

Controlling Respirable Dust on Longwall Mining Operations



The findings and conclusions in this presentation have not been formally disseminated by NIOSH and should not be construed to represent any agency determination or policy.

Impact of Overexposure to Respirable Coal Dust

1970 – 2004

Direct or contributing cause of death for 69,377 underground miners

1970 – 2009

Over \$44,000,000,000 in CWP benefits paid to miners and their families



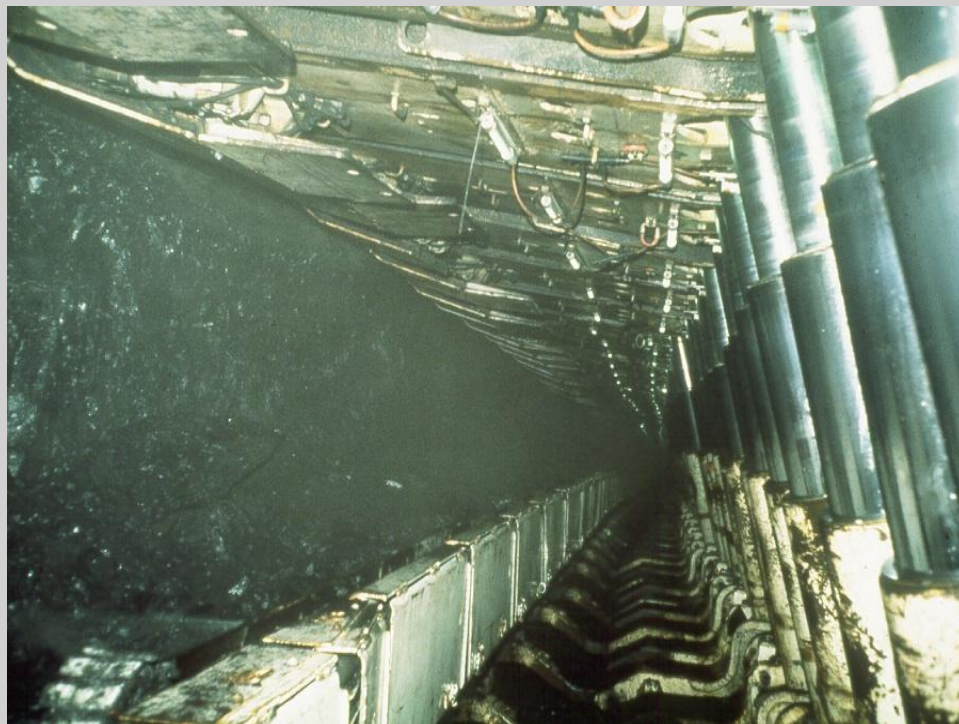
Longwall Production

- 2005 - 188.1 million tons
- 2008 - 179.2 million tons
- 50 % of underground production
- 17 % of total US production
- Working Faces
 - 1994 – 80
 - 2008 – 46
- Average Shift Production
 - 1994 – 3,600 tons per shift
 - 2008 – 5,500 tons per shift



