Effective Respirable Dust Control for Preventing Black Lung

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Presentation topics

- coal workers pneumoconiosis (CWP) and silicosis
- disease impact on mine workers and industry
- dust sampling instruments
- dust control approach
- examples of dust controls
- commitment to dust control
- black lung video

CWP and silicosis in coal mining

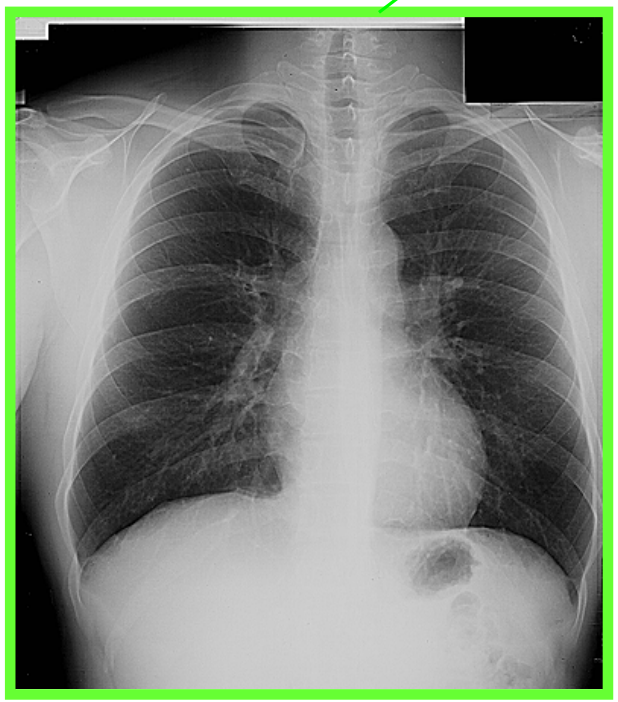
- overexposure to respirable dust (less than 10 microns in size) is the cause of these lung diseases
- both are fibrotic diseases that damage/destroy lung tissue
- both diseases have a similar pattern on chest x-rays
- both diseases have simple and complicated forms (Progressive massive fibrosis – PMF)
- International Labour Office (ILO) standards are used to determine severity of disease
- **diseases cannot be cured, so <u>preventing dust exposure is the key</u>**

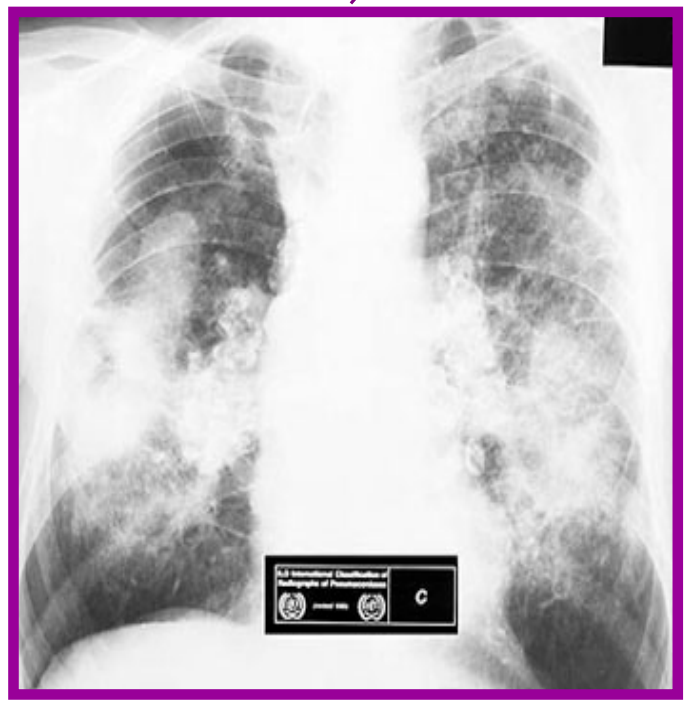
ILO classification of radiographs

ILO classification scale

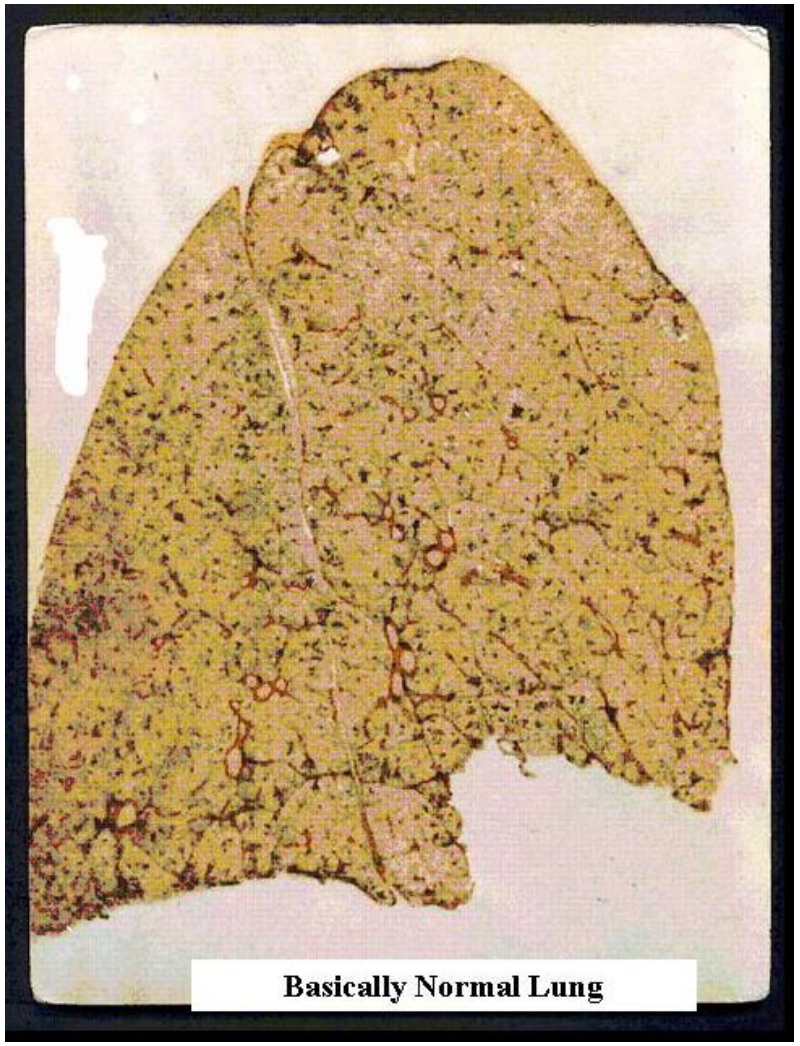
|---------- simple CWP ----------| |---- PMF ----|

0/- **0/0** 0/1 1/0 **1/1** 1/2 2/1 **2/2** 2/3 3/2 **3/3** 3/+ **A** **B** **C**





Coal Workers' Pneumoconiosis - lung sections



Basically Normal Lung

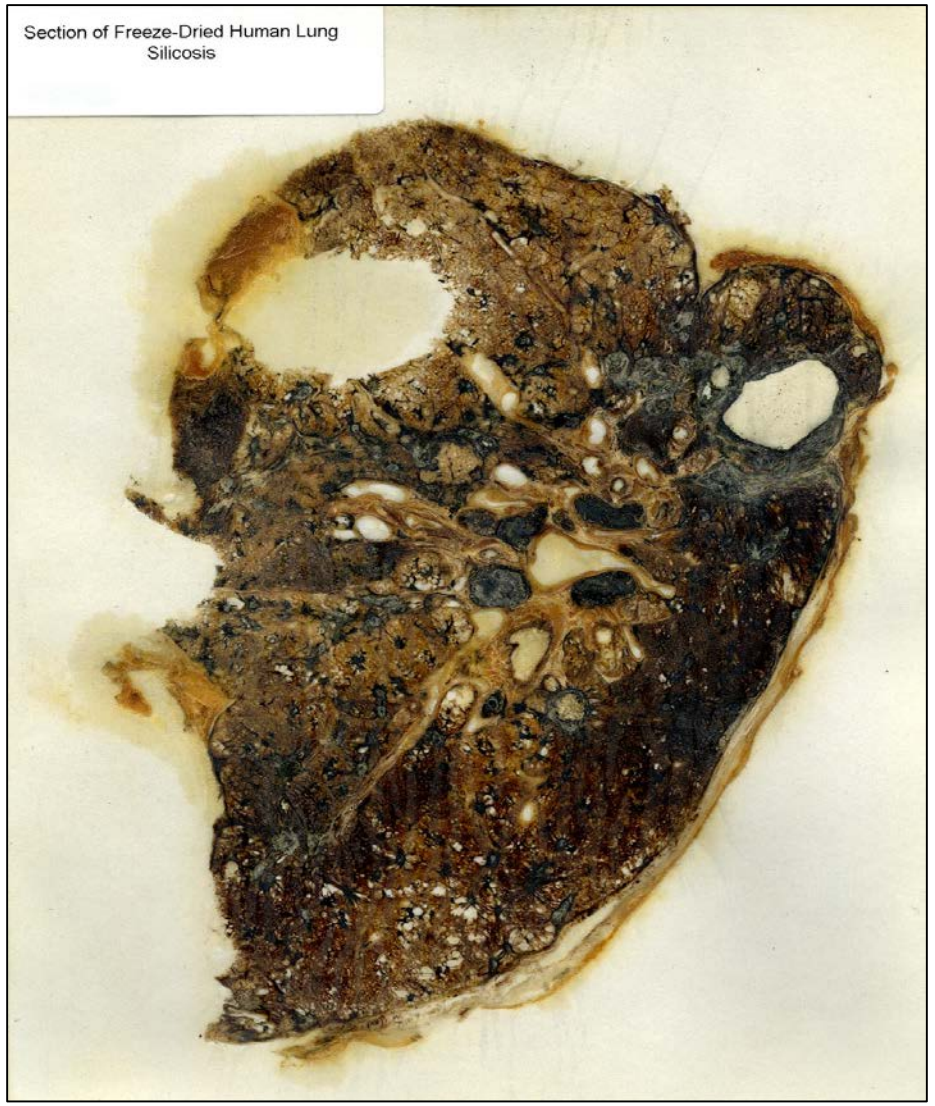
Simple
Coal Workers'
Pneumoconiosis

Progressive Massive
Fibrosis

Silicosis

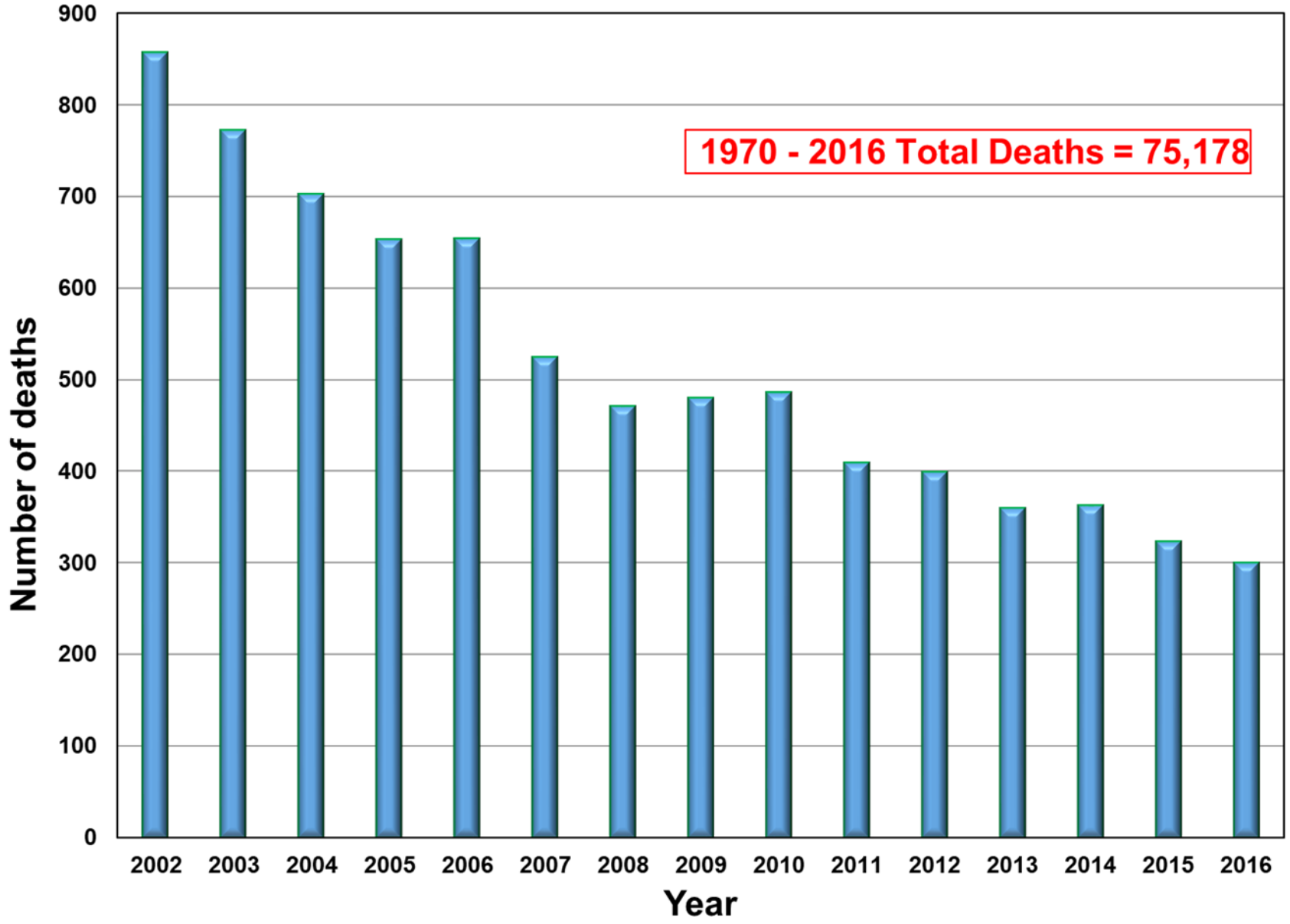
Simple

PMF



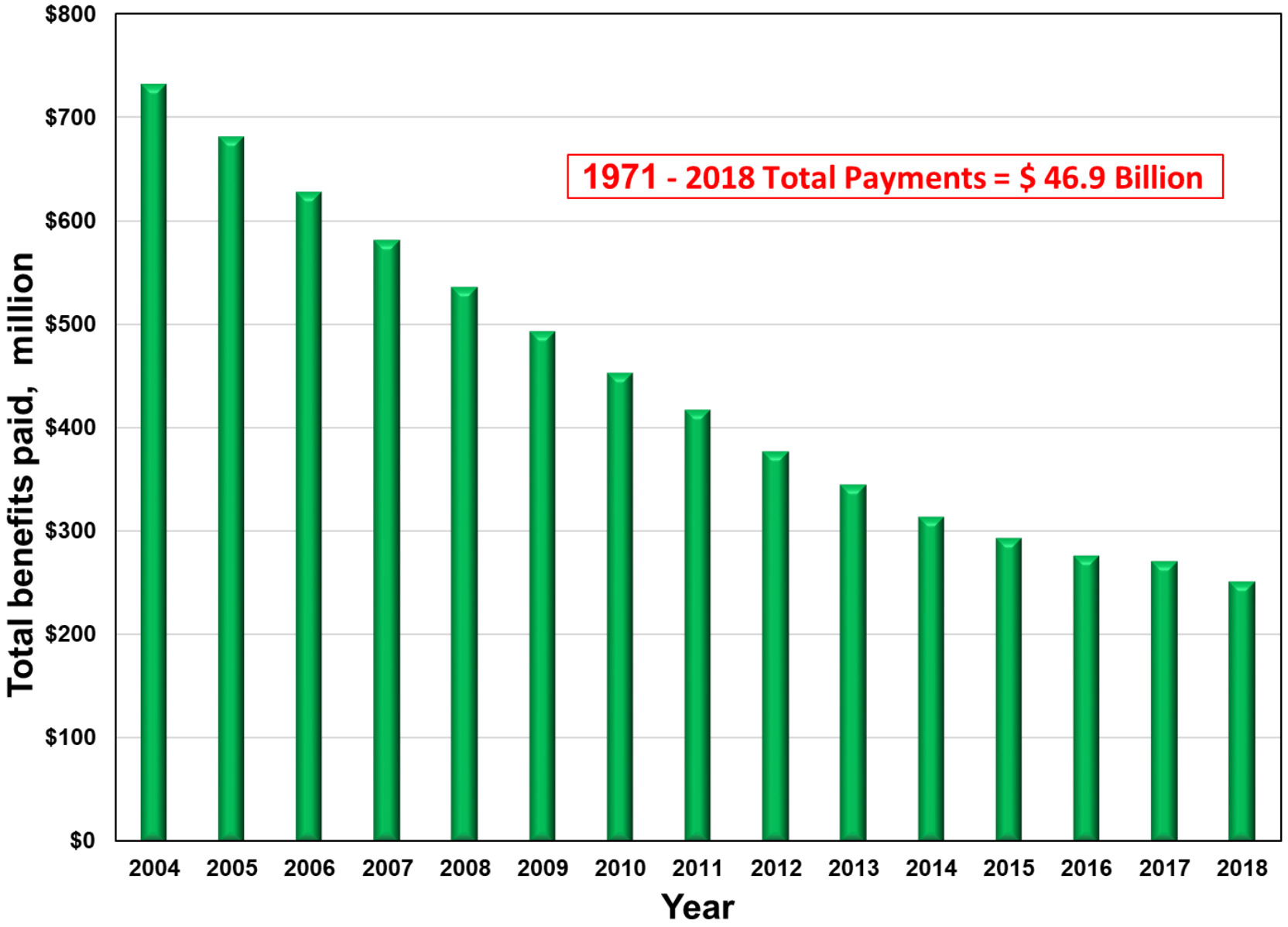
Coal miner deaths with CWP as underlying or contributing cause

