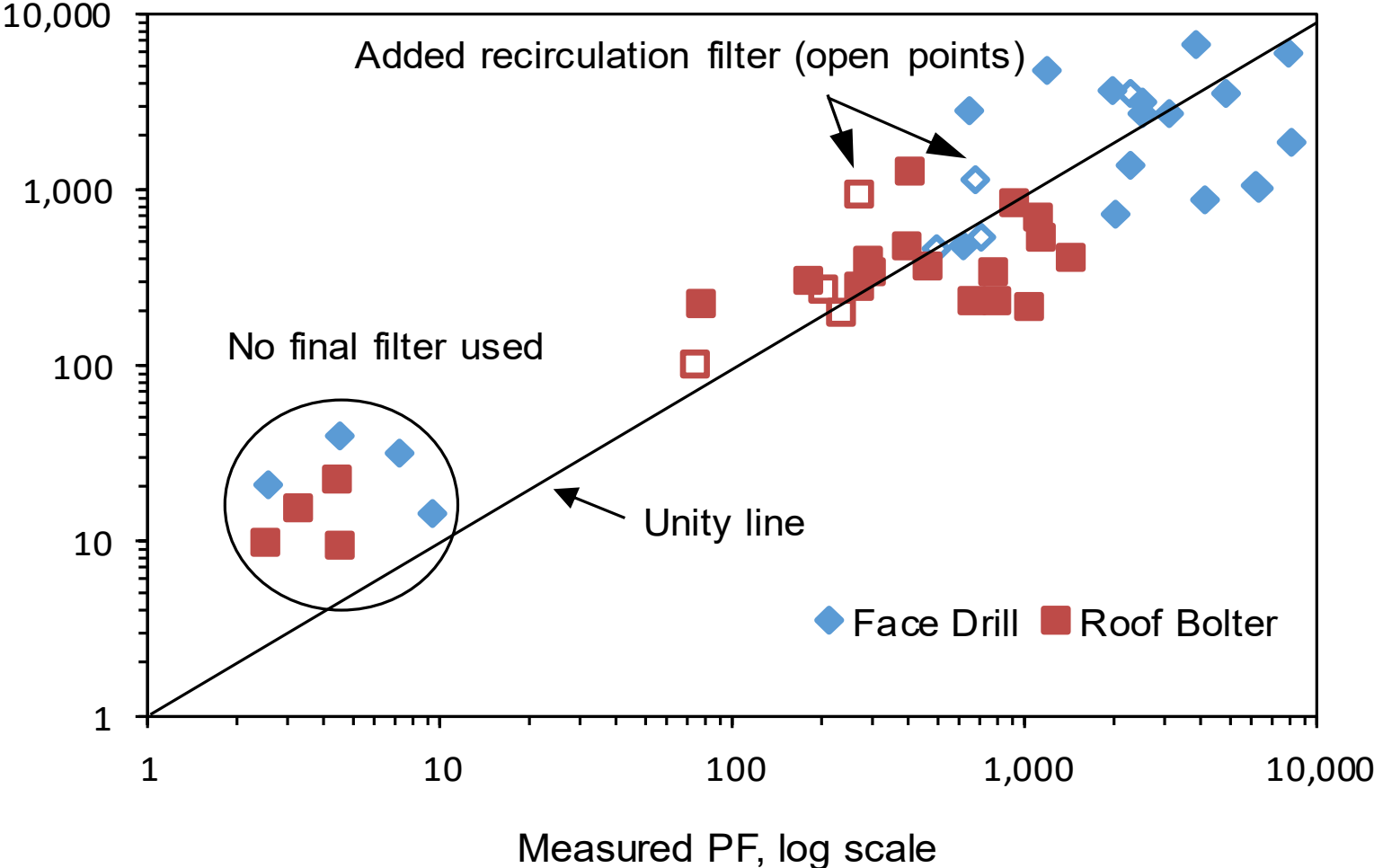


Recirculated Cab Air

- Effectiveness is by multiple passes through filter media
- Substantial reduction in cleaning time from in-cab dust sources
- MERV 14 -16 rated filter media
- 3-4 times the intake airflow quantity (200-300 cfm typical)
- Unidirectional design