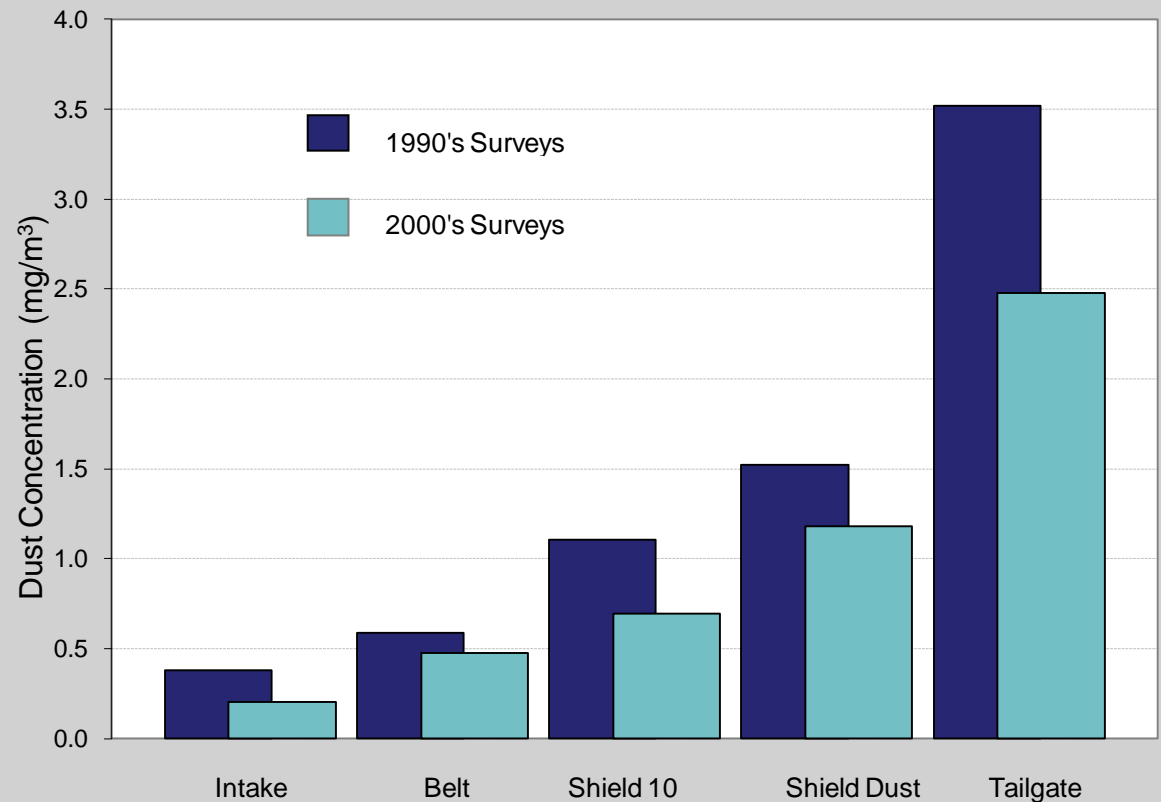
Recent Longwall Surveys

- Face Velocities
 - Average - 637 ft/min
 - 28 % increase when compared to the 1990 longwall surveys
 - 8 faces > 600 ft/min
 - 2 faces > 800 ft/min
- Air Quantities
 - 61,500 ft³/min
 - 7 faces > 64,000 ft³/min
 - 51 % increase when compared to the 1990 longwall surveys



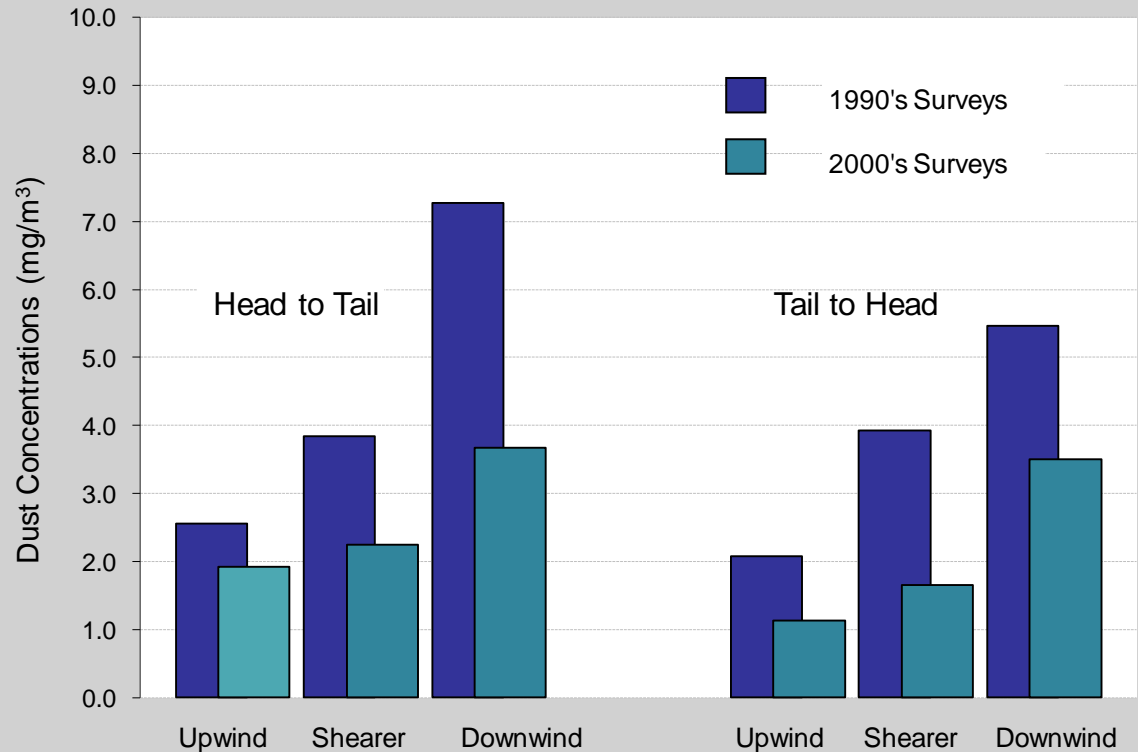
Reductions in Dust Levels 1990's vs 2000's

- Intake - 47%
- Belt - 20%
- Shield 10 - 37%
- Shield Dust - 22%
- Tailgate - 30%