(CDC - National Occupational Respiratory Mortality System)



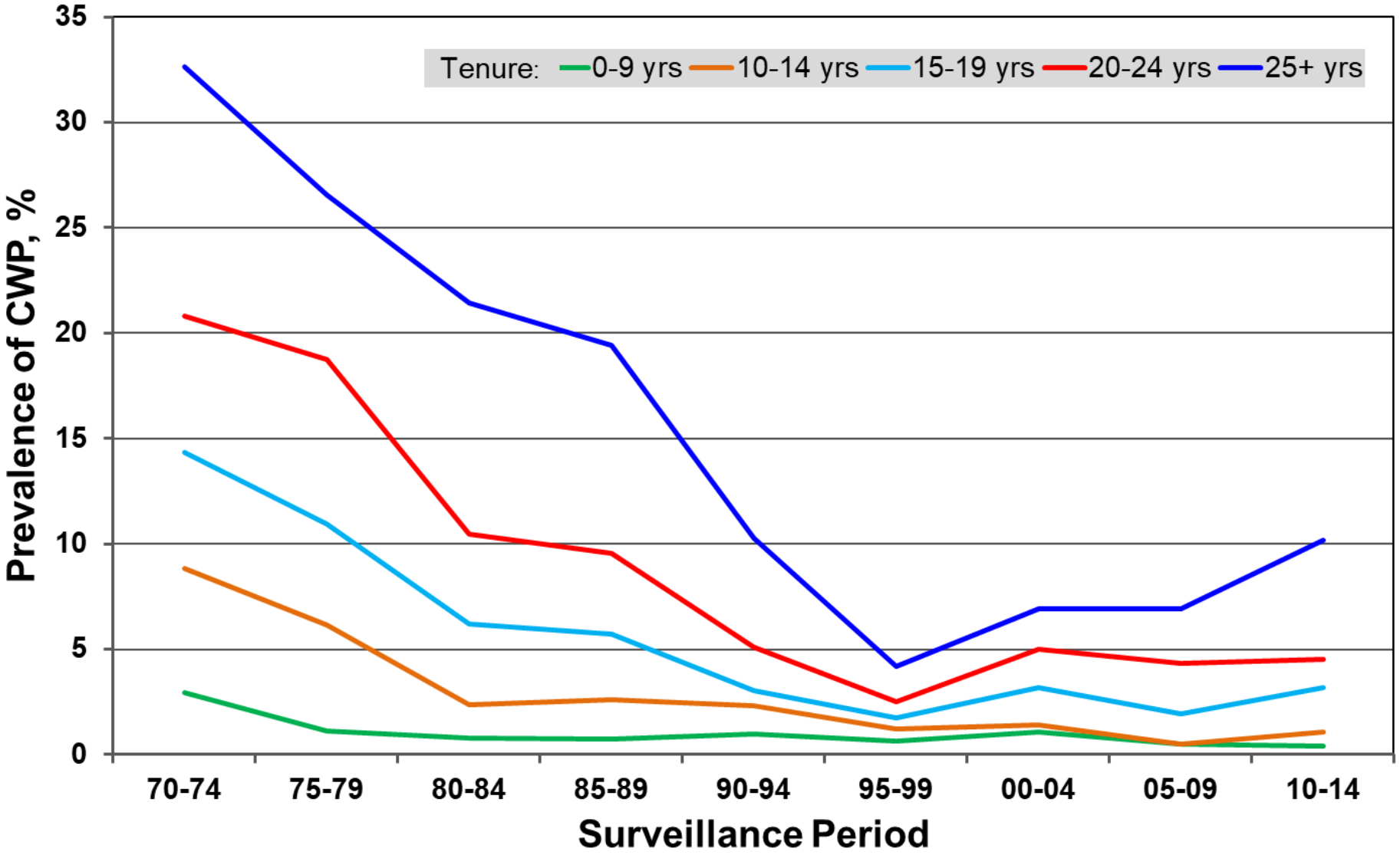
Federal Black Lung Benefits Program total payments

(Dept. of Labor – Office of Workers' Compensation Programs, Division of Coal Mine Workers' Compensation)



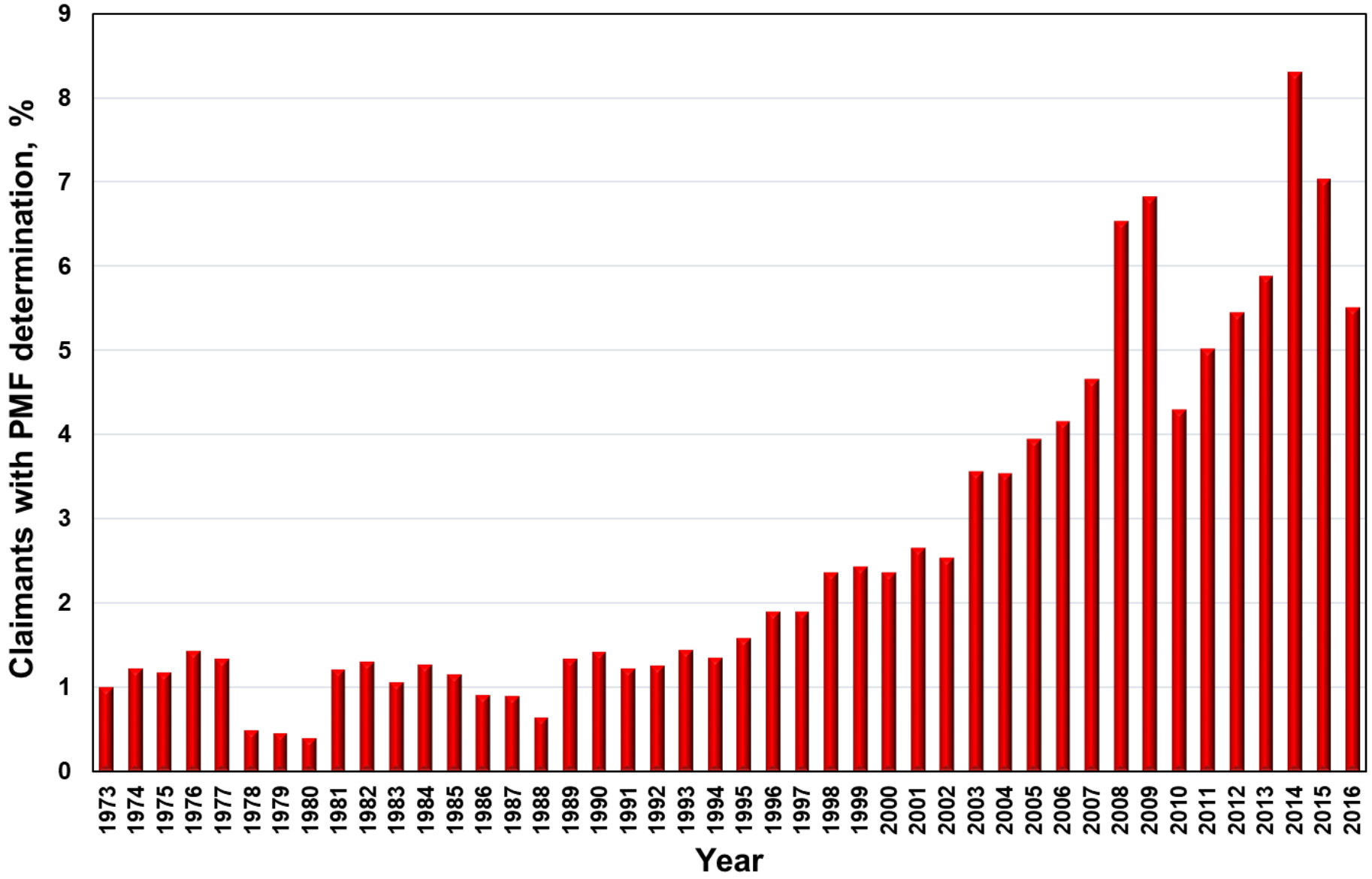
Percentage of examined coal miners with CWP Category 1 or greater by tenure in mining

(NIOSH - Coal Workers' Health Surveillance Program Data Query System)



Miners filing for federal black lung benefits found to have PMF

(Dept. of Labor, Office of Workers Compensation Programs, Division of Coal Mine Workers' Compensation)

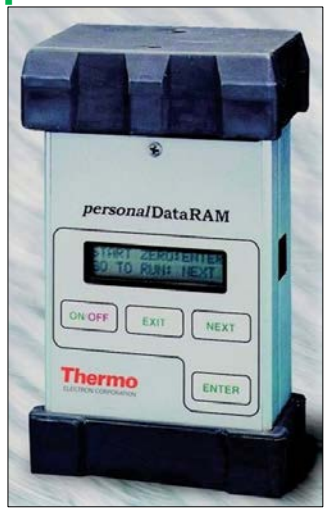


Permissible dust sampling instruments

- gravimetric sampler (Escort Elf pump)
  - Dorr-Oliver cyclone separates respirable dust which is deposited on filter
  - filter weighed in lab to obtain an average concentration
- light-scattering sampler (pDR 1000AN)
  - provides instantaneous readings at user selected intervals and records data for analysis
- personal dust monitor (PDM 3700)
  - records dust levels each minute and provides an end-of-shift dust concentration

Escort Elf pump w/cyclone

pDR-1000 AN



PDM 3700

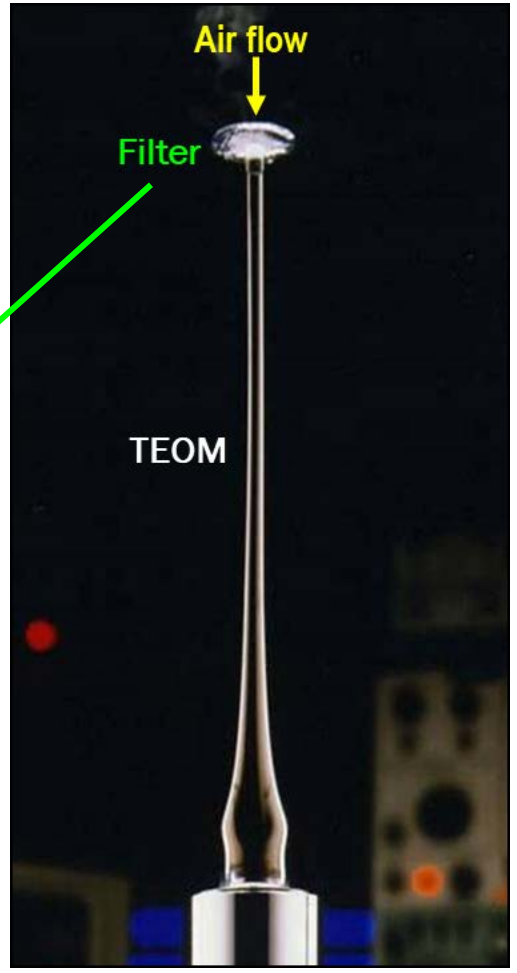
personal DataRAM (pDR-1000AN)

- passive sampler – no pump
- 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
- PMRD adjusts readings with ratio obtained from adjacent gravimetric samplers

Personal dust monitor (PDM 3700)

- mass-based measurement not impacted by dust characteristics (internal heater)
- provides continuous respirable dust monitoring with real-time feedback to miner
- records dust readings and instrument operating parameters (each minute)
- provides an accurate end-of-shift dust concentration