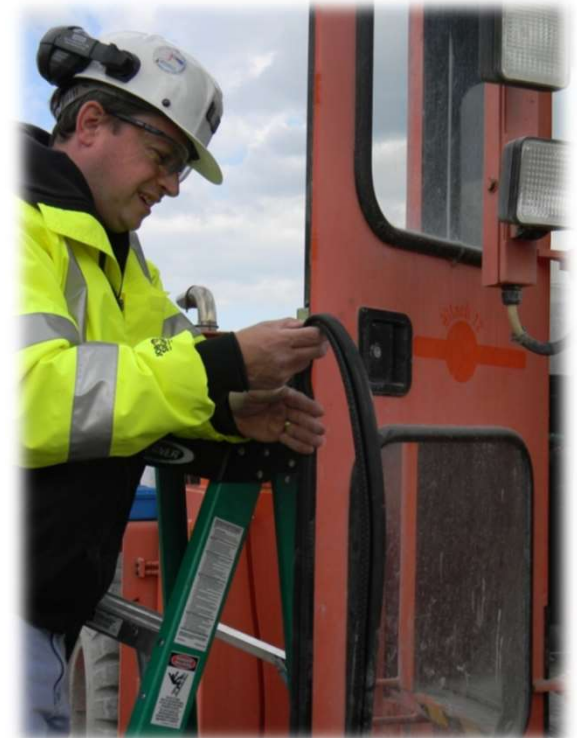


Modeled PF, log scale

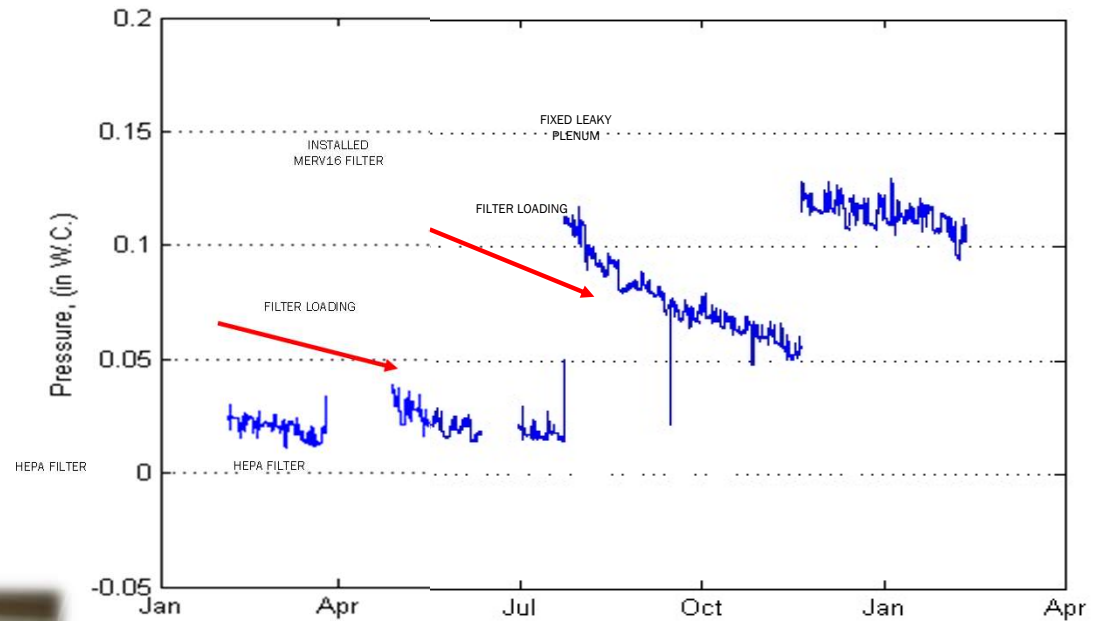


Cab Integrity

Installing new doors gaskets and seals/plugging and sealing cracks and holes

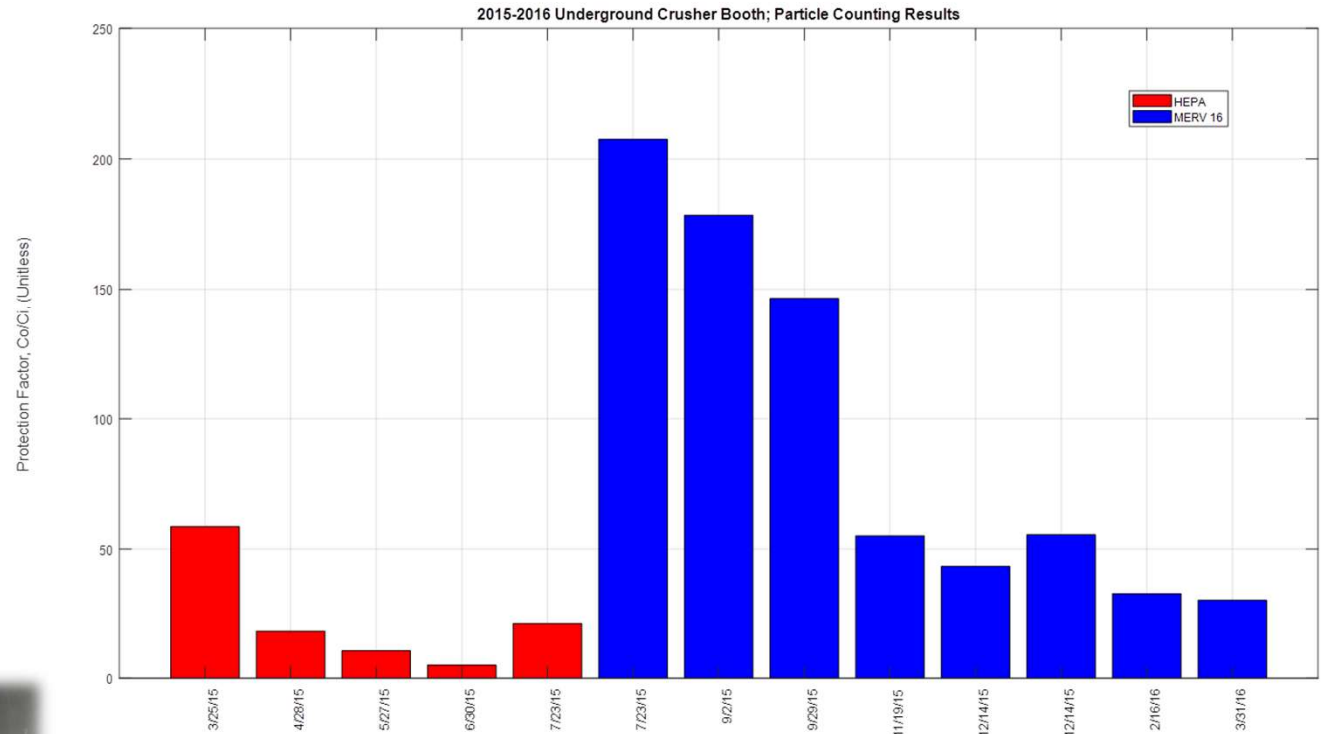


Cab Pressure Monitoring and Maintenance



Patts JR, Cecala AB, Rider JP, Organiscak, JA. [2018] Improving Protection against Respirable Dust at an Underground Crusher Booth. *Mining Engineering*, 70(7):8-12.

Crusher Booth: Protection Factors



Protection Factors with MERV 16 was 4 times greater when compared with HEPA



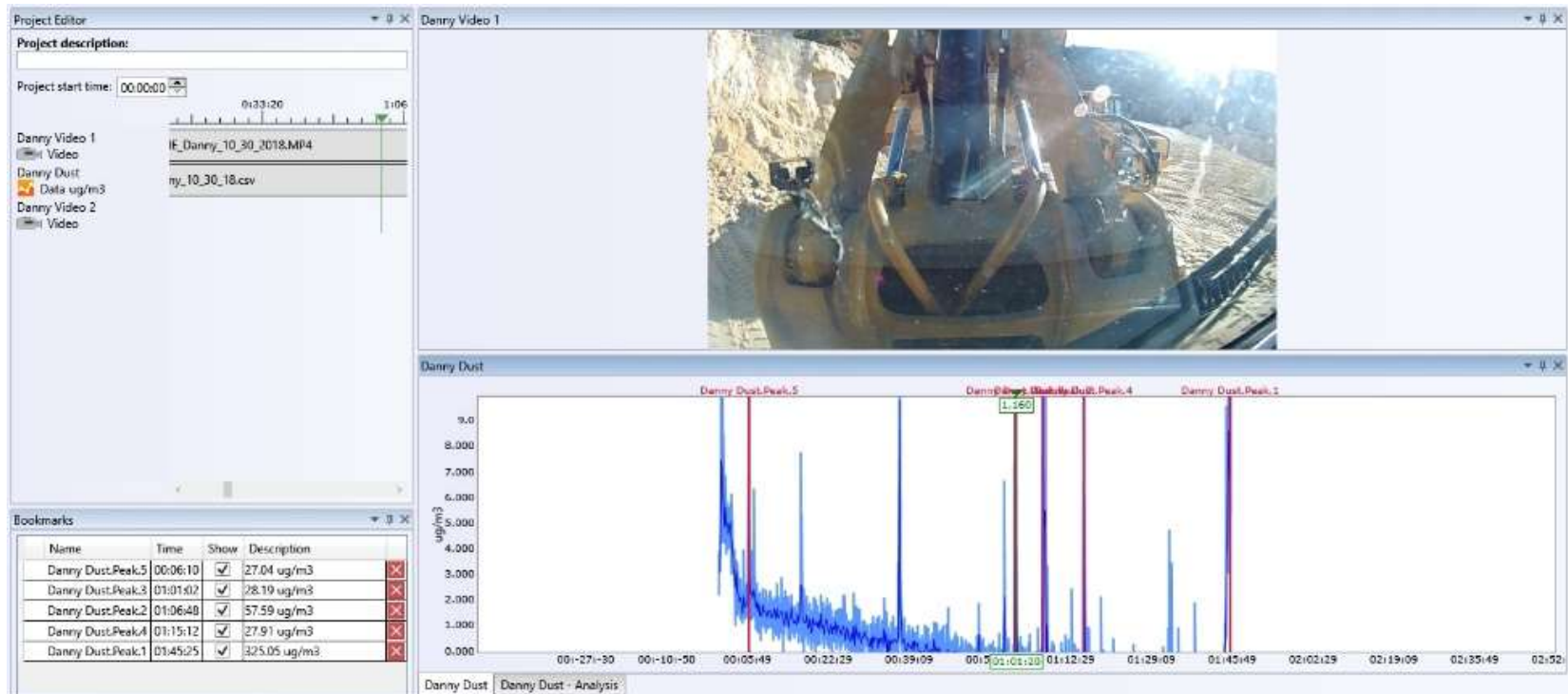
Our ability to provide these filtration systems across many of our product lines was heavily influenced by the work provided by NIOSH, both technical papers and the interactions we've had with you and members of your team. The visit you and John made to present at our cab summit (2015) was a very positive influence to our cab design and machine product partners. This provided a great deal of knowledge and understanding to our cab partners which then made it much easier to incorporate advanced filtration systems into our operator cab designs.

Daniel Spurgeon, Engineering Manager, Earth Moving Division

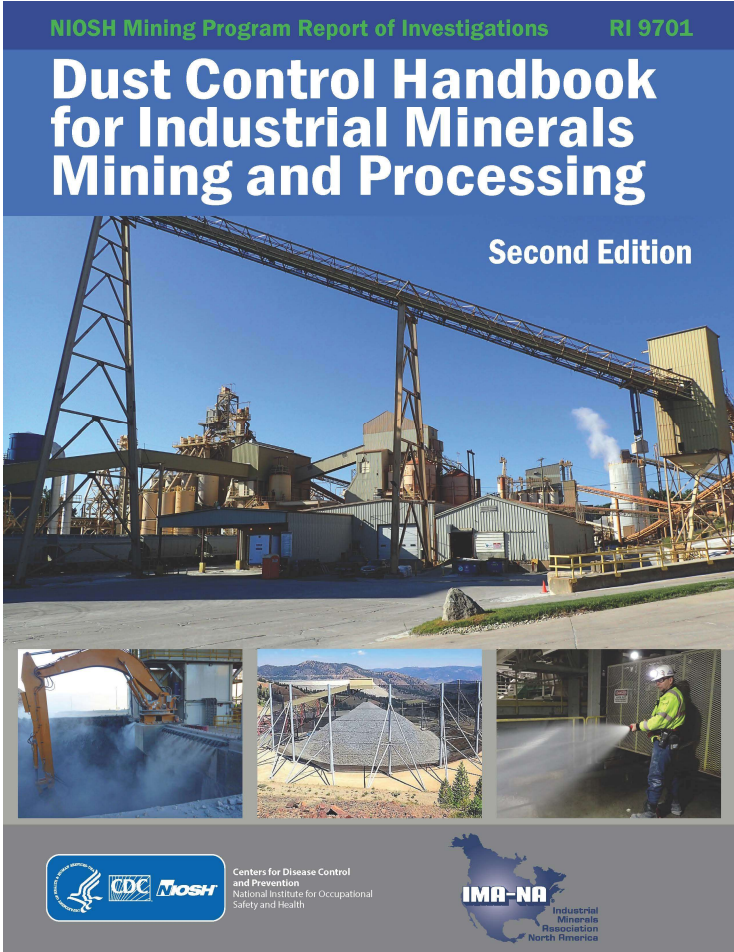
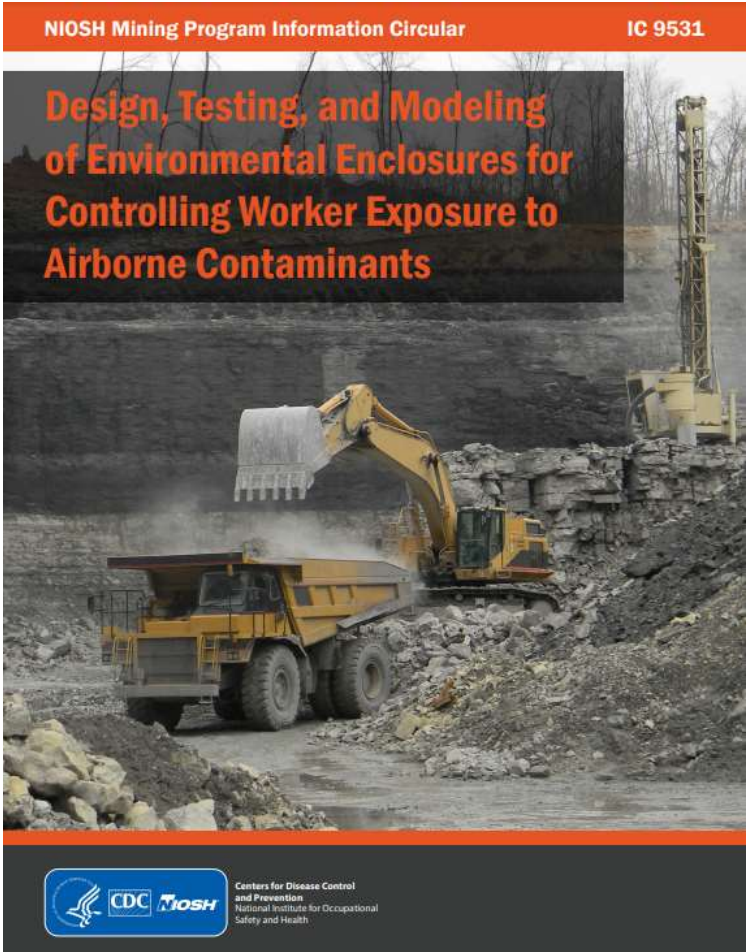