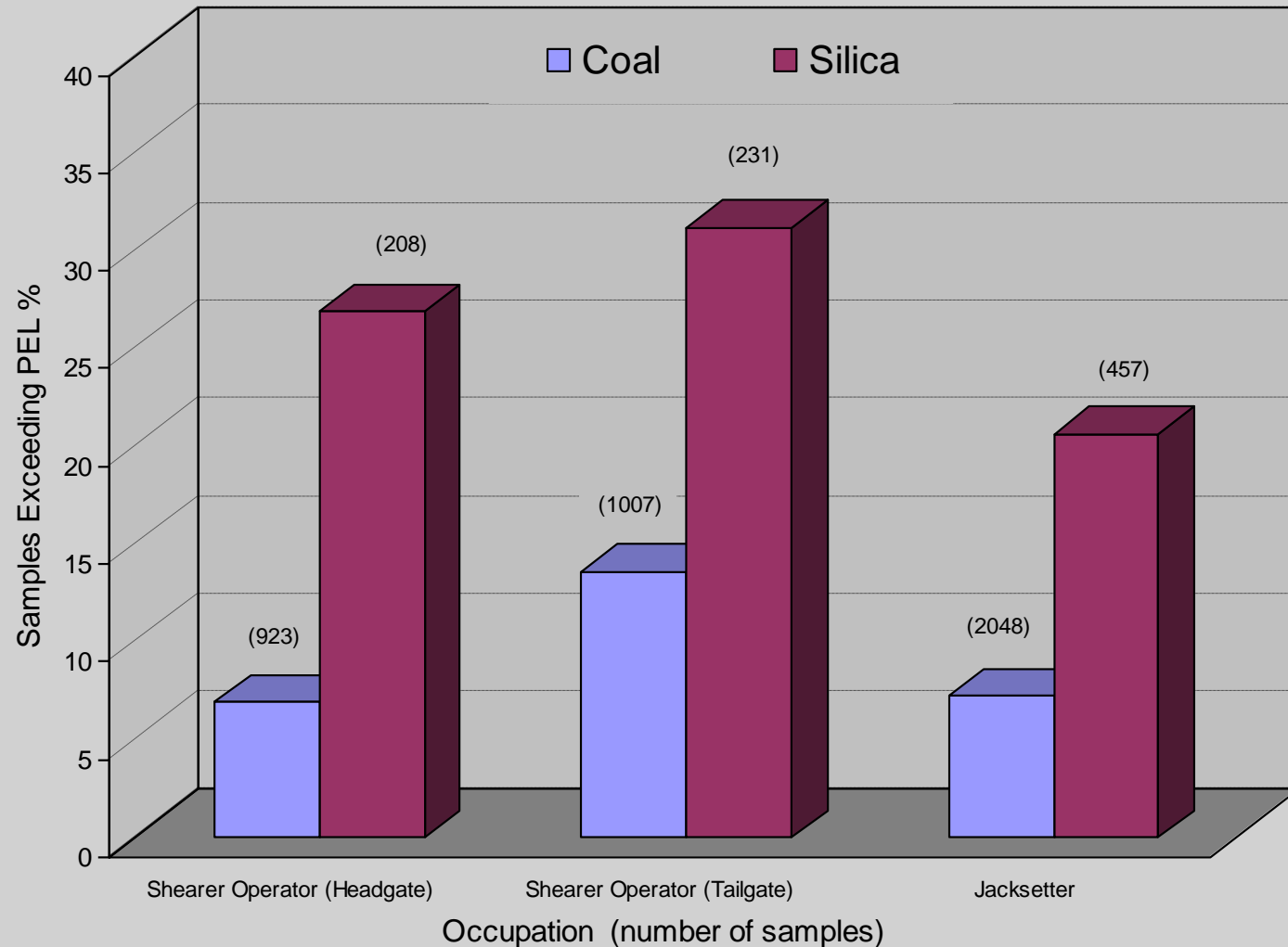


Reductions in Dust Levels 1990's vs 2000's

- H→T
 - Upwind - 24%
 - Shearer - 41%
 - Downwind - 49%
- T→H
 - Upwind - 45%
 - Shearer - 48%
 - Downwind - 36%



MSHA Inspector Samples Exceeding PEL, 2004 - 2008



Controlling Respirable Dust on Longwall Mining Operations

Topics of Discussion

- Controlling Dust On Intake Roadways
- Controlling Dust from the Belt Entry
- Stageloader/Crusher Dust Control
- Dust Control in the Headgate Entry
- Controlling Shearer Dust
- Controlling Shield Dust
- Summary - Guidelines