Tapered Element Oscillating Microbalance

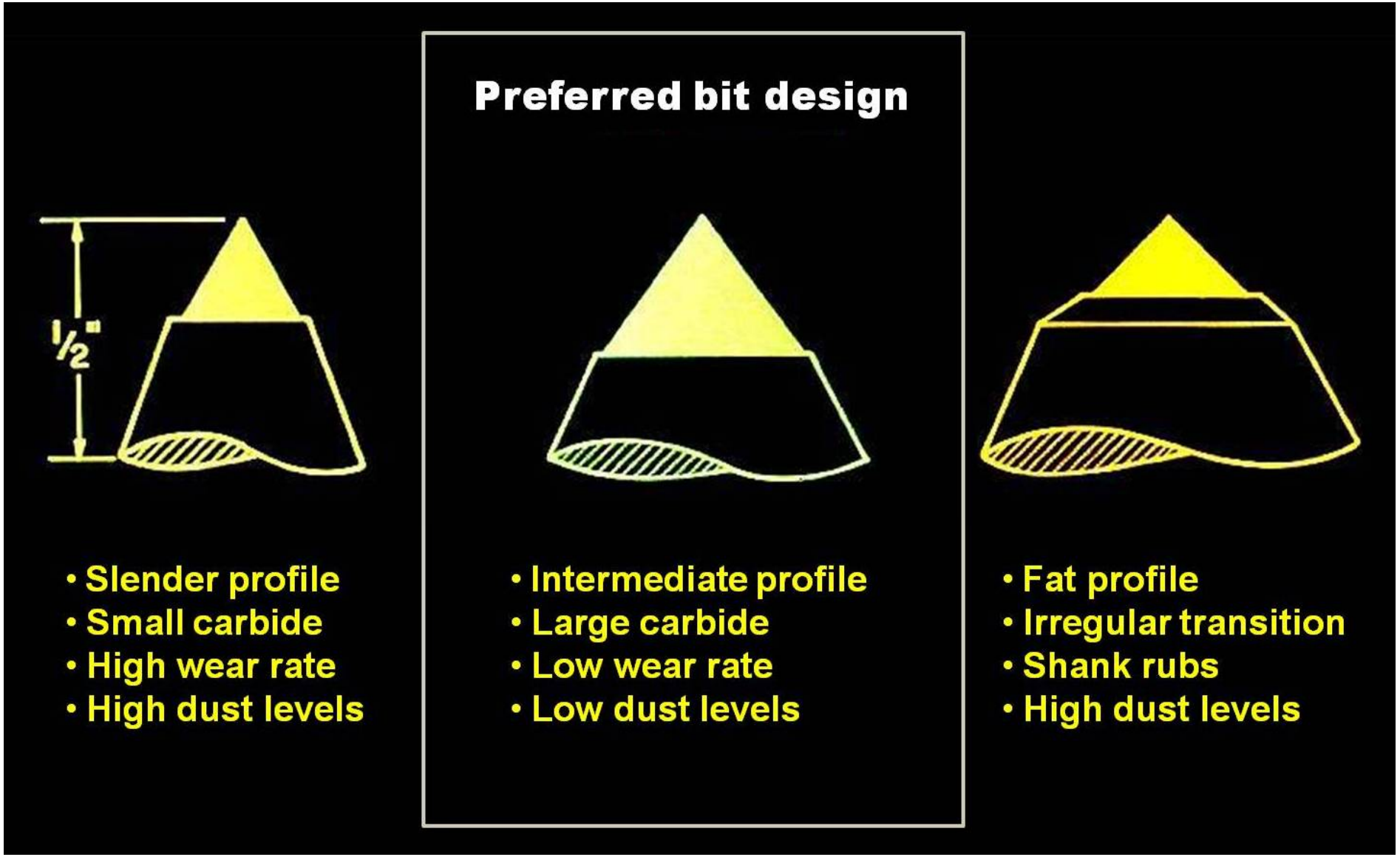


Screen displays

Dust control approach

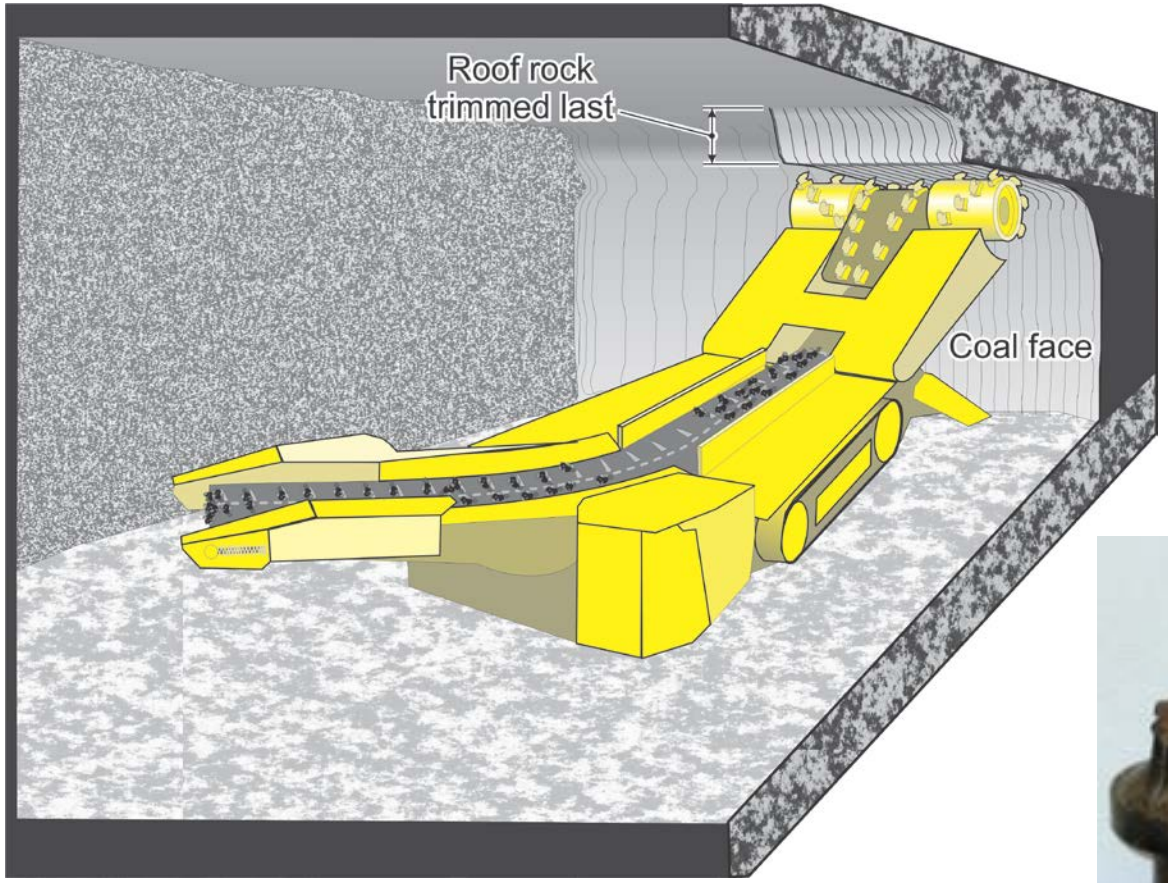
1. **minimize the quantity of respirable dust generated**
   a. efficient cutting *(bit design, bit sharpness, cutting method)*
2. **prevent the respirable dust from getting airborne**
   a. wet dust at generation point *(water sprays, foam)*
   b. enclose dust sources *(stageloader, belt transfer)*
3. **remove the respirable dust from the ventilating air**
   a. flooded-bed scrubbers *(continuous miners, stageloaders)*
   b. dry dust collectors *(roof bolters, air curtains)*
   c. water sprays *(nozzle type, location, operating parameters)*
4. **dilute remaining airborne dust**
   a. ventilation quantity
   b. distance from source *(shield advance, CM cuts)*
5. **prevent respirable dust from reaching workers' breathing zones**
   a. ventilation velocity and direction
   b. air movement with water sprays *(directional sprays, blocking sprays)*
   c. physical barriers *(belting, enclosed cabs)*

Bit design impact on dust generation



Efficient cutting reduces respirable dust

Undercut roof rock



Reduce drum rotation speed

- maintain same advance rate
- bit penetration increases
- reduces respirable dust

Replace worn bits

Dust control approach

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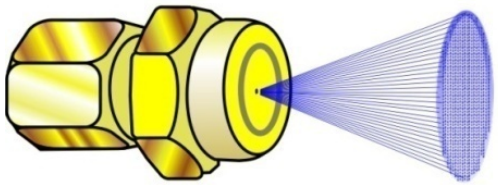
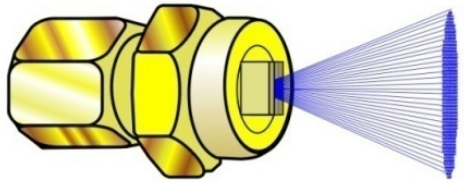
Impact of water sprays for dust control

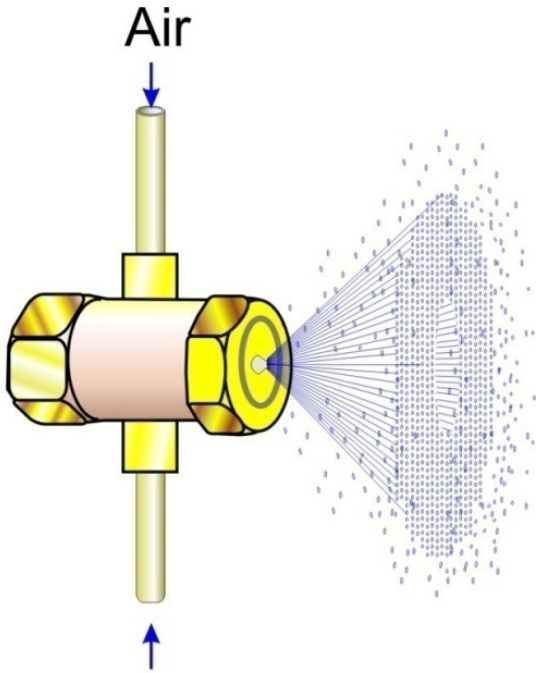
- suppression – prevent dust from getting airborne
- capture – remove dust from ventilating air
- redirect airflow – direct dust away from workers



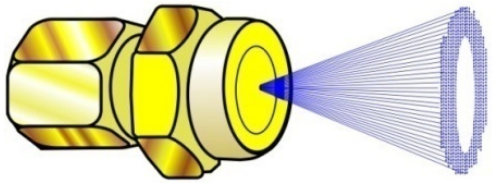
Full Cone



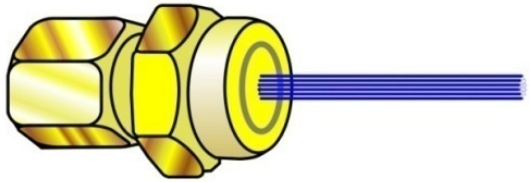
Flat Spray



Atomizing Spray



Hollow Cone

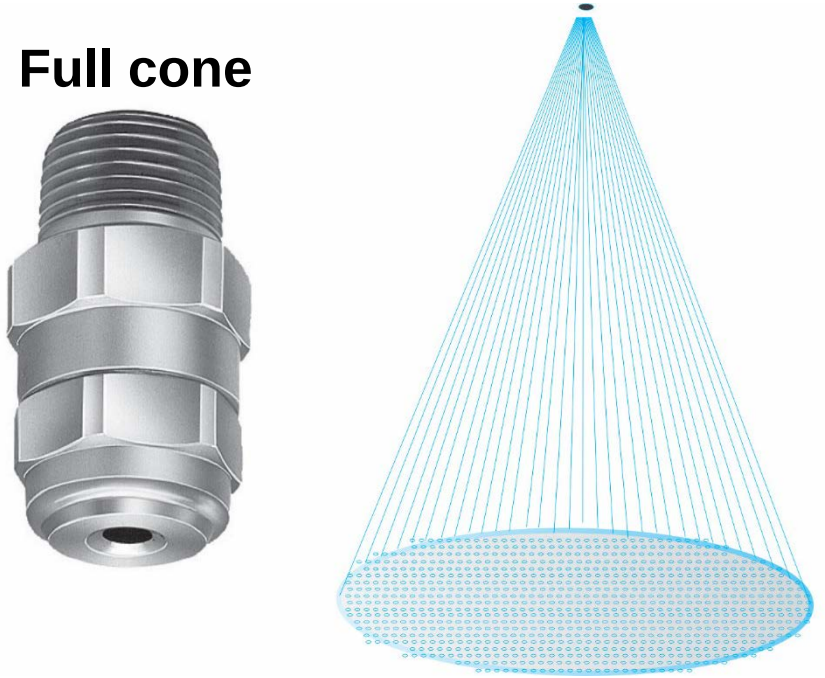


Solid Stream

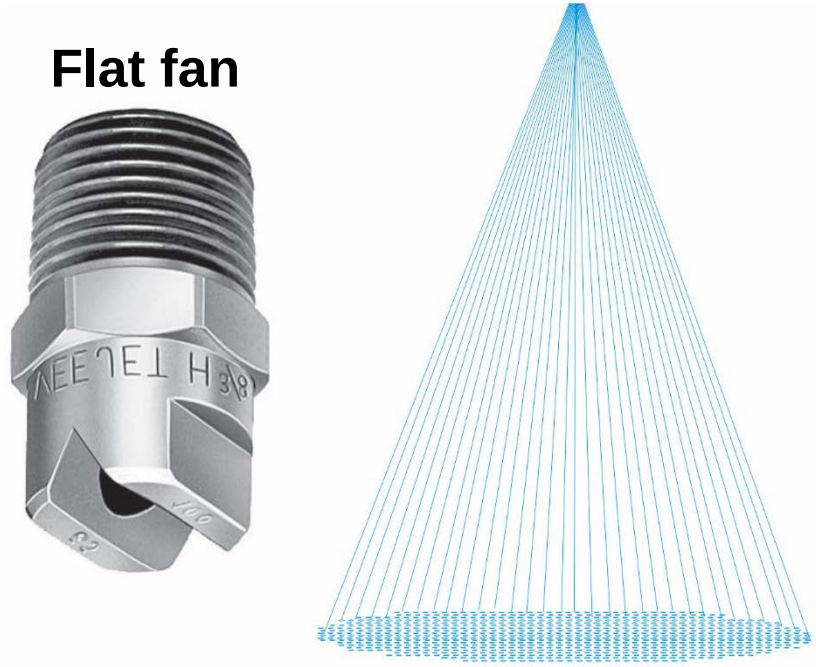
Water sprays for suppressing dust

- full cone and flat fan sprays
- water quantity and full coverage are key
- lower pressure typically preferred

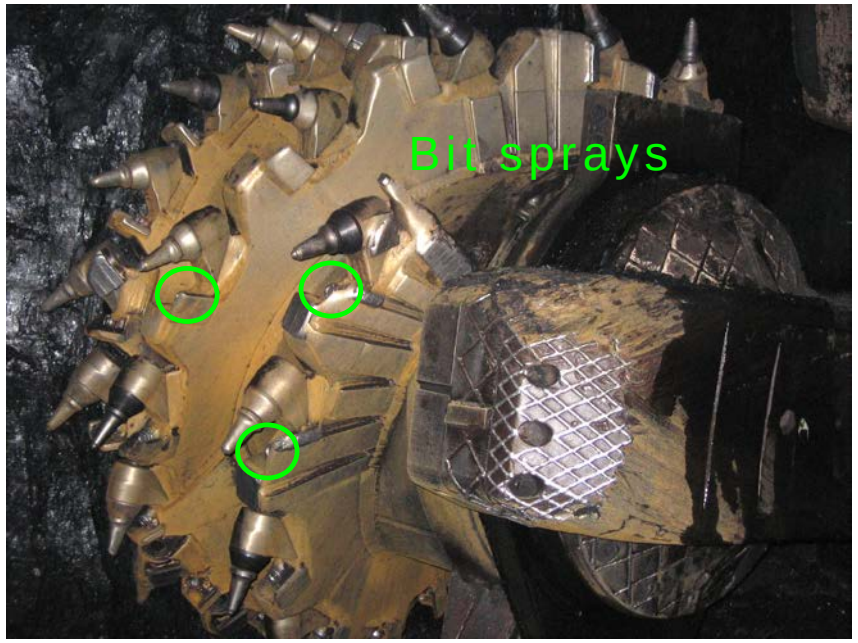
Full cone



Flat fan

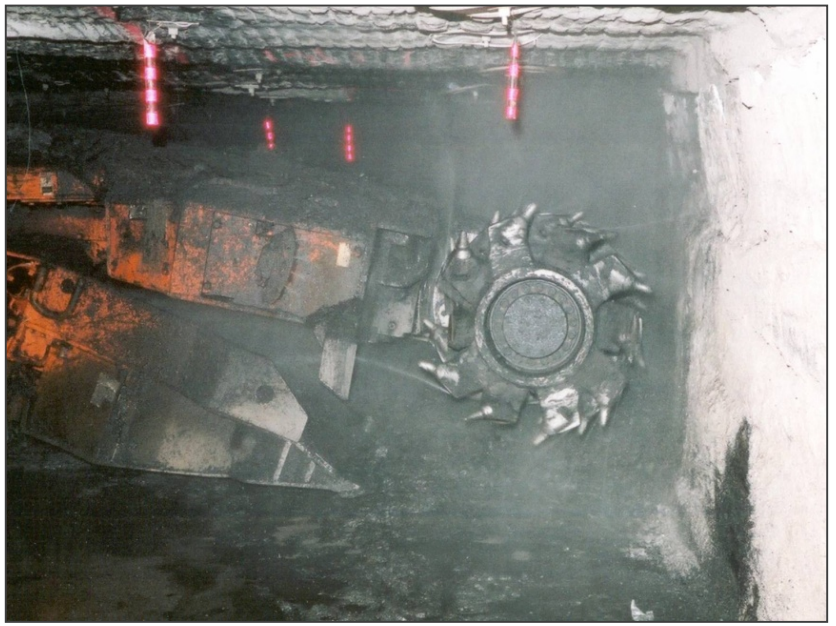


Wet dust at generation point



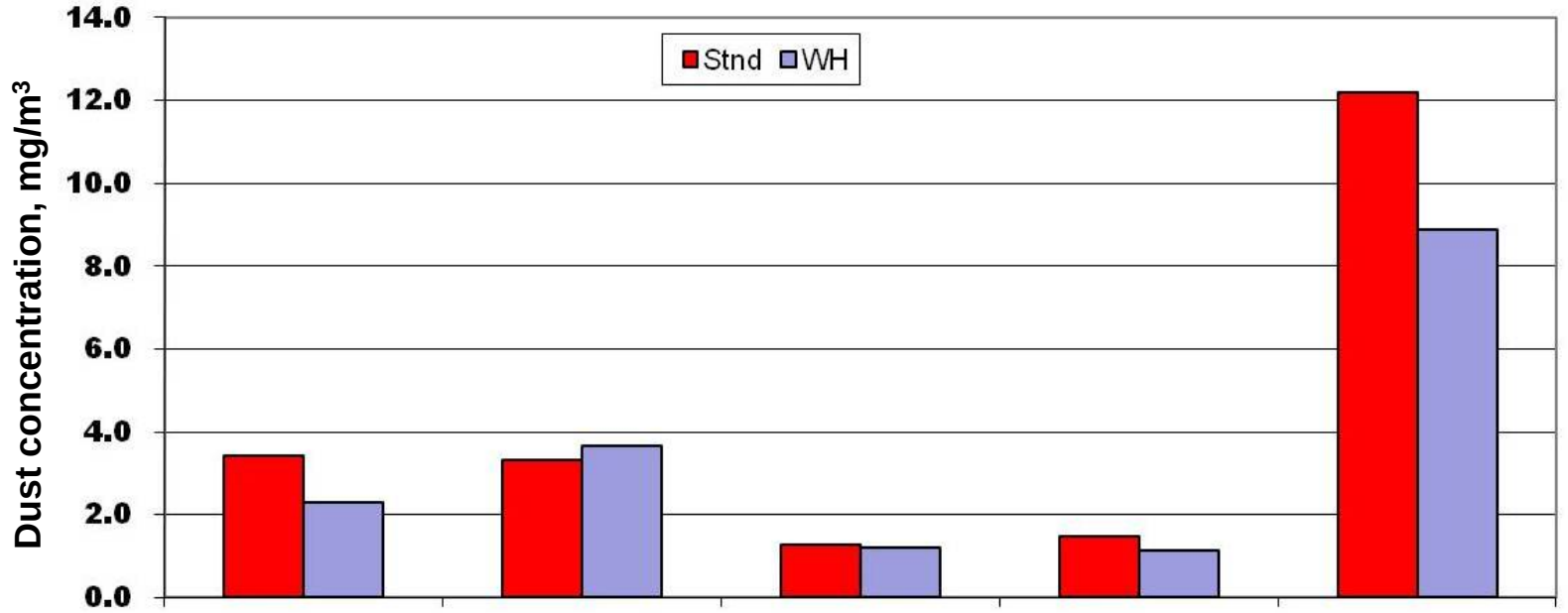
Wet head spray system

- locates spray directly behind bit
- bit cooling reduces frictional ignitions
- no increase in water consumption (25 – 30 gpm @ 100 psi)
- do these sprays reduce respirable dust??
- NIOSH conducted surveys at 5 mines