Note how extremely low respirable dust levels were in the enclosed cab of the new CAT988K front-end loader.
Average concentration = $0.42 \mu\text{g}/\text{m}^3$

Respirable Dust Reduction: 95–99 pct.



Key Resources



Application: Enclosed cabs of mobile equipment, control rooms/command centers at oil and gas sites



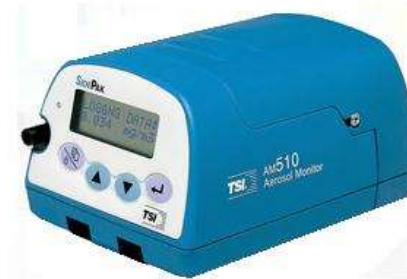
Video Exposure Assessment Monitoring: Helmet-CAM and EVADE

- Helmet-CAM technology and EVADE software to assess dust sources and magnitude of exposures
- Helmet-CAM also provides effectiveness of engineering controls and interventions to lower exposures.



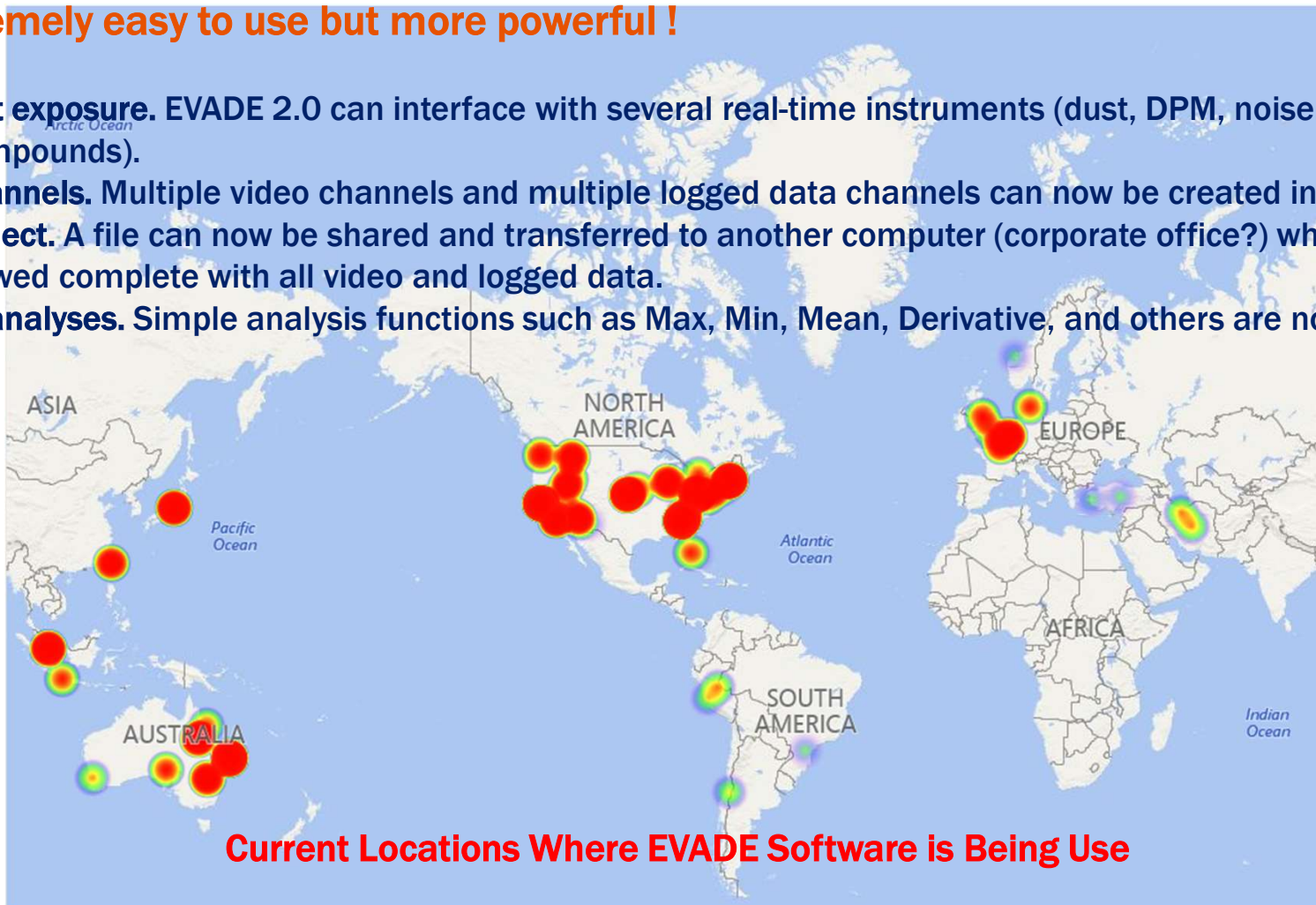
EVADE Software Adapted - Dust Monitors and Cameras

Dust Monitors: Thermo pDR 1000, Thermo pDR 1500, TSI AM 520/510, Nanozen DustCount 9000 or any device where data can be stored to a Comma-Separated Values “CSV” file (Excel file): Video Cameras: Contour ROAM3, BODYCAM by PRO-VISION, GoPro Hero Series.



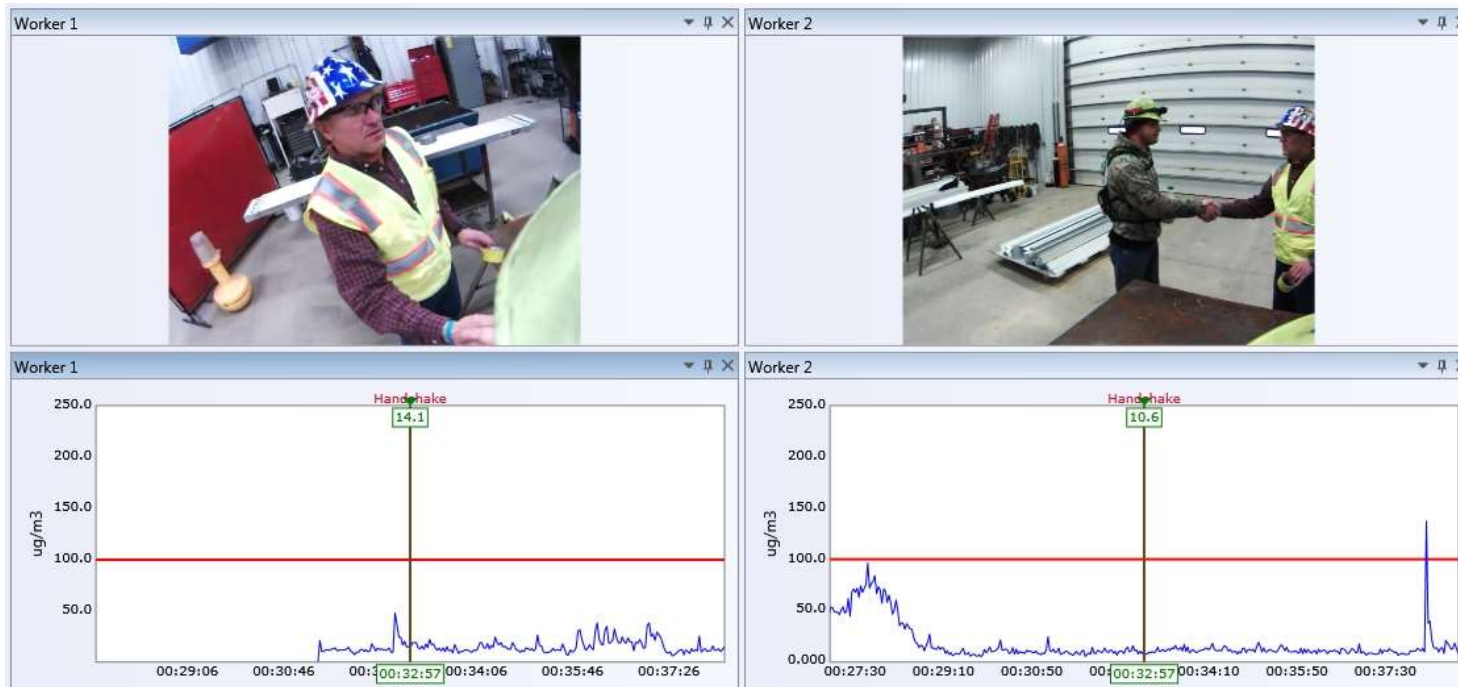
EVADE 2.0 – *the second generation*

- **Still extremely easy to use but more powerful !**
- **Beyond dust exposure.** EVADE 2.0 can interface with several real-time instruments (dust, DPM, noise, organic compounds).
- **Multiple channels.** Multiple video channels and multiple logged data channels can now be created in a single project.
- **Share a project.** A file can now be shared and transferred to another computer (corporate office?) where it can be viewed complete with all video and logged data.
- **Basic data analyses.** Simple analysis functions such as Max, Min, Mean, Derivative, and others are now available.