Recent Longwall Surveys

- Last Open Crosscut
 - Average - 0.20 mg/m³
 - 70 % of longwalls below 0.25 mg/m³
- Belt Sampling Location
 - 6 longwalls utilizing belt air
 - Ranged between 0.30 - 0.72 mg/m³
- Intake Dust Level
 - Average - 0.23 mg/m³
 - Ranged between 0.03 - 0.44 mg/m³
- Shield 10 Dust Levels
 - Good indication of dust entering face from outby sources
 - Average - 0.70 mg/m³
- Stageloader/Crusher Area
 - 0.47 mg/m³



Controlling Dust on Intake Roadways

Limit support activities during production shifts

- Vehicle movement
- Removal of stoppings
- Delivering / unloading of supplies



Controlling Dust on Intake Roadways

Water Application

- Maintain moisture content at approximately 10 %
- Operators must diligent in monitoring moisture content

Salts

- Apply calcium and magnesium chloride to increase surface moisture

Utilize Surfactants

- Beneficial in maintaining proper moisture content
- Decrease surface tension
- More uniform wetting of the dust particles



Controlling Dust from the Belt Entry

Wetting of the Coal Product - With the substantial increase in airflow rewetting of the coal may be necessary along the belt

- Flat or full cone sprays
- Quantity - 1 to 4 gpm
- Pressure - 50 -60 psi



Controlling Dust from the Belt Entry

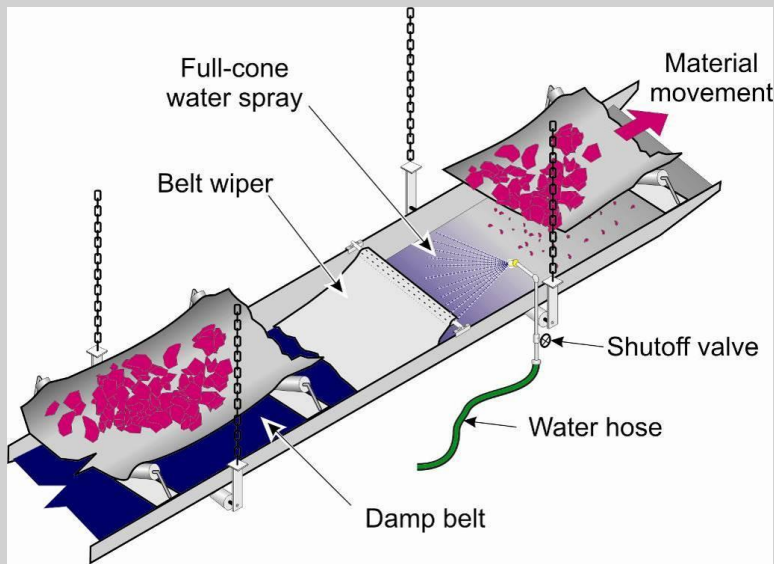
Belt Maintenance - Missing rollers, belt slippage, and worn belts can cause belt misalignment and create spillage



Controlling Dust from the Belt Entry

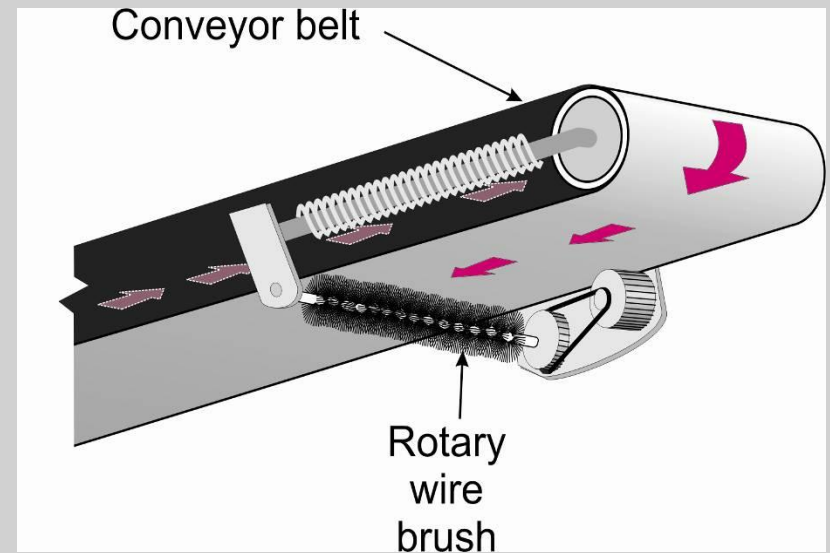
Wetting of the Belt

Full cone spray on top surface of non-conveying side belt followed by material to wipe belt and remove dust fines



Rotary Brush

Clean the conveying side of the belt



Controlling Dust from the Belt Entry

Belt Cleaning – The top and bottom of the belt should be cleaned with spring-loaded or counter-weight scrapers

- Slightly moisten belt with low quantity sprays to complement the scrapers
- Water sprays in conjunction with scrapers have the potential to reduce dust level along the belt



Stageloader/Crusher Dust Control