Photos courtesy of Joy Mining Machinery

Return dust levels

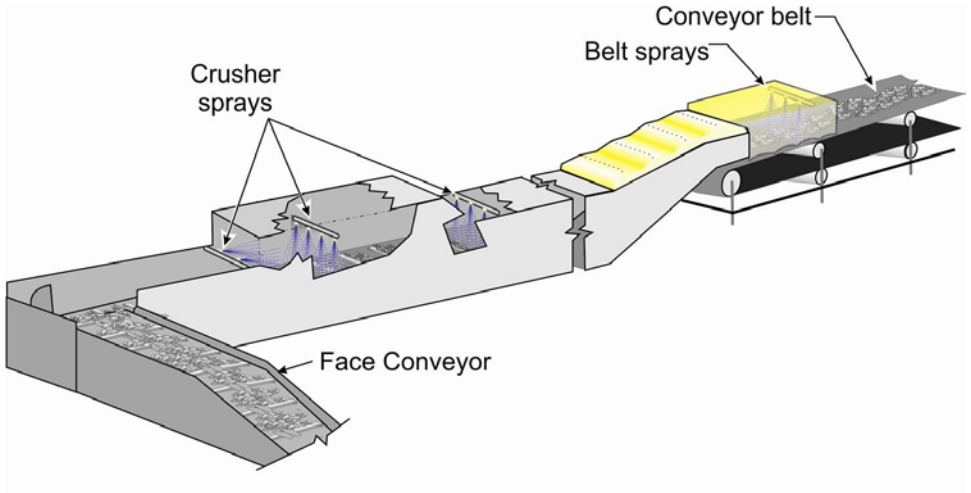


	Mine A	Mine B	Mine C	Mine D	Mine E
Ventilation	Blowing	Exhausting	Blowing	Blowing	Exhausting
Section	Super sect.	Single	Super sect.	Single	Single
Scrubber	Yes	Yes	Yes	Yes	No

- wet head overshadowed by scrubber resulting in variable performance
- operators noted an increase in visibility with wet head sprays

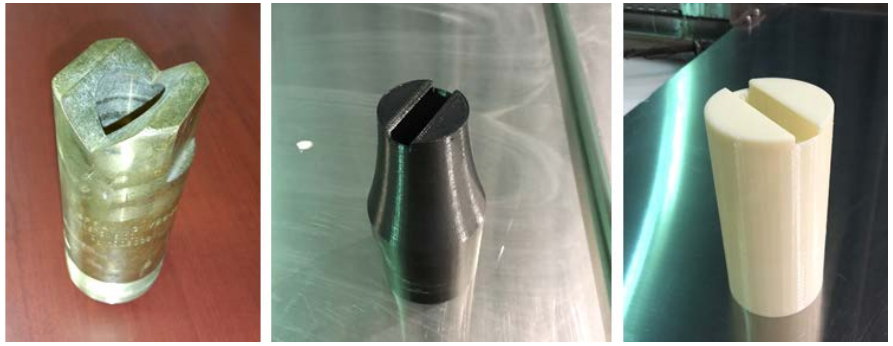
Stageloader/crusher dust control

- totally enclose unit
  - conveyor belting/brattice/steel plates
  - expanding foam to seal gaps
- use water sprays for wetting
  - entrance
  - both sides of crusher
  - discharge to section belt
- spray performance
  - sprays cover full width of coal stream
  - water quantity is key
  - water pressure of 60 psi or less



Ongoing research - foam application on longwalls

- past research showed foam was more effective than plain water
- foam generation
  - blower vs compressed air
  - nozzle type
  - operating parameters
- suitable foam system identified
  - shearer-mounted system for shield dust control
  - inside stageloader/crusher to limit intake air contamination
- seeking mine site for underground evaluation



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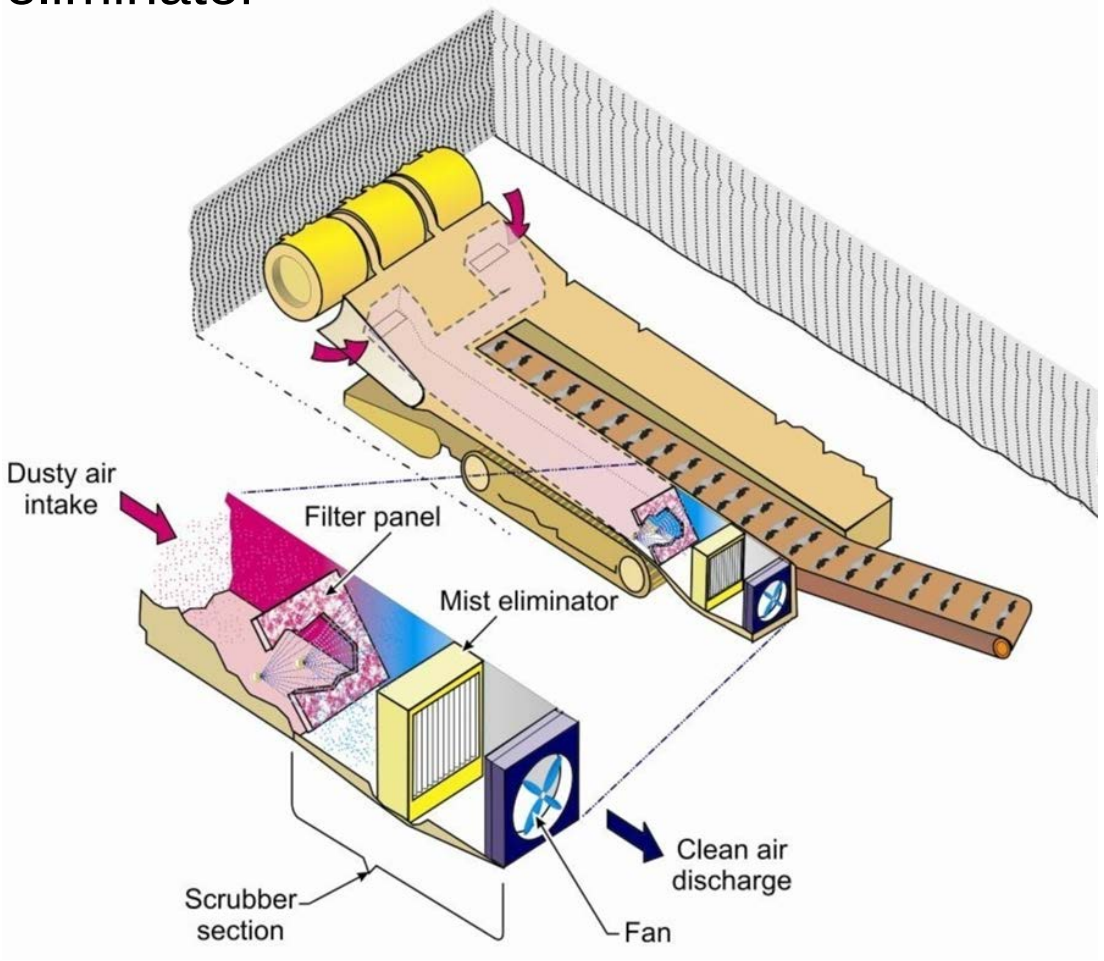
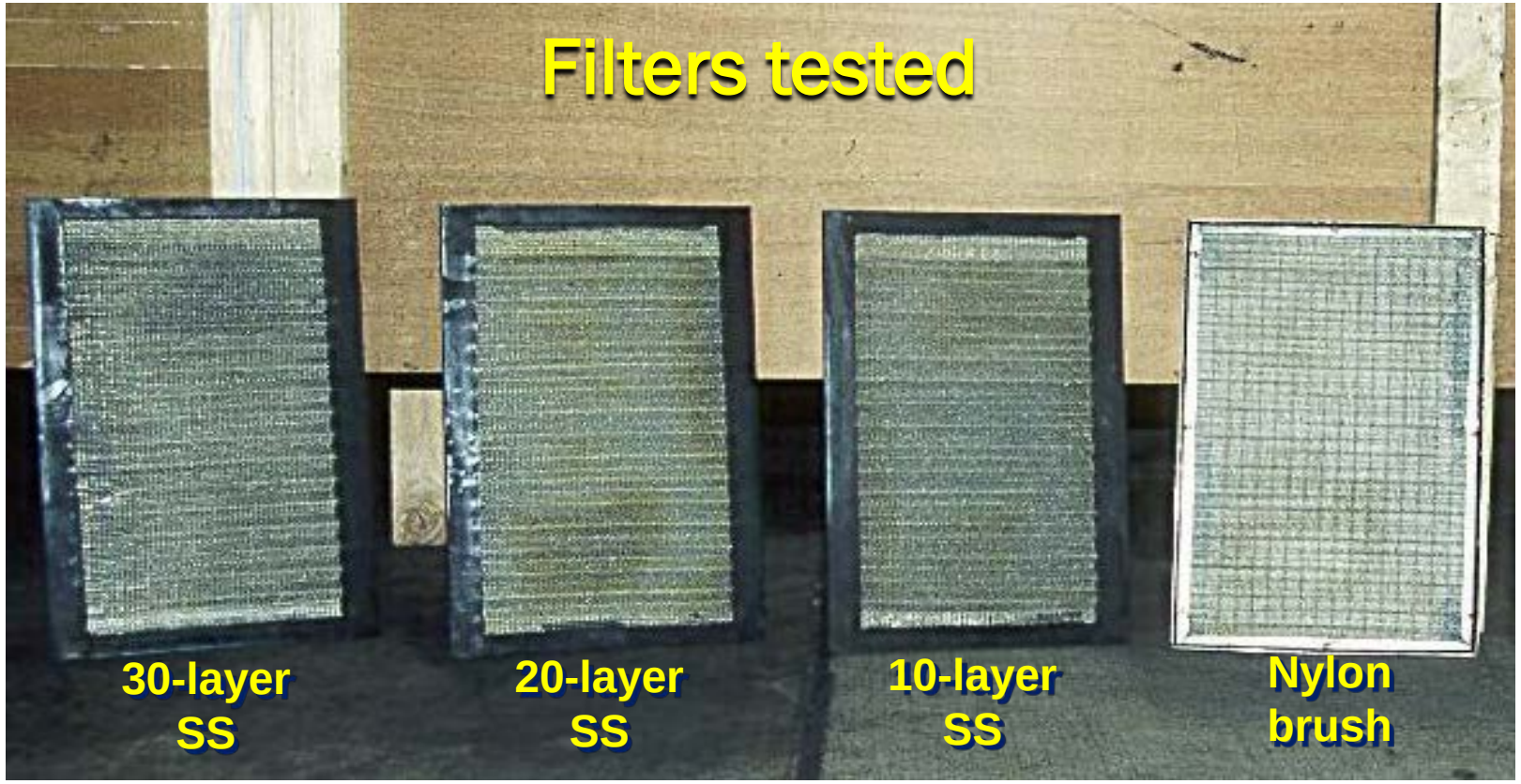
Flooded-bed scrubbers

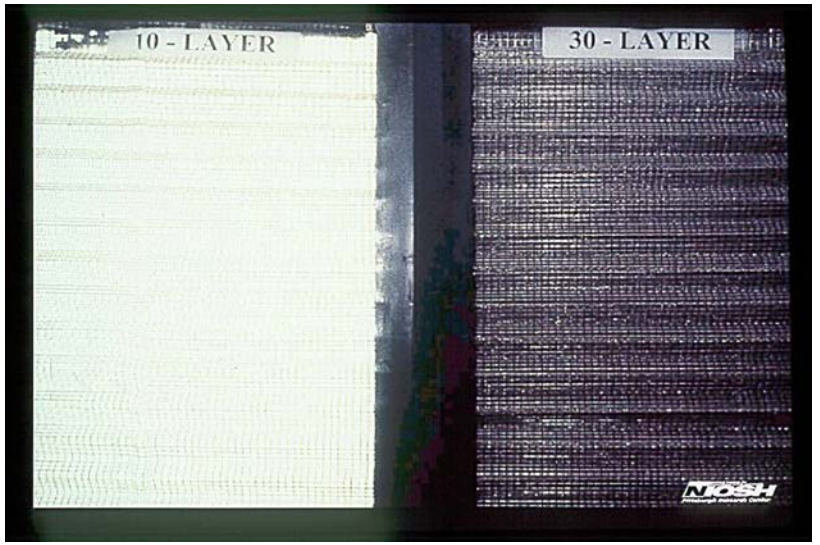
- very effective capture and removal of airborne dust
- removes dust with wetted filter panel and mist eliminator
- assists in moving air to face (deep cuts)