EVADE Version 2.0 Screen

Two maintenance workers wearing Helmet-CAM



Exposure sources were mitigated through workers' proactive initiatives

Infographics were created to encourage worker adoption of best practices



Reduce your dust exposure
Clean dust from work clothes

▶ 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



Findings based on NIOSH field studies
To learn more, visit go.usa.gov/xXCS9



Reduce your dust exposure
Cover or replace cloth seats

▶ Did you know?

Cloth chairs in mobile equipment, break rooms, and offices can hold **high levels of dust**

Use vinyl or leather seat covers or plastic chairs when possible



Findings based on NIOSH field studies
To learn more, visit go.usa.gov/xXCS9



Reduce your dust exposure
Tying bulk or mini-bags

▶ Did you know?

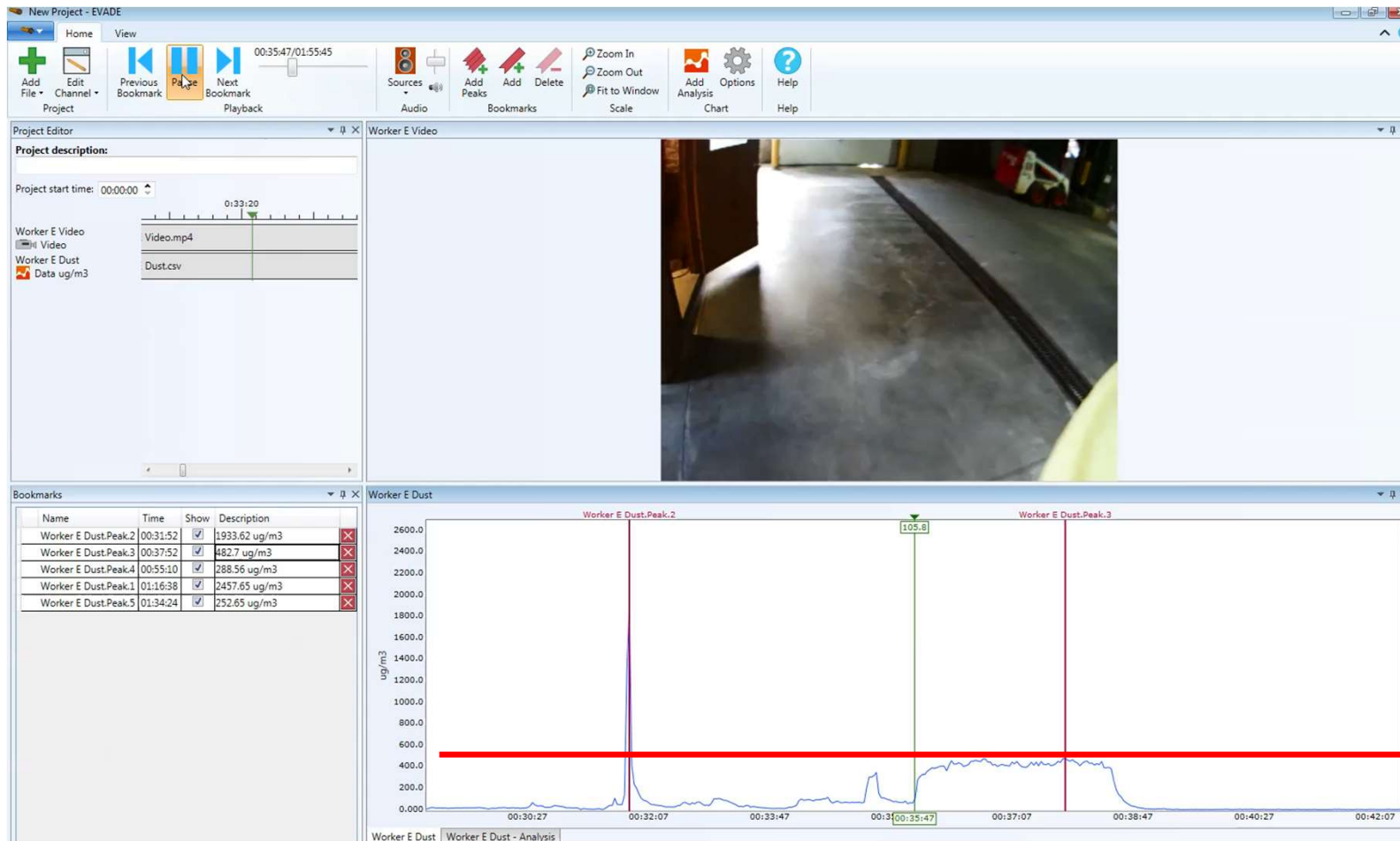
Folding bulk or mini-bag loading collars away from your breathing zone can reduce peaks in respirable dust exposure up to **92%**



Findings based on NIOSH field studies
To learn more, visit go.usa.gov/xXCS9

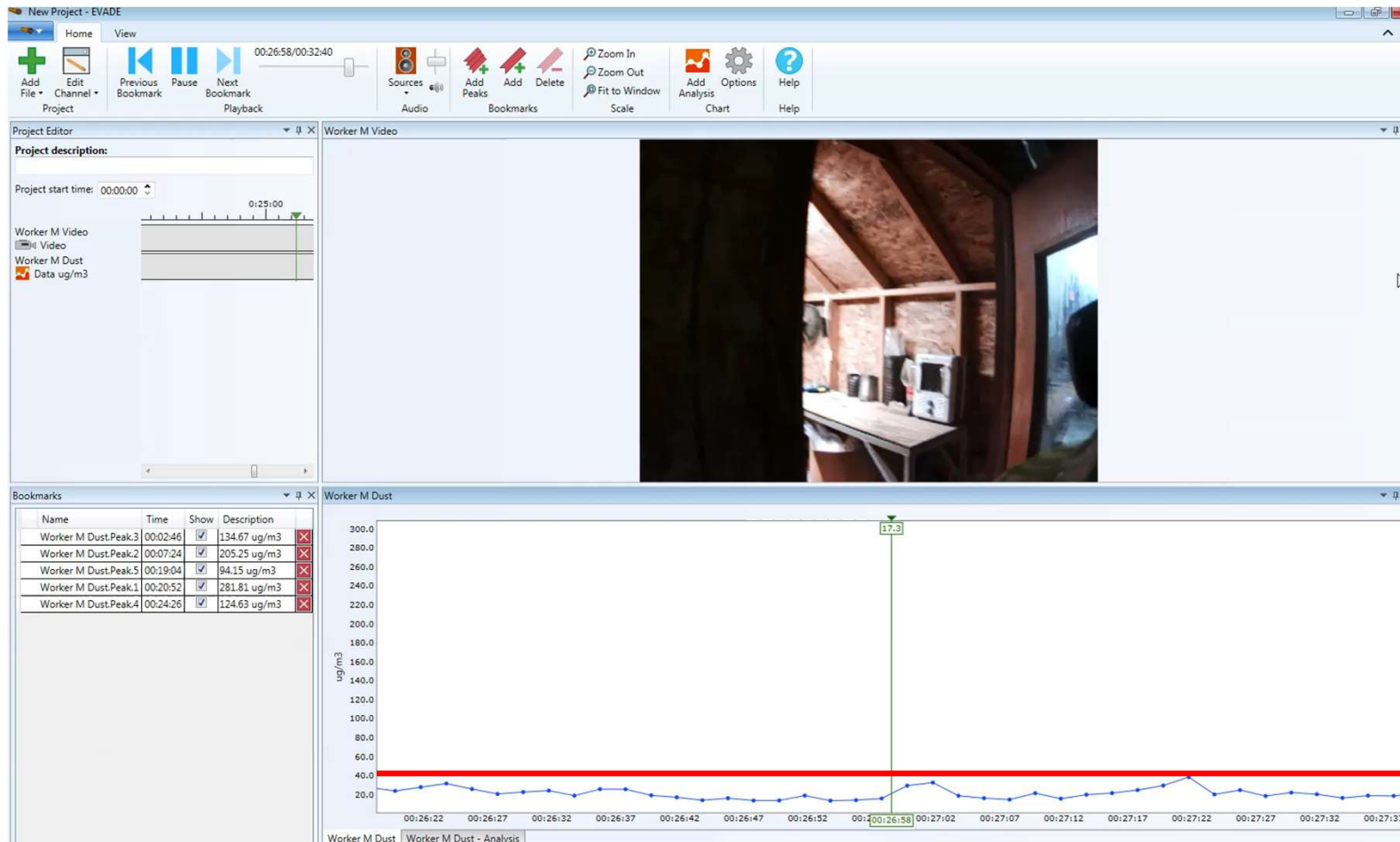


Example: Day shift analysis shows elevated exposures in dry lab (without fan)



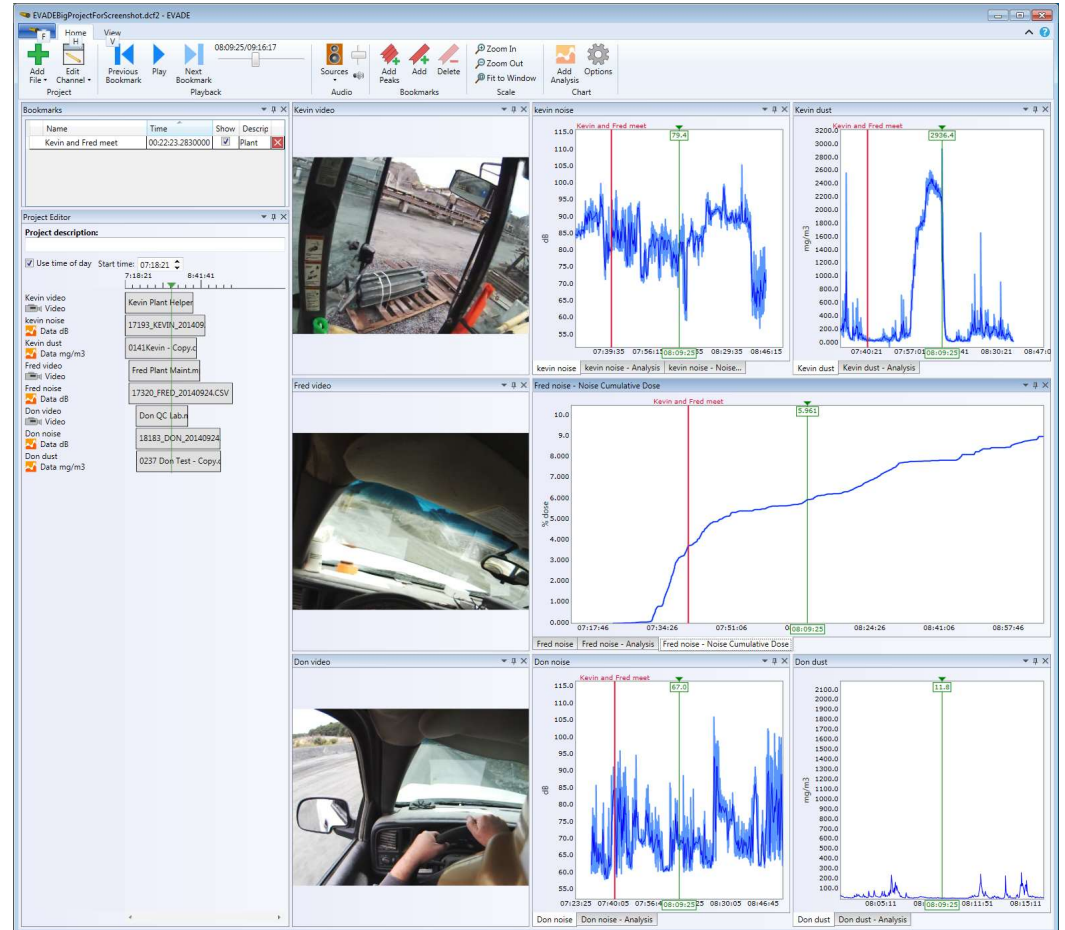
Exposures in dry lab consistent at 400 $\mu\text{g}/\text{m}^3$

Example: Second shift analysis (*with fan*) shows a significant reduction



Exposures in dry lab consistent at $20 \mu\text{g}/\text{m}^3$

Helmet-CAM and EVADE for use with samplers for dust, diesel, noise, chemical, lighting, and other hazard assessments



Microphone for dosimeter, Larson
Davis Spark Model 706RC
dosimeter used



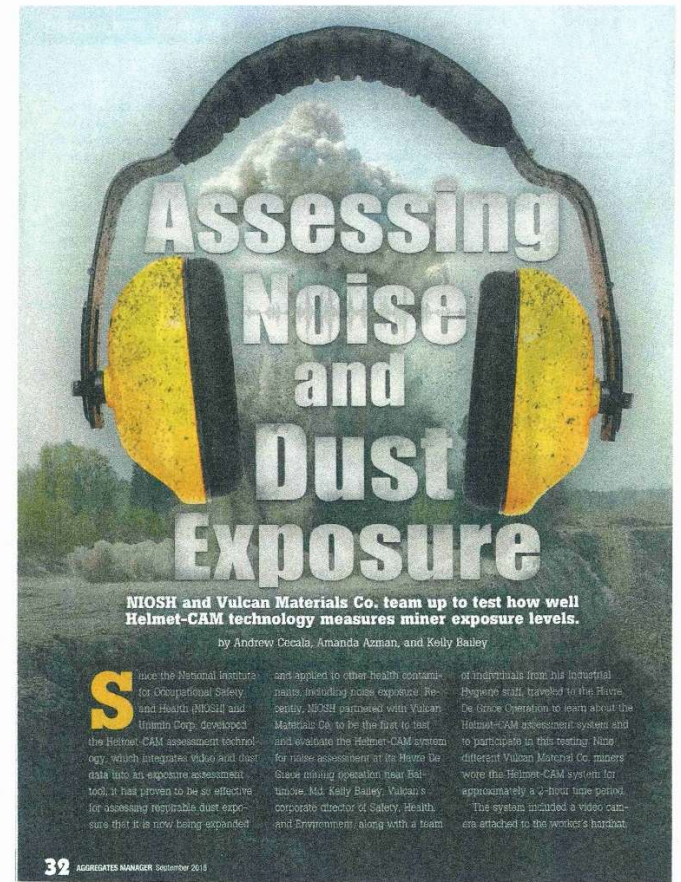
10mm Dorr- Oliver cyclone classifier
for respirable dust, Thermo Model
pDR-1500 dust monitor used



Cooperative Study with Vulcan Materials Company Havre DeGrace Facility near Baltimore, MD



Kelly Bailey, Former Corporate Director of Industrial Hygiene and Health Services, Vulcan Materials Company – National Stone, Sand and Gravel Association (NSSGA)



Application: Determining dust, noise, chemical exposures at oil & gas sites



ALTAIR 4XR Multigas Detector: Hydrocarbon (combustibles LEL), O₂, CO, and H₂S Hydrogen Sulfide.



Cleaning Dust From Soiled Work Clothing



**A safe and effective method
for removing dust from
work clothes.**

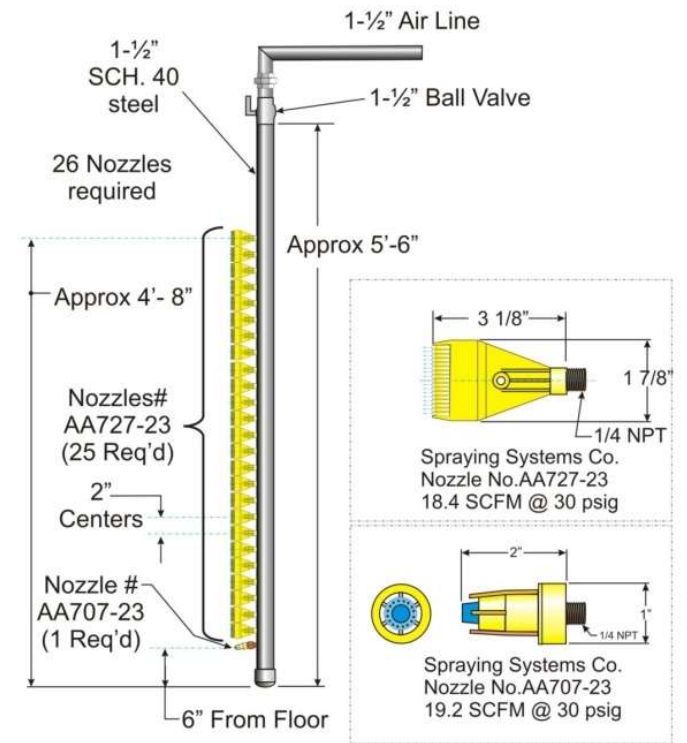
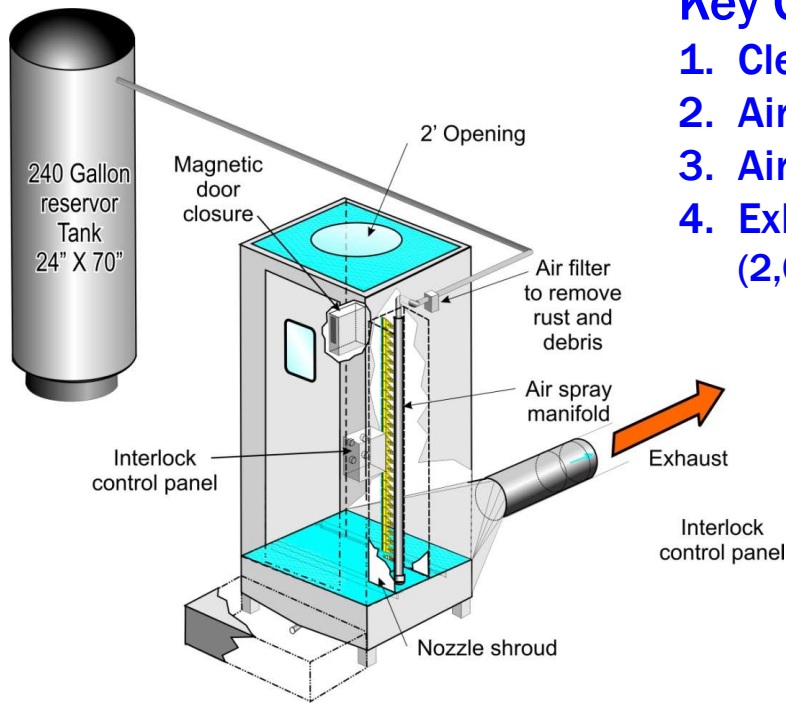
Cooperative research effort.