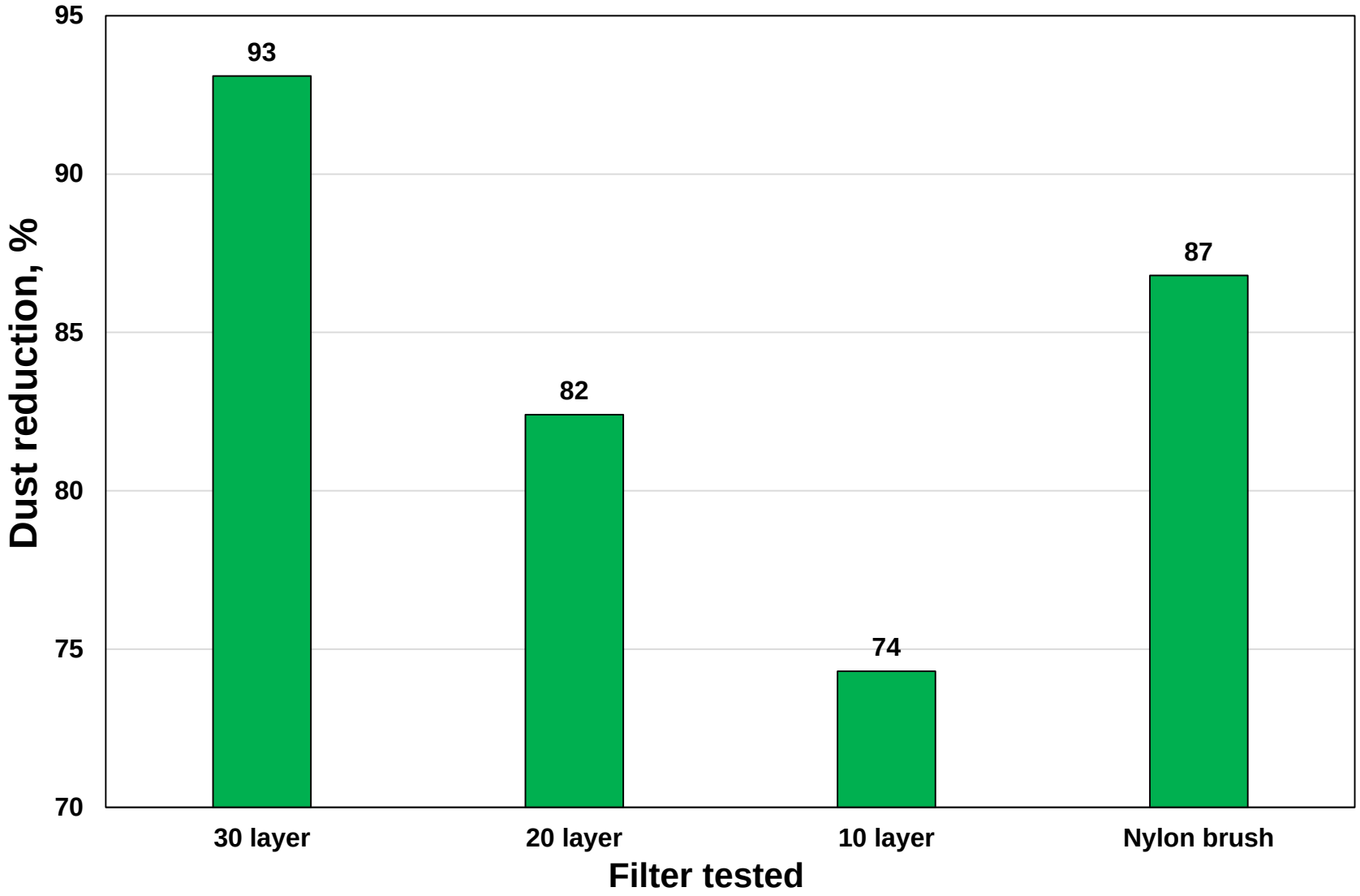
Scrubber filter study



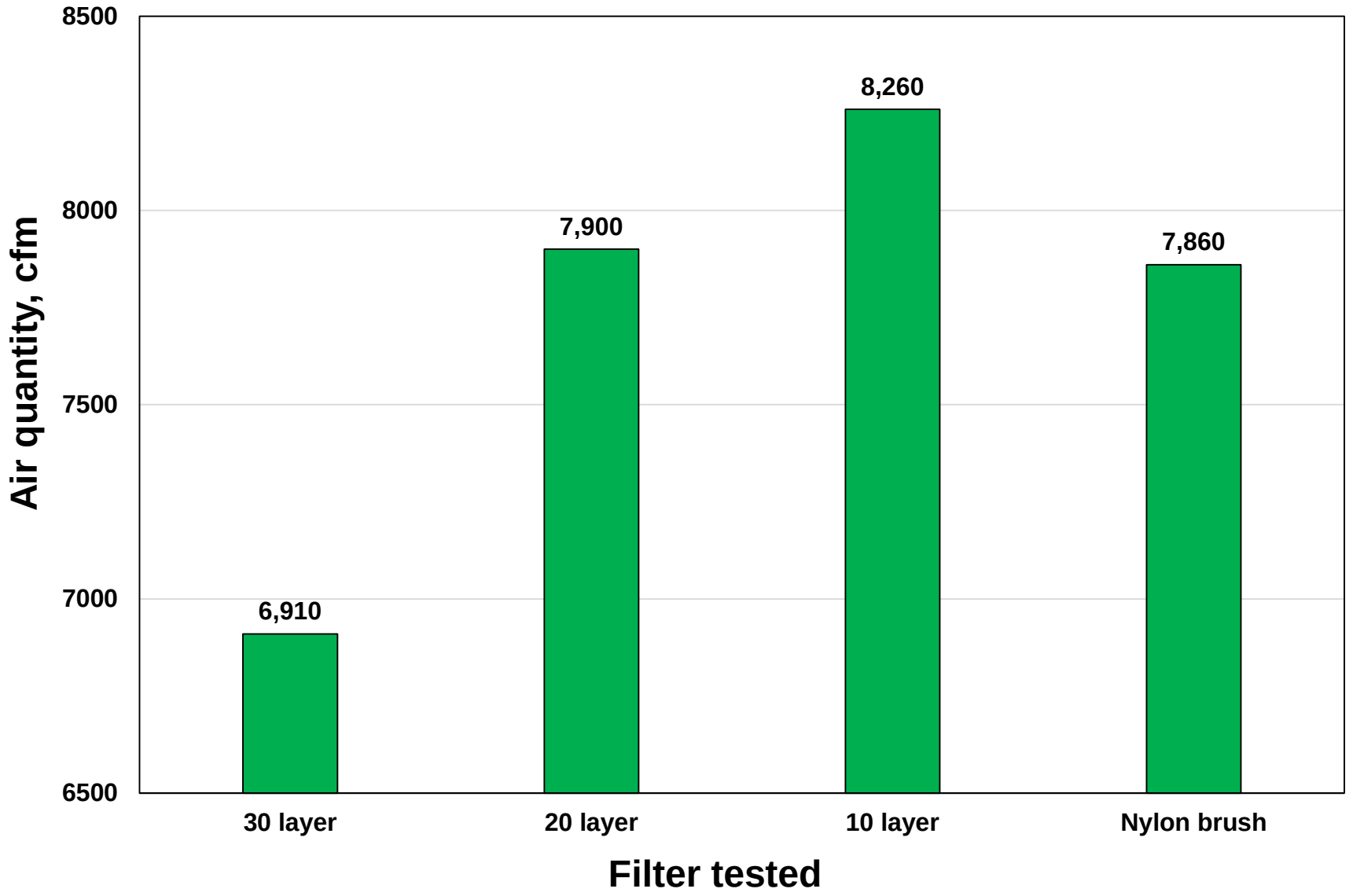
density of 10 vs 30 layer filter - backlit



Respirable dust collection efficiencies



Air quantity measured with each filter panel



Underground studies of flooded-bed scrubber effectiveness on CM sections

1) **Industry: Are deep cuts dustier than standard cuts?**
   - 6 mines sampled by NIOSH
   - blowing and exhausting ventilation systems evaluated
   - compared dust levels in first 20 feet of cut to last 20 feet

2) **MSHA: How do dust levels compare in 20-foot cuts with and without a scrubber operating?**
   - 3 mines sampled by NIOSH
   - all mines used exhaust ventilation
   - compared dust levels in 20-foot cuts with and without a scrubber operating

Comparing dust levels in first and second half of deep cuts

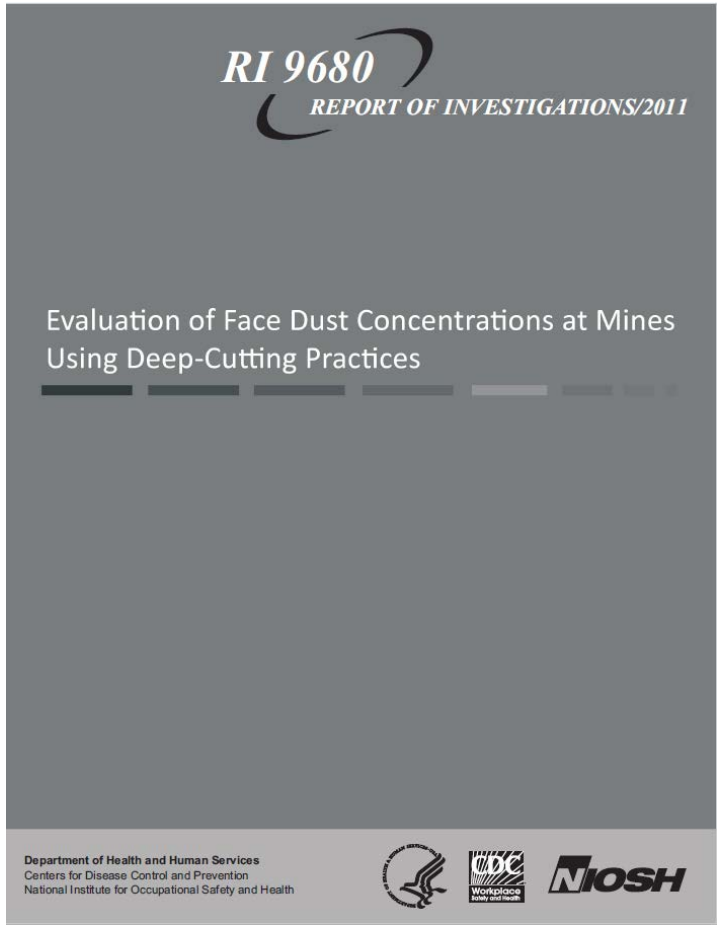
During cutting and loading, shuttle cars maintain a consistent position with respect to the continuous miner, so shuttle car dust levels were used for analysis.

40-foot deep cuts results

No statistically significant difference in SC operators' dust between first 20 feet and last 20 feet

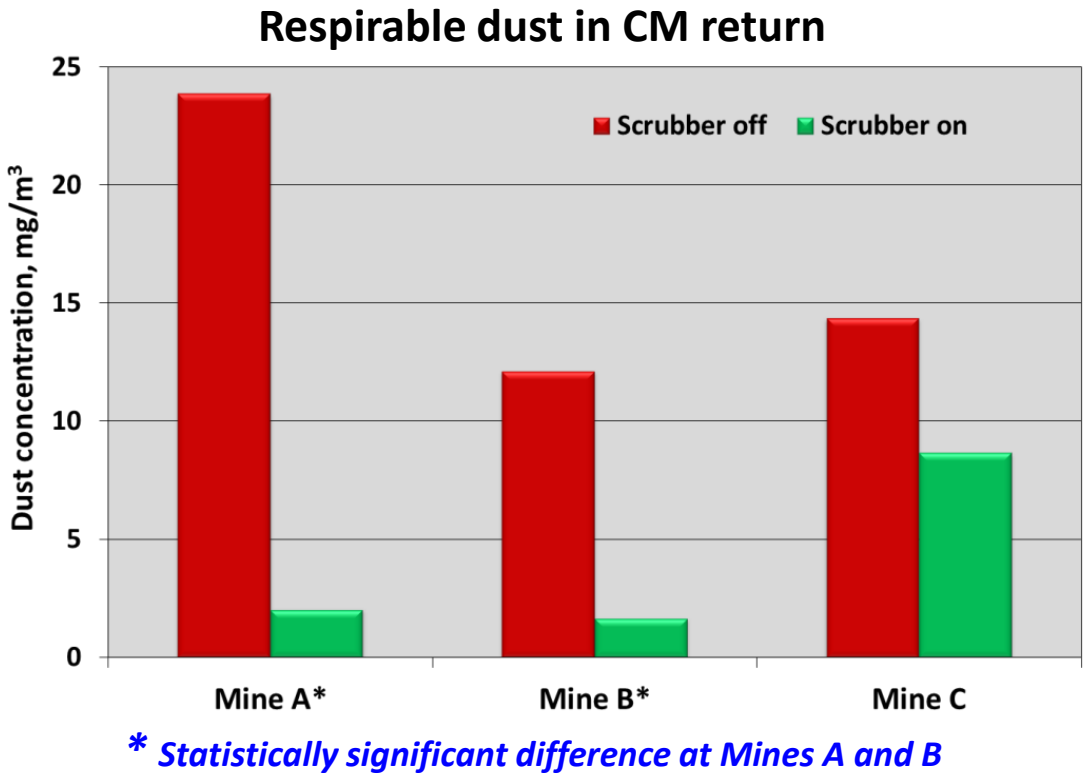
Mining conditions during testing:

- all mines had required face and scrubber airflows to start the cut
- for blowing faces, face-to-scrubber airflow ratio of 1.0 established with the scrubber off
- 20 layer filters used in all scrubbers
- 30 to 50 foot curtain setback distances were used

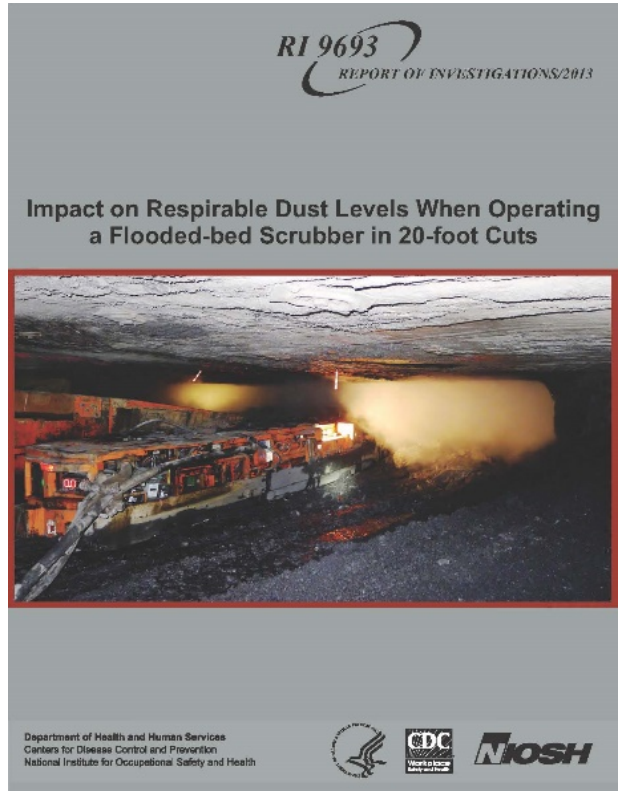


20-foot cuts with and without FBS operating

- 30 layer filters used at all three mines
- no statistically significant differences in CM and SC operator dust levels
- **CM return dust concentrations: 40 – 91% lower with FBS operating**
- quartz dust levels in CM return: reduced by 14 – 86% with scrubber



** Statistically significant difference at Mines A and B*

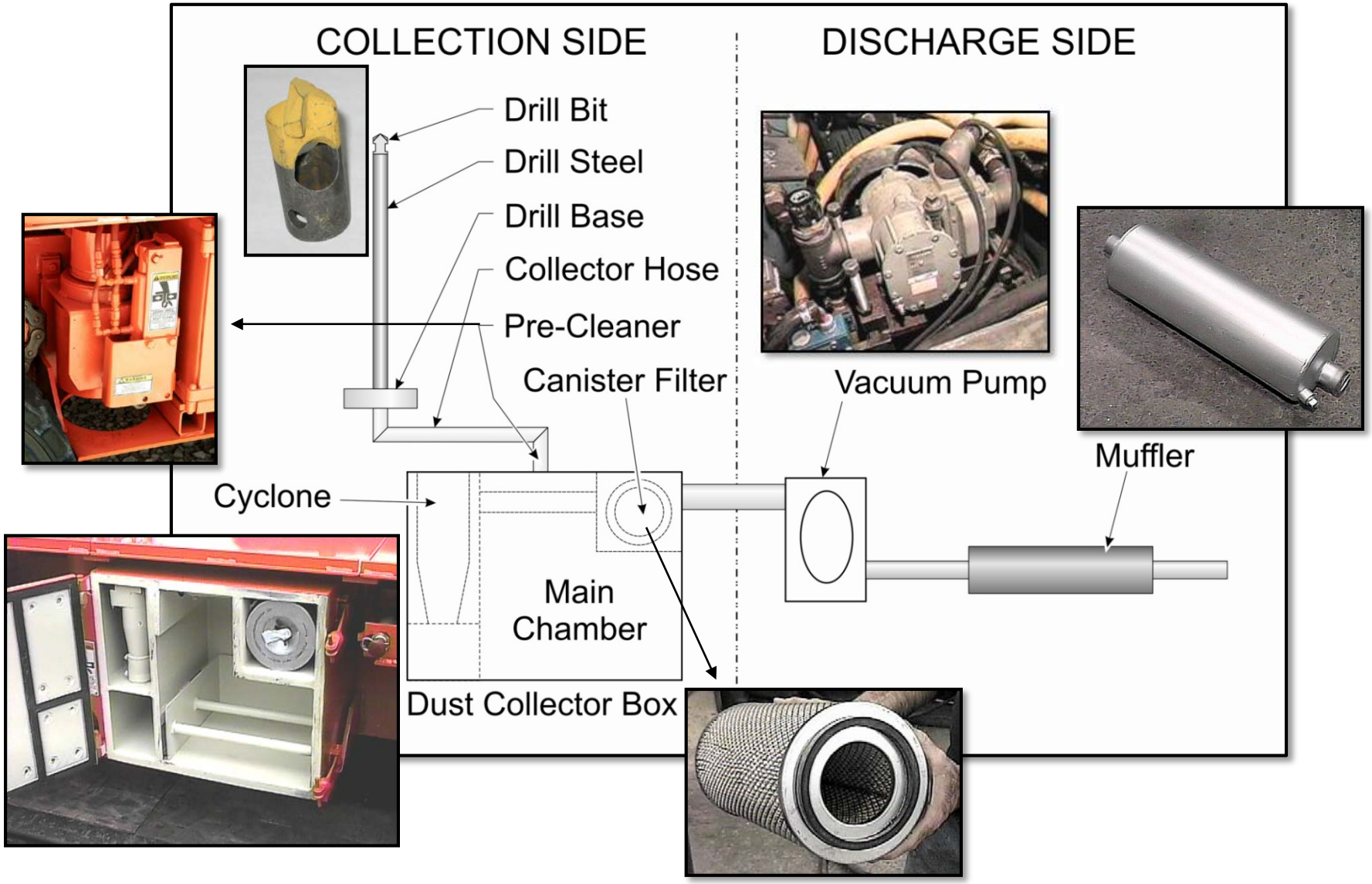


Maximizing scrubber effectiveness

- clean filter after each cut
  - 20 layer panels had 20-35% reduction in airflow after 40-foot cuts
  - 30 layer panels had 29-35% reduction in airflow after 20-foot cuts
- spray(s) should completely wet the entire filter area (full cone sprays)
- clean ductwork at least once per shift and demister/sump as needed to maintain airflow
- check scrubber flow before each cut to ensure rated flow rate is obtained (centerline pitot tube reading vs full traverse)