Clothes Cleaning System

Key Components

1. Cleaning Booth
2. Air Reservoir (240 gallon)
3. Air Spray Manifold
4. Exhaust Ventilation System (2,000 cfm)





Pre-Cleaning



Post-Cleaning

Vacuum:

Cleaning Time: 7 minutes 48 seconds



Pre-Cleaning



Post-Cleaning

Air Spray Manifold

Cleaning Time: **17 seconds**

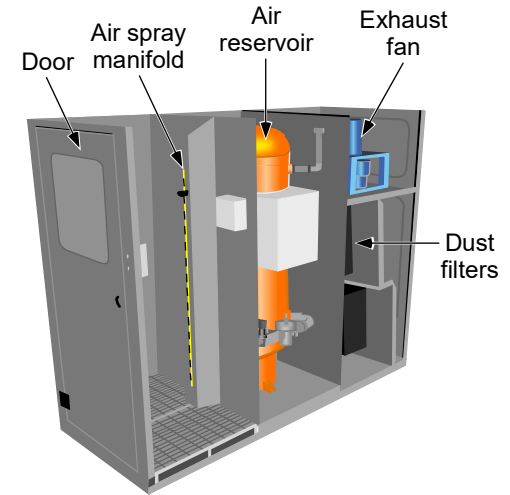
Cleaning Effectiveness: (18 seconds)

Clothes cleaning system was 40–50 pct. more effective than vacuuming/ single air hose technique.



Respirable Dust Reduction: 90–99 pct.

Commercial Clothes Cleaning Booth Systems

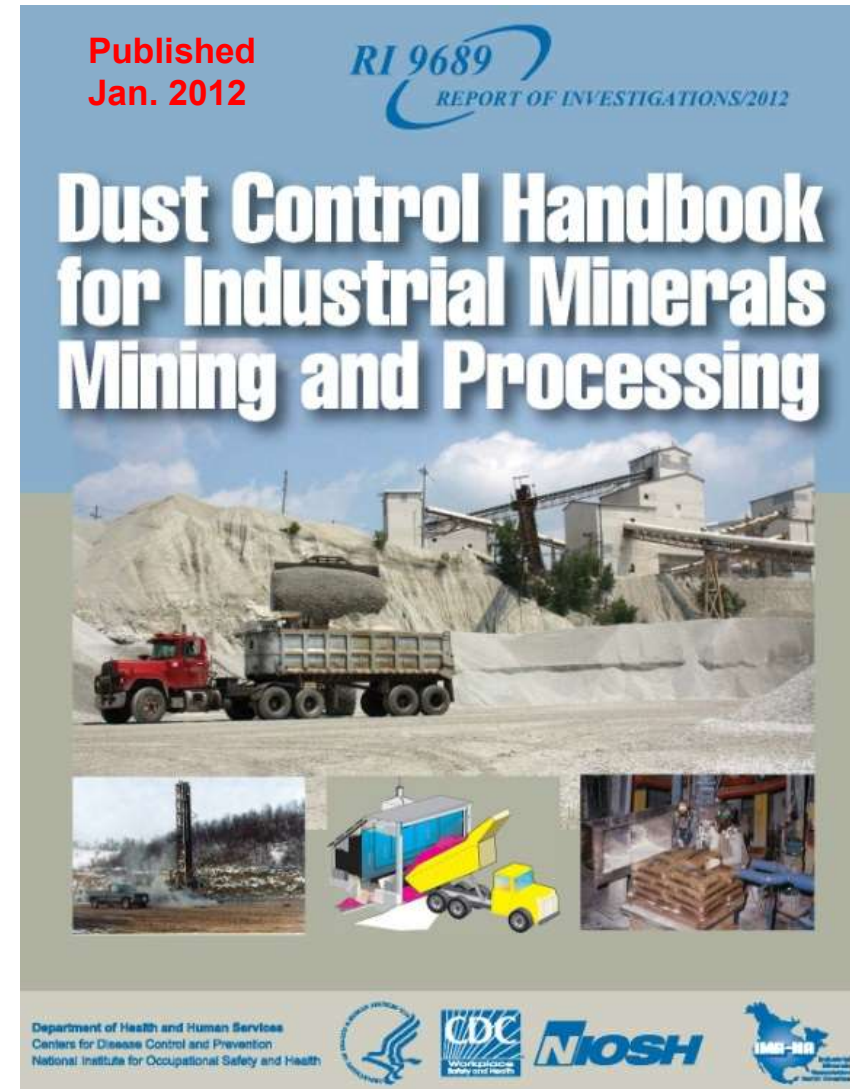


**Application:
Cleaning dusty
work clothing at
oil & gas sites**



Dust Control Handbook for Industrial Mineral Mining and Processing – First Edition

- Final Meeting December 2010
- Published January 2012
- Over 2,200 copies distributed
- 7,700 views on website
- Over 3,700 copies downloaded



NIOSH Mining Program Report of Investigations RI 9701

Dust Control Handbook for Industrial Minerals Mining and Processing

Second Edition

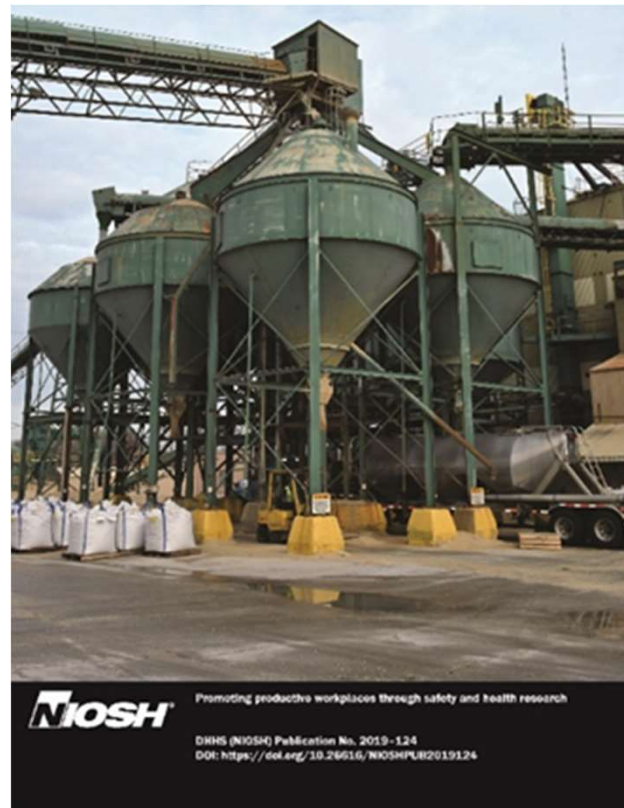


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6 Previous and 9 New
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engineers, 3 mining
engineers, 1 mechanical
engineer, behavioral
scientist, health
communication specialist
and manager of national
industrial mining
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Promoting productive workplaces through safety and health research

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- ❖ **IMA-NA**
- ❖ **3M Corporation**
- ❖ **Mine Safety & Health Admin.**
- ❖ **Unimin Corporation/Covia**
- ❖ **NIOSH**



CHAPTERS (1 New/3 Minor/7 Significant/Major)

1. Overview of Dust Exposure Assessment and Control (New)
2. Fundamentals of Dust Collection Systems (Minor)
3. Wet Spray Systems (Significant)
4. Drilling and Blasting (Minor)
5. Crushing, Milling, and Screening (Minor)
6. Conveying and Transport (Major)
7. Bagging (Significant)
8. Bulk Loading (Major)
9. Controls for Secondary Sources (Major)
10. Filtration and Pressurization Systems for Environmental Enclosures (Major)
11. Haul Roads, Stockpiles, and Exposed Areas (Major)

**362 Page
document: 78
pages longer
than first
edition.**

**236 Color
illustrations
throughout the
handbook.**

Chapter 3: Wet Spray Systems

- Principles of Wet Spray Systems
- Nozzle Types and Spray Patterns
- Spray Controls and Optimization
- Maintenance Issues with Wet Spray Systems



Figure 3.14. Typical wind fence installations. Left: porous windbreak material around stockpile drop. Right: material being used in loadout hopper.