Roof bolter dry dust collector

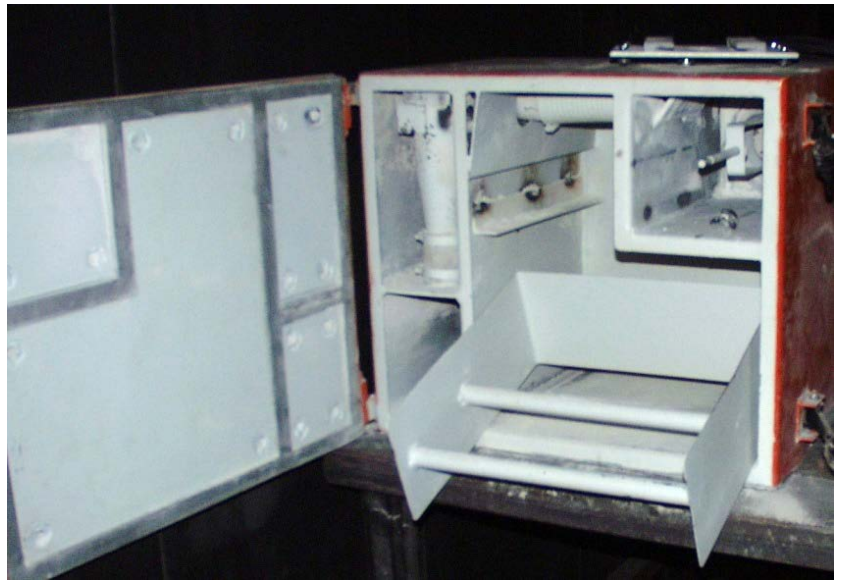
(approximately 60 cfm at 12” Hg vacuum at drill head)



Exposures when maintaining dry collector

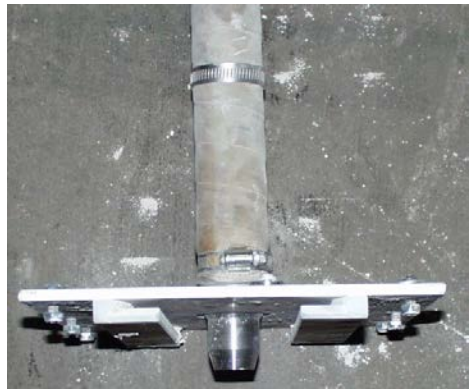
Cleaning dust box

- breathing zone is close to dust liberation
- often lower airflow in bolter entry
- contaminated clothes can continue to liberate dust
- high silica content dust



Disposable collector bags

- bag system can be retrofitted to most Fletcher bolters
- pre-cleaner recommended to reduce dust loading in bag and extend bag life



Without bag

With bag

Collector bag testing

Laboratory

- 99% of dust feed retained in collector bag
- 50% less dust in exhaust with bag
- Pressure drop across canister filter
  - 3.0 to 3.3 inches w.g. with bag
  - 4.0 to 8.4 inches w.g. without bag

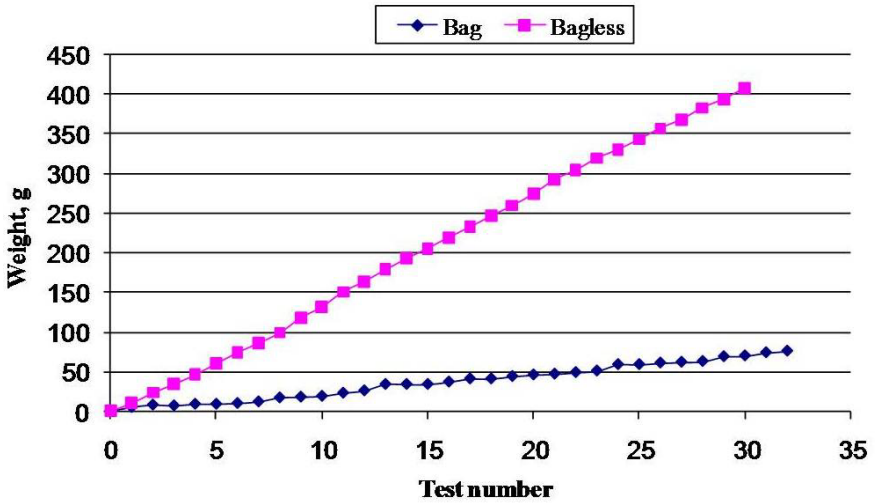
In-mine testing

- respirable dust in collector exhaust
  - 0.96 mg/m^3 without bag
  - 0.14 mg/m^3 with bag
- box cleaning time reduced from 4 minutes to 30 seconds

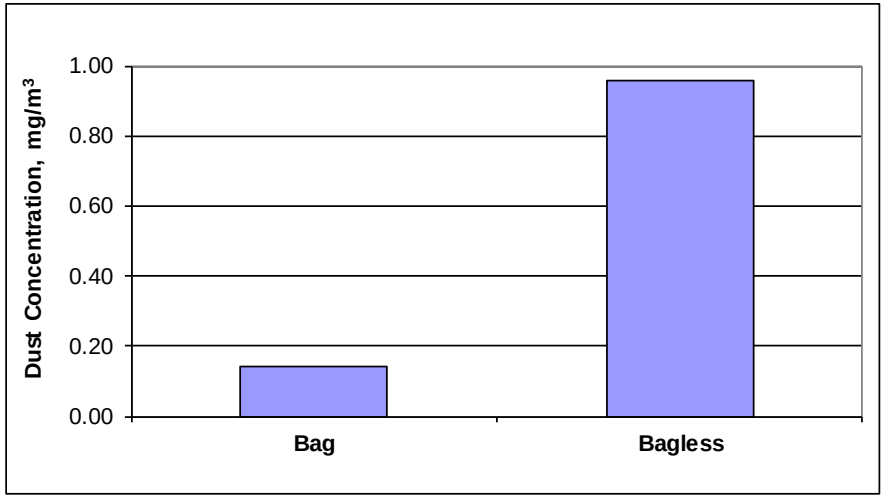
Benefits

- dust contained while removing from box
- no dust piles in roadway
- prolongs canister filter life (replace – don't clean)
- reduces dust emissions from collector exhaust

Canister filter weight gain



Dust emissions in UG bolter exhaust

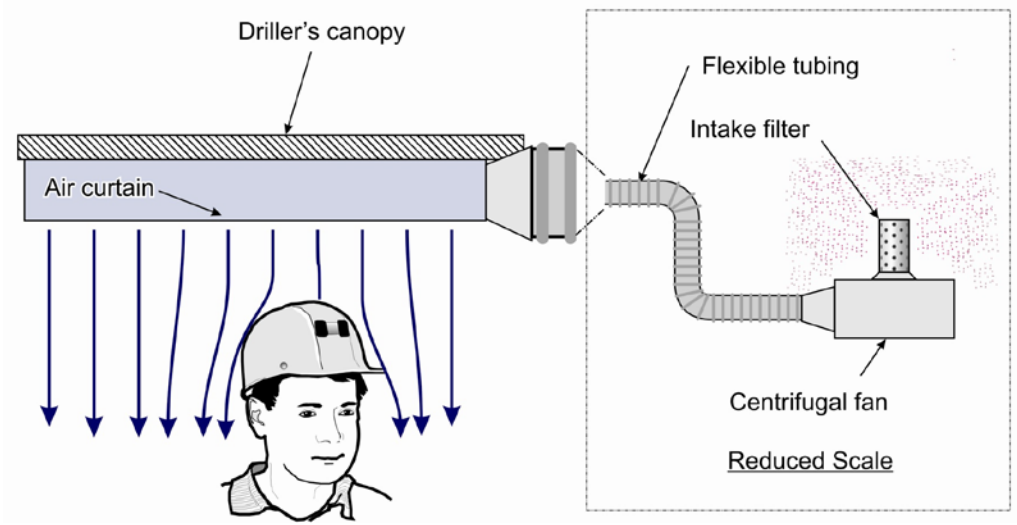


Maintaining dust collector performance

- routinely check to ensure that required vacuum is achieved
- eliminate leaks in vacuum system
  - hoses and clamps
  - integrity of collector door gasket
  - door latches intact and seating is tight

Canopy air curtain

Provides filtered air to bolter operator to reduce dust exposures

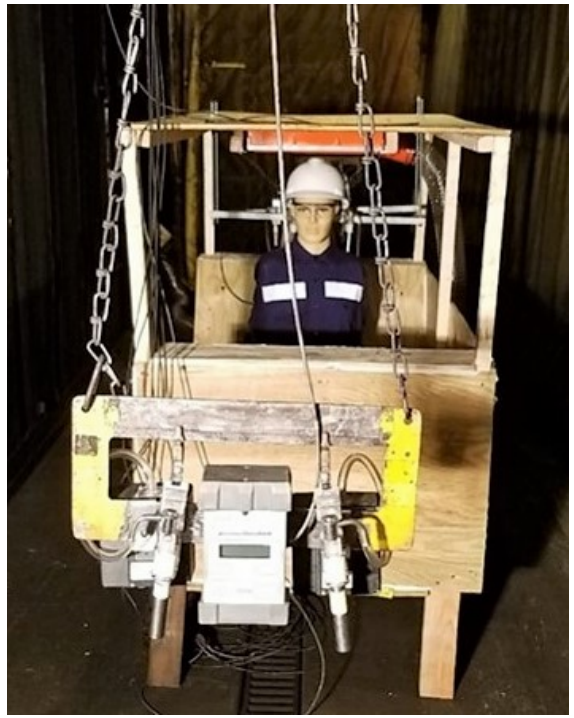


Canopy air curtain results

- lab study showed 95% reduction under canopy at 60 fpm mean entry air velocity *(sampling 100% of time under canopy air curtain)*
- in initial mine survey, air curtain reduced operator dust levels by 35 to 89% *(impacted by bolter operator time spent under canopy)*
- Fletcher integrated air curtain into their canopies and includes this option in quotes for all new roof bolters
- Fletcher - approximately 50 roof bolters are equipped with canopy air curtains

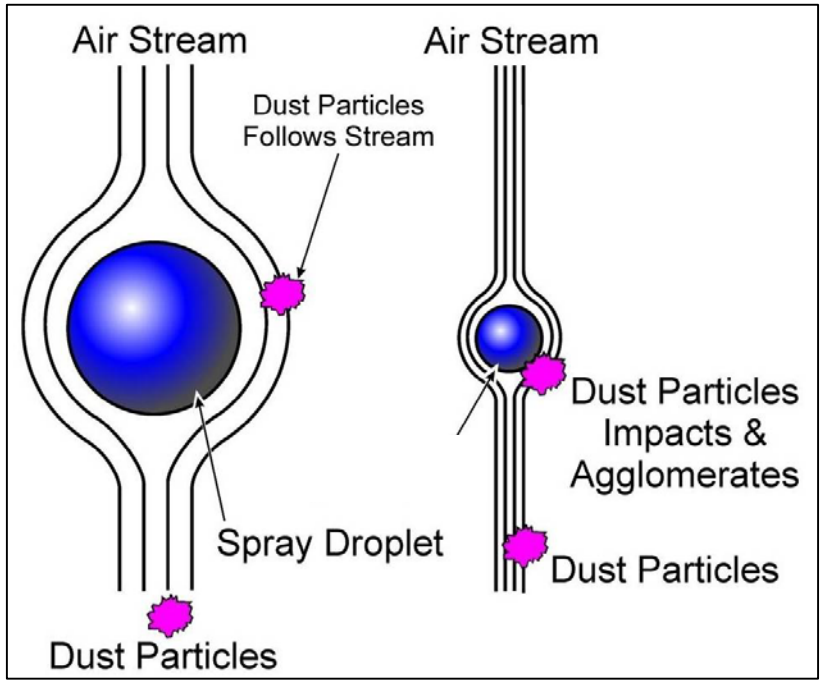
Ongoing research - canopy air curtain for haulage vehicles

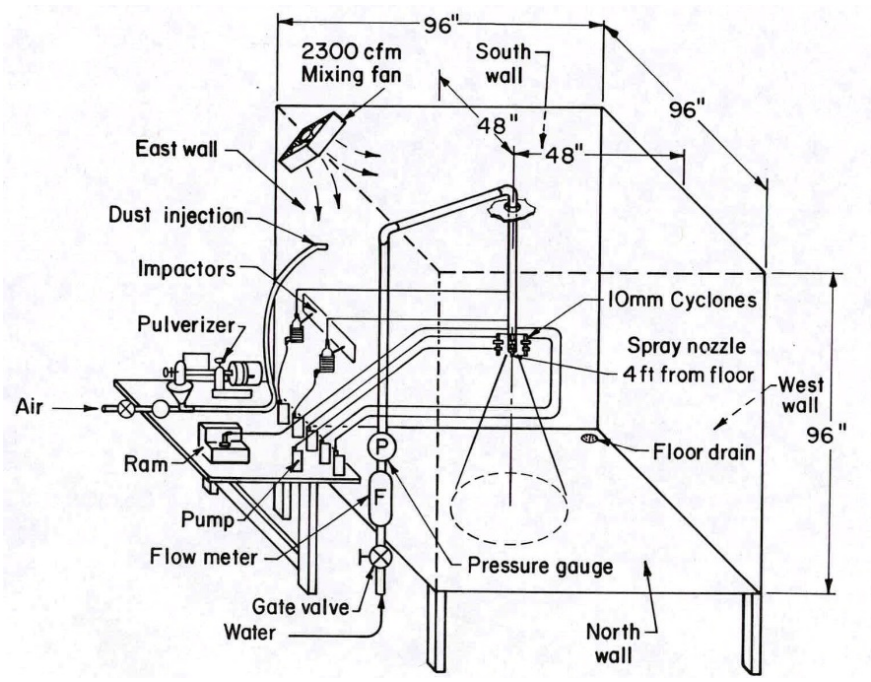
- historically, increased exposure for haulage car operators when using blowing face ventilation
- contract awarded to Marshall University/Fletcher to design and fabricate a canopy-air-curtain for shuttle cars
- laboratory testing at NIOSH
  - 70% reduction at 120 fpm entry air velocity
  - 51% reduction at 850 fpm entry air velocity
- canopy is installed at a mine and NIOSH is completing a full evaluation this week

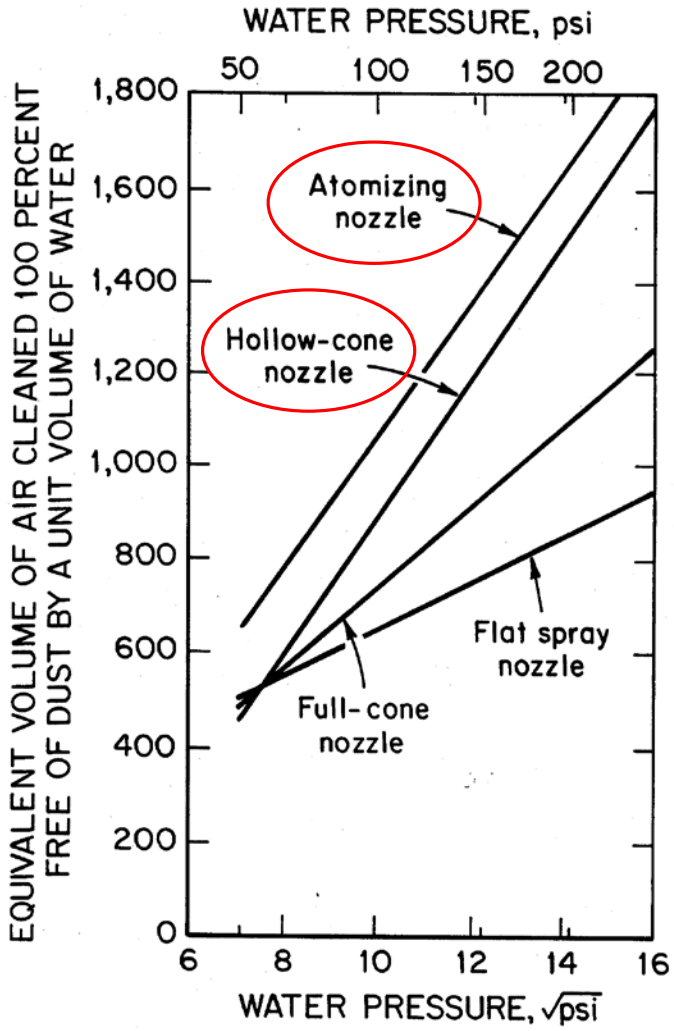


Water sprays for airborne dust capture

- smaller and higher velocity droplets are better for respirable dust capture
- benefits obtained through nozzle selection and increased pressure