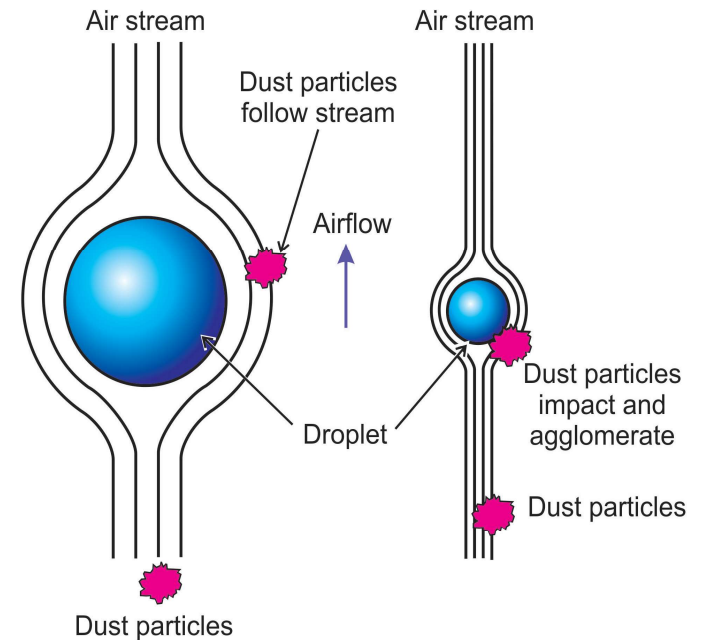


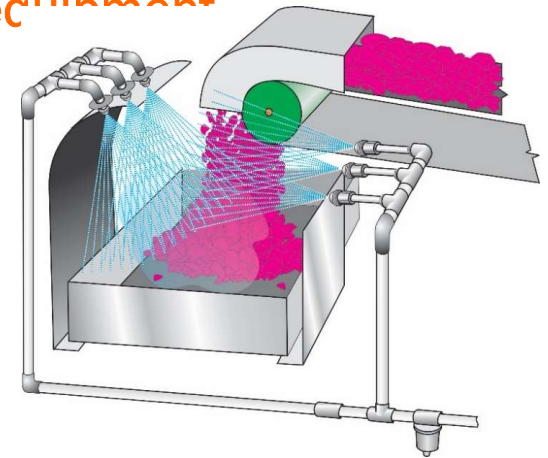
Figure 3.3. Illustration of the effect of droplet size on dust particle impingement

Principles of Wet Spray Systems

- Keys to effective wet spray dust control: application of moisture; nozzle location; droplet size; spray pattern and nozzle type; proper maintenance of equipment

- Airborne *dust prevention*

- Achieved by direct spraying of the ore
- Increase moisture content of the ore: Quantity > Pressure
- Larger water droplets



- Airborne *dust suppression*

- Removing dust from airstream
- Smaller, like-sized droplets (collide and agglomerate)
- Higher pressures more effective



Dust Exposure Identified from Climbing Ladder

Video: Worker getting ready to climb down ladder



Peak exposure of 243 µg/m³ when worker climbs down the ladder

Respirable dust exposure to a worker from climbing down a ladder and exposure from dust released from ladder rungs.

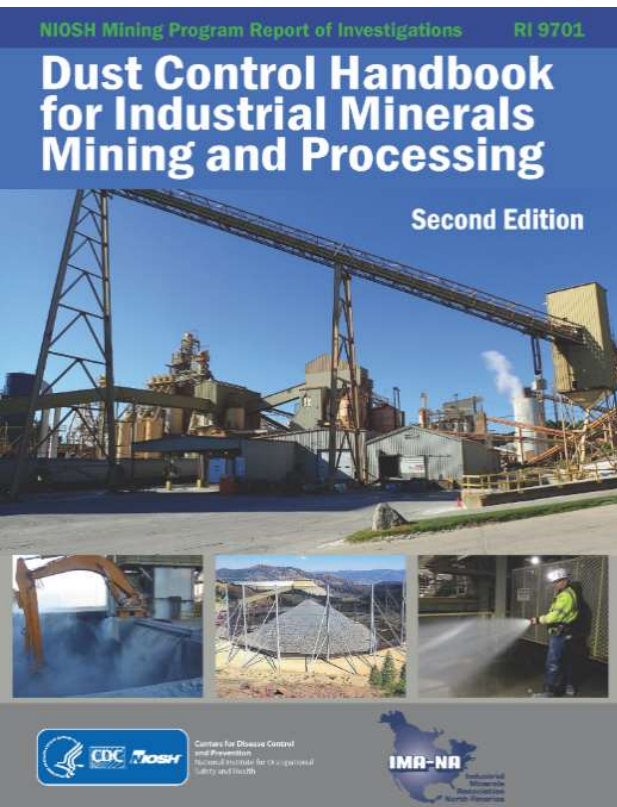
Three types of ladder designs (vertical ladder, alternating tread stairs, traditional stair) and their footprint. Alternating tread & traditional stairs provide both ergonomic advantages and lower respirable dust exposures.



Chapter 11 – Haul Roads, Stockpiles and Exposed Areas

- Haul road dust control measures
 - speed control
 - traffic control
 - proper road construction
 - water application
 - surface treatments
- Stockpiles and exposed areas
 - wetting
 - enclosures and wind fences
 - physical stabilization (1st edition)