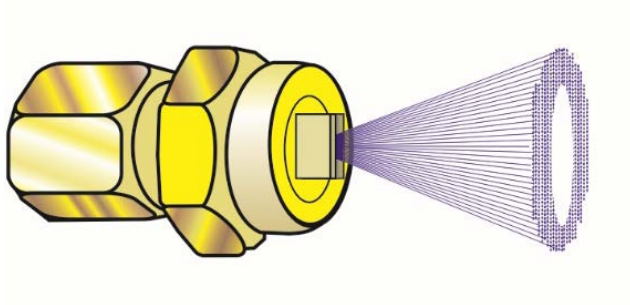




Water sprays for airborne dust capture

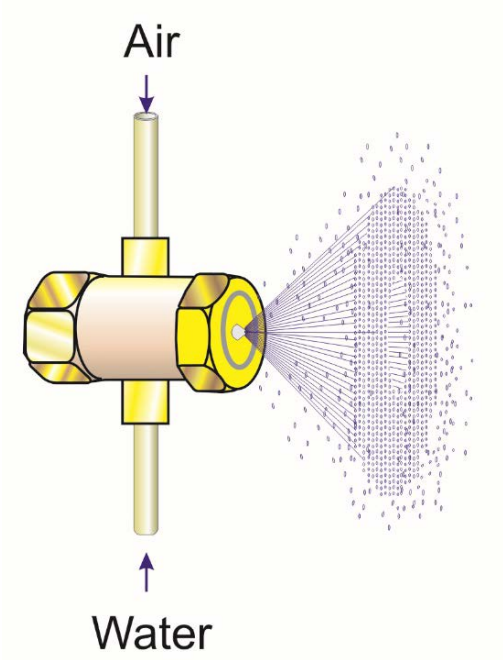
Hollow cone sprays

- hollow cone commonly used
- small to medium droplets
- larger orifice with less clogging
- effective air moving



Air atomizing sprays

- smallest droplets
- need for air and water supplies hinders use in mining
- nozzle shapes prone to damage

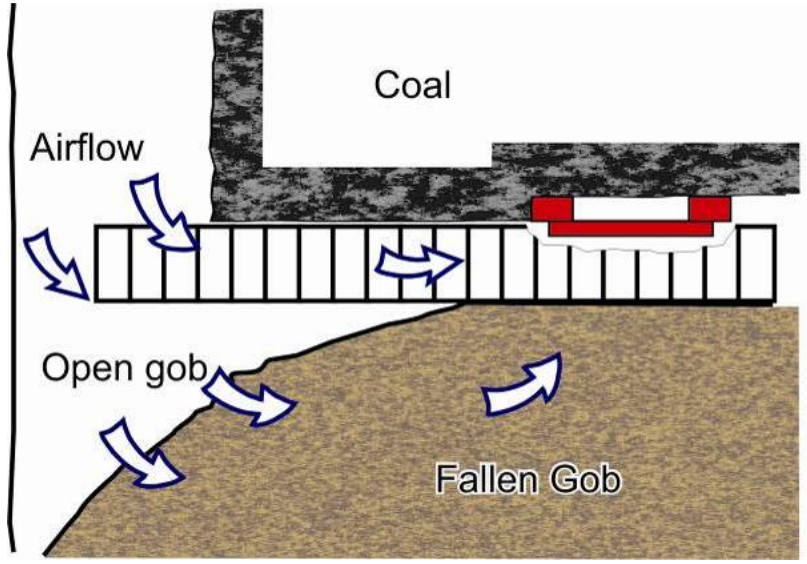


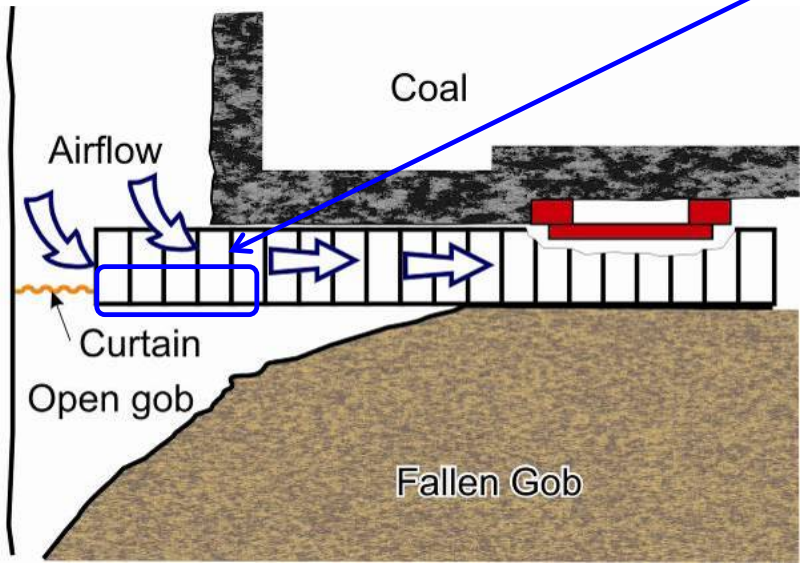
Dust control approach

1. **minimize the quantity of respirable dust generated**
   a. efficient cutting *(bit design, bit sharpness, cutting method)*
2. **prevent the respirable dust from getting airborne**
   a. wet dust at generation point *(water sprays, foam)*
   b. enclose dust sources *(stageloader, belt transfer)*
3. **remove the respirable dust from the ventilating air**
   a. flooded-bed scrubbers *(continuous miners, stageloaders)*
   b. dry dust collectors *(roof bolters, air curtains)*
   c. water sprays *(nozzle type, location, operating parameters)*
4. **dilute remaining airborne dust**
   a. ventilation quantity
   b. distance from source *(shield advance, CM cuts)*
5. **prevent respirable dust from reaching workers' breathing zones**
   a. ventilation velocity and direction
   b. air movement with water sprays *(directional sprays, blocking sprays)*
   c. physical barriers *(belting, enclosed cabs)*

Maximize air quantity down longwall face

Install and maintain a tight gob curtain…extend brattice along first few shields



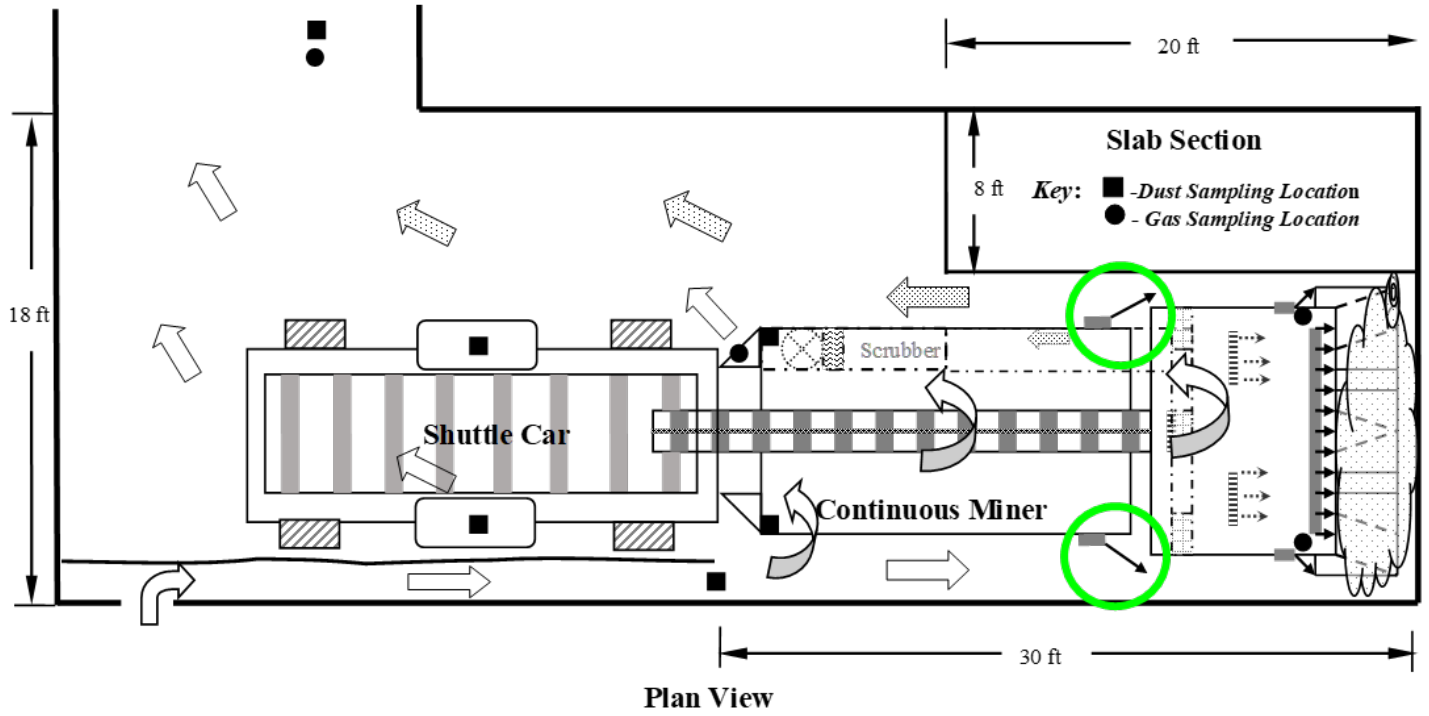


Dust control with blowing face ventilation

- blowing ventilation typically better for methane control but not dust control
- MSHA typically requires face airflow to be within 1,000 cfm or 10% of scrubber airflow
- evaluated several operating parameters in CM dust gallery (box & slab cuts with scrubber operating at 7,000 cfm)
  - face ventilation quantity (8,000 & 12,000 cfm)
  - curtain setback distance (30 & 50 feet)
  - blocking sprays on & off

Dust control with blowing face ventilation

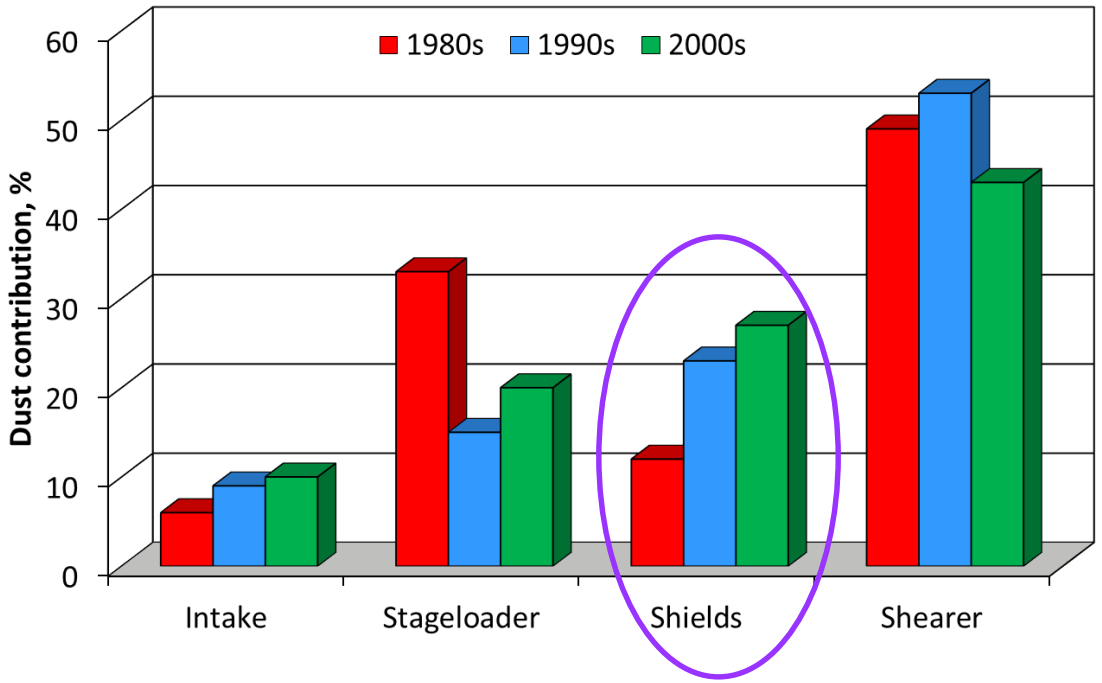
- test parameters that minimized shuttle car operator exposure
  - 50 foot curtain setback
  - blocking sprays on
  - 12,000 cfm face airflow (statistically significant reduction at SC and return); represents a change from previous guidance

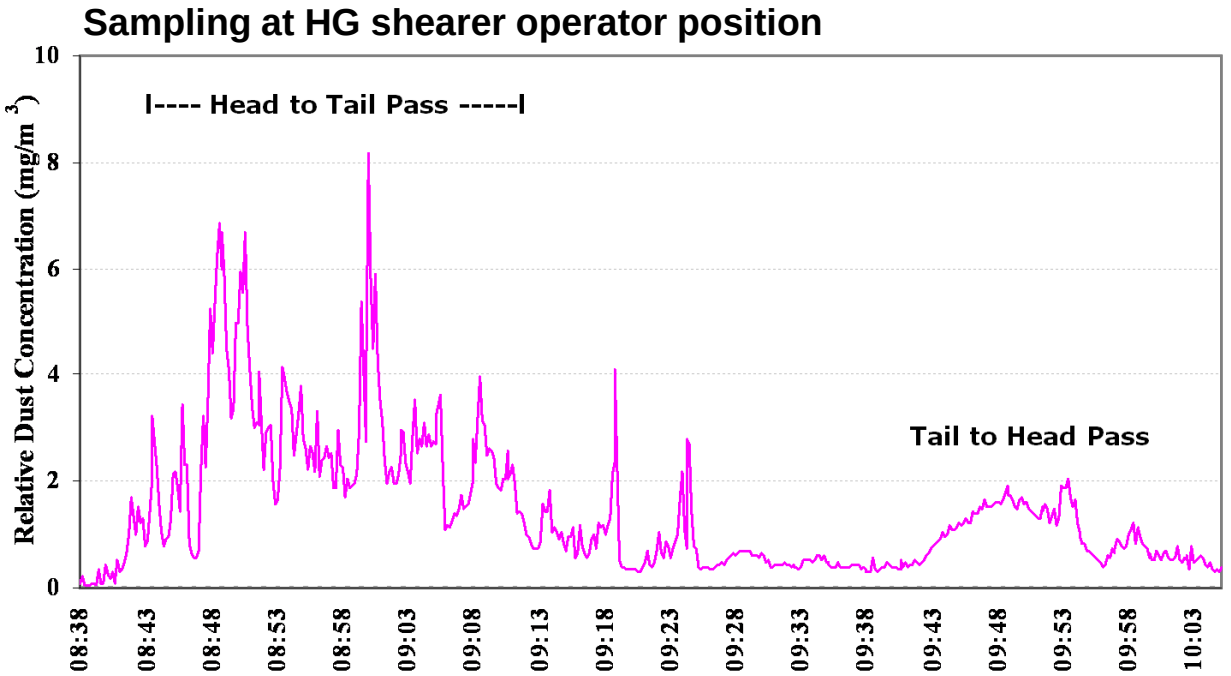


Increase distance from dust source

Longwalls

- shield advance on longwalls contributes more dust than in past
- automated shield advance is much closer to shearer operators reducing time for mixing/dilution
- advance shields as far upwind of HG operator as possible





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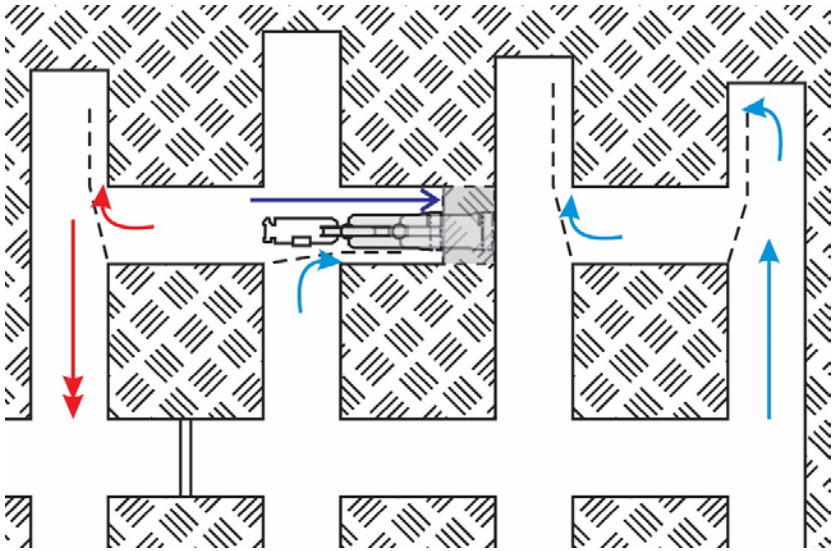
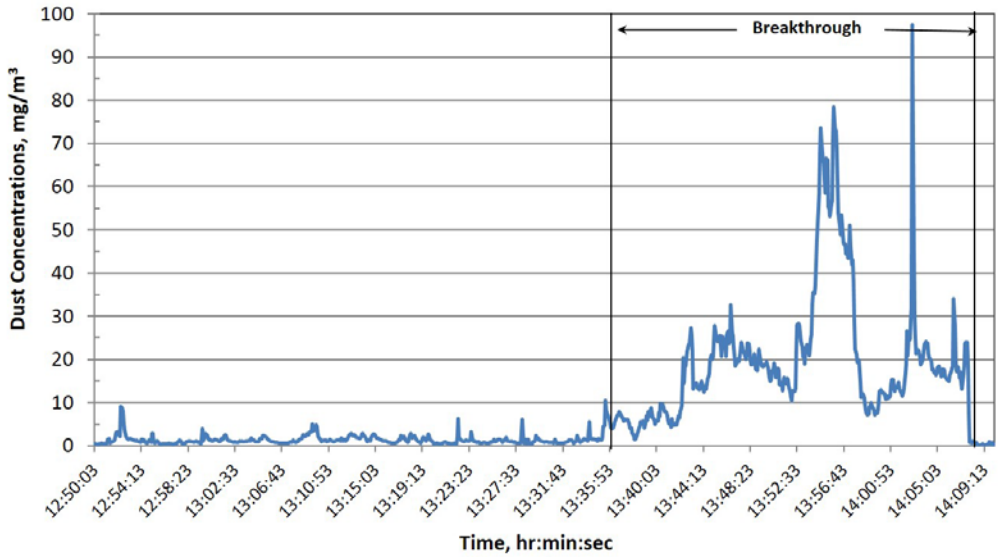
CM operator dust levels in crosscut breakthroughs

crosscut breakthrough into intake air

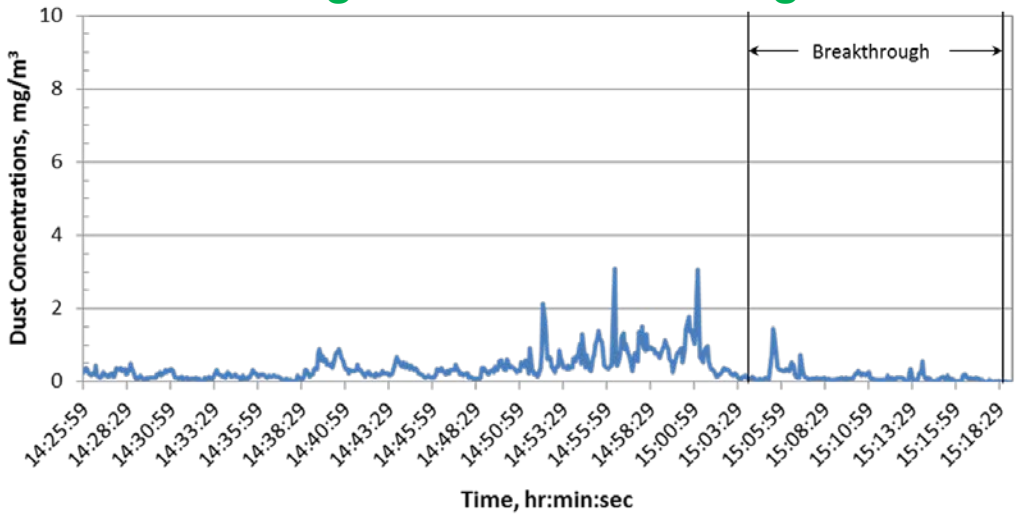


- as much as possible, mine crosscuts with the direction of section ventilation
- mining crosscuts against the direction of section ventilation--- minimize the breakthrough time by squaring up the face (slab cut) a few feet before breakthrough

cutting into the ventilating air

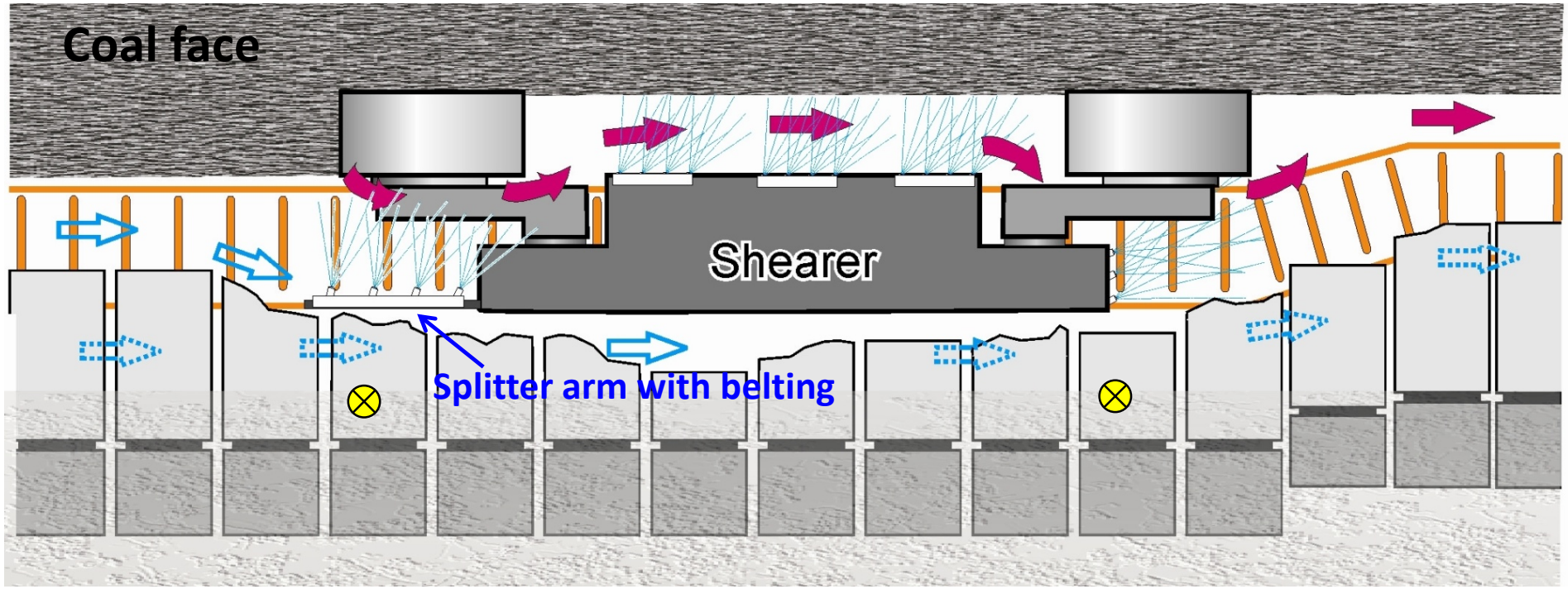


cutting with the ventilating air



Directional spray system (shearer clearer system)

- shearer-mounted sprays that are oriented downwind
- headgate splitter arm designed to split the face airflow at the shearer
- splitter arm sprays induce airflow movement toward face
- belting on splitter arm provides physical barrier to confine dust



⊗ - Shearer operators

Components of a directional spray system

Performance of directional spray systems

Effective directional sprays keep walkway clear

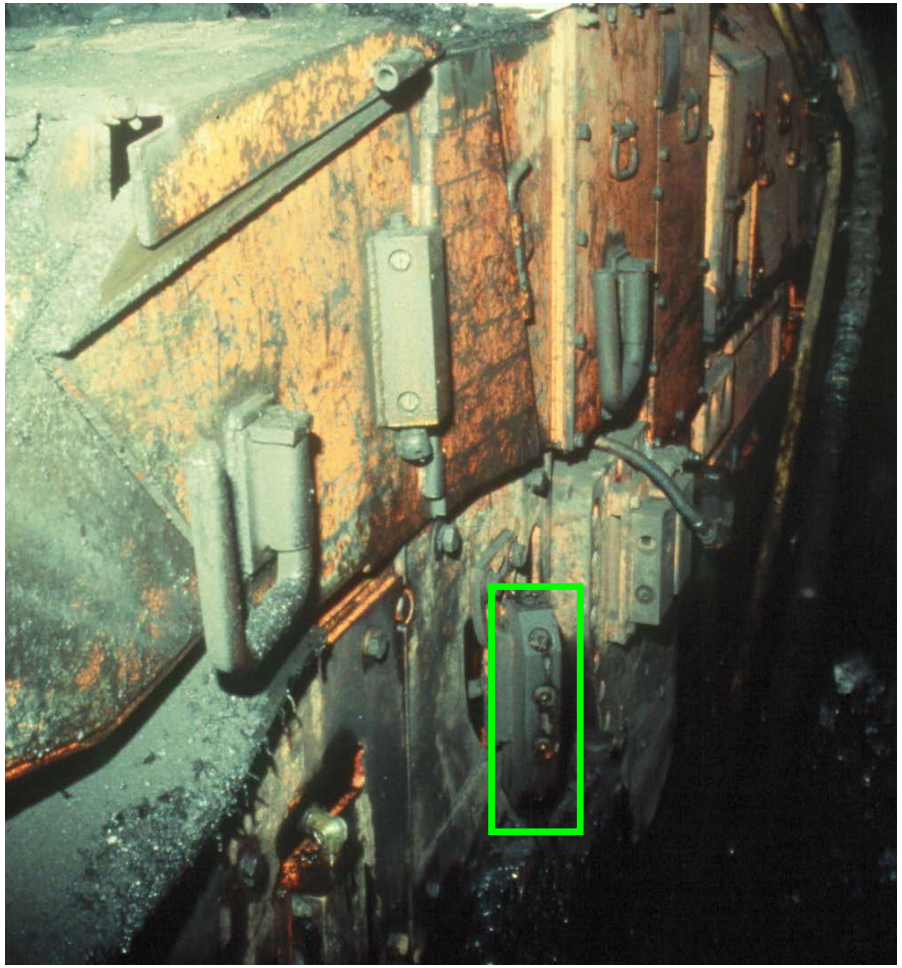
Ineffective directional sprays allow dust to roll into walkway

Ongoing research - underside shield sprays

- underside shield sprays can negatively impact dust control at the shearer
- properly designed sprays could be an extension of “shearer-clearer” sprays; help prevent HG drum and face spall dust from reaching walkway
- testing in full-scale LW gallery to evaluate spray type, spray angle, spray pressure, and location recently completed
- seeking mine site for an underground evaluation

Blocking sprays help to prevent dust rollback

- sprays help contain dust at face
- move air on sides of machine toward face
- lower dust levels at operator location



Physical barriers

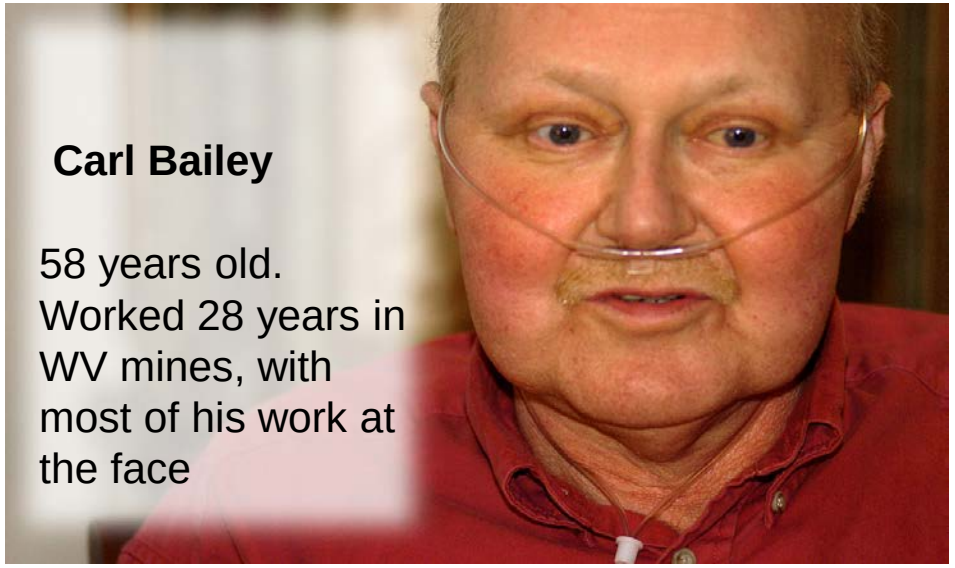
- prevent dust movement toward workers
- can assist effectiveness of spray systems
- cab enclosures on mobile equipment and operator booths in processing plants

Ongoing commitment for successful respirable dust control

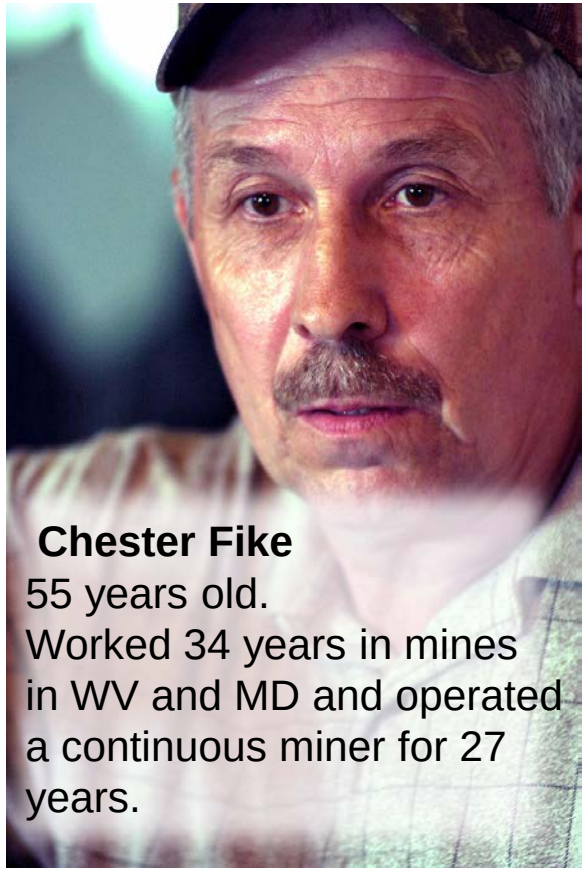
- **Worker AND management involvement for maximum success**
- **Attitude adjustments needed (safety is immediate; health is long term)**
- **Maintenance of controls is critical for ongoing success**

Faces of Black Lung DVD

- RHD interviewed two coal miners that have contracted CWP
- miners discuss the importance of protecting themselves from dust exposure
- NIOSH website (http://www.cdc.gov/niosh/docs/video/2008-131/default.html)



"And always remember: What's on your face you can wash-off, but what's on your lungs you can't. So be safe, and take care of yourself ".



"I was always trained to avoid injuries and I should've paid more attention to the dust."

Thank you for your attention.

Questions??

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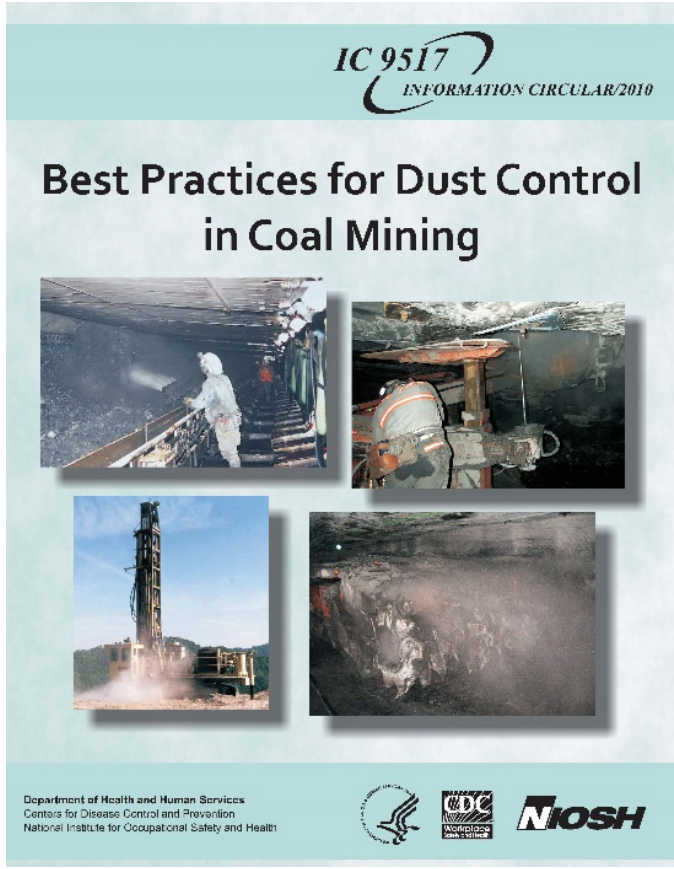

https://www.cdc.gov/niosh/mining/works/coversheet861.html