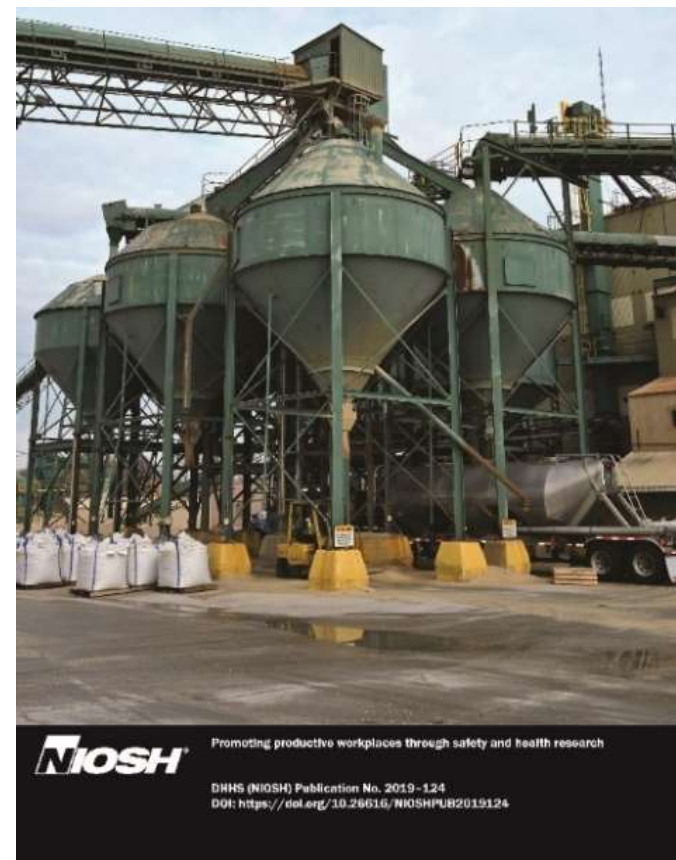


FOR COPIES OF THE DUST CONTROL HANDBOOK

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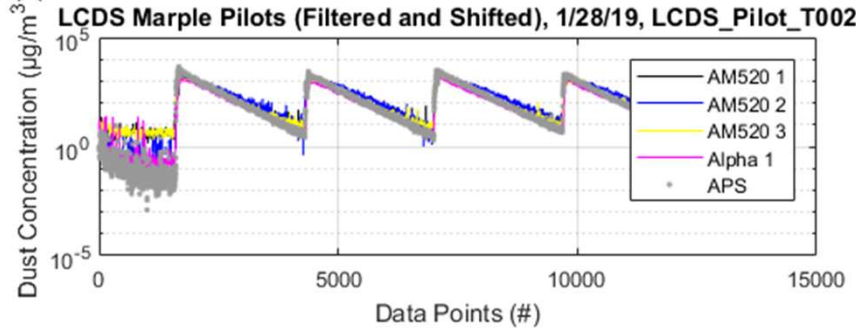
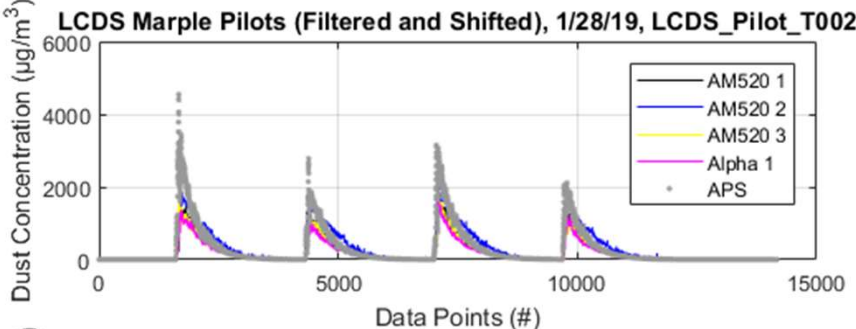
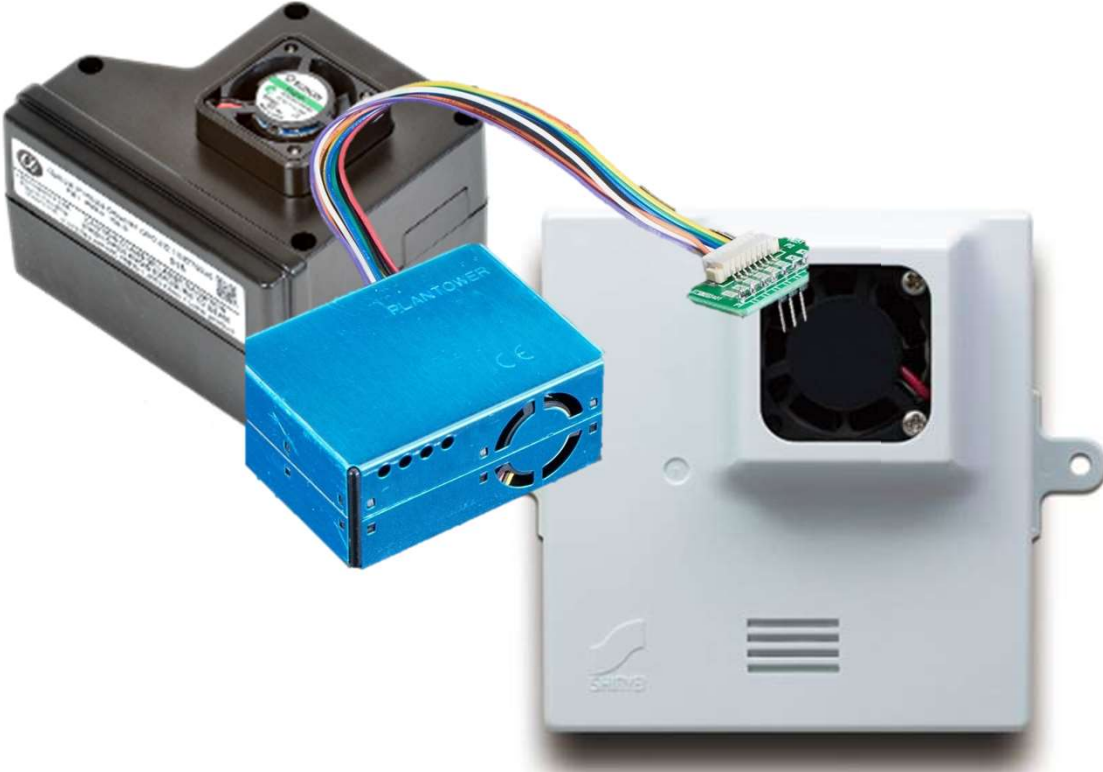
<https://www.cdc.gov/niosh/mining/works/coversheet2094.html>

Hard copies



Current Potentially Applicable Research

Can Low-Cost Dust Sensors be useful in Mining Applications?



\$20 Sensor; \$250 package

LCDM Testing @ Lab



Travel Restrictions and New Opportunities



M/NM - 3M



Coal - Peabody



Foundry

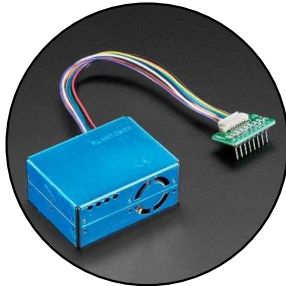
NMA Safety Video Featuring LCDM work with Peabody



...We know its accurate enough to tell us where the problems are, and that's really what we're trying to do. – Matt Pedersen-Howard VP Peabody

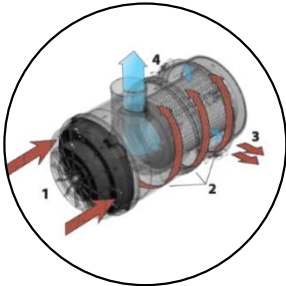
<https://vimeo.com/509220469>

What Level of Operator Protection is Possible with a “SmartCab”?



Measure

- Dust levels
- CO2
- Cab Pressure



Improve

- Adjust intake airflow
- Change recirculation airflow



Inform

- Display cab pressure
- Suggest filter change
- Log air quality



[Link to Smart Cab Notice of Intent @ Sam.gov](#)



Jeff Moredock (Sy-Klone) Led Development of ISO 23875

Smart Filtration and Pressurization System for Enclosed Cabs on Mobile Mining Equipment

A. Kyle Louk, PhD
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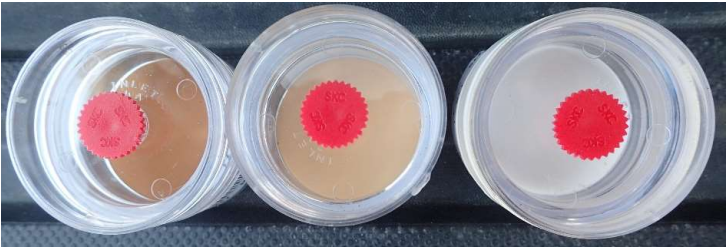
CDC/NIOSH NIOSH Mining Program

Kyle Louk, CDC/NIOSH
(Ventilation, and Toxic Substances)

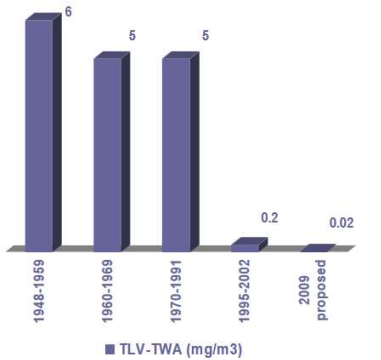
SME MINE XCHANGE 12:56

1. Evaluation from non-biased perspective, effectiveness of treated coatings of silica proppant for dust suppression at oil & gas sites.
2. Portable ventilation systems to minimize welding fume exposures in field (non-shop) applications.

How Effective are Portable Welding Fume Capture Units?

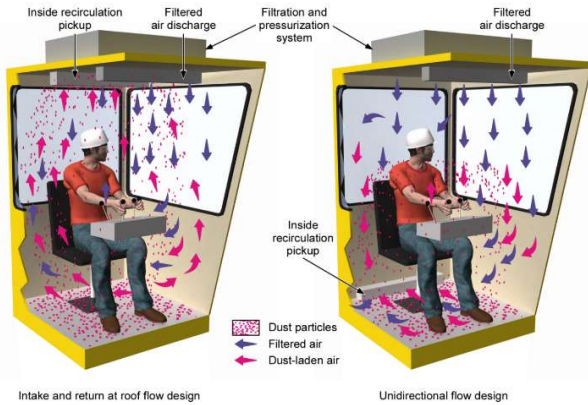


Proposed + adopted values over the years



Conclusion

95-99 pct.



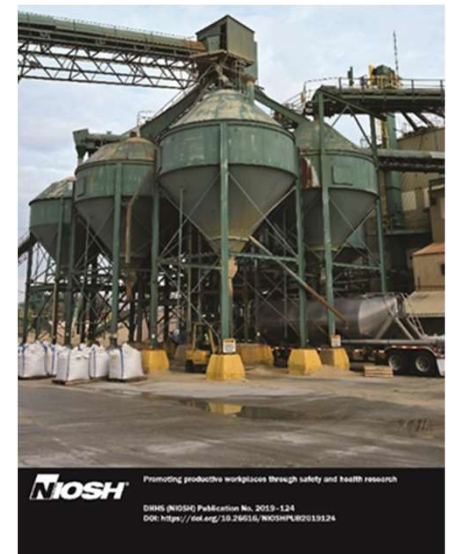
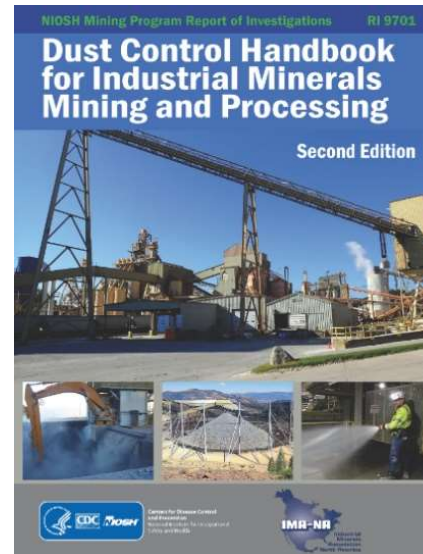
90-99 pct.



All Control Technology



Respirable
Dust
Assessment



Application of respirable crystalline silica control technology with potential application to the oil and gas industry



Questions



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Disclaimer: 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.

Safe Mines, Healthy Miners!



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To eliminate mining fatalities, injuries, and illnesses through relevant research and impactful solutions



NIOSH Mining Program
www.cdc.gov/niosh/mining

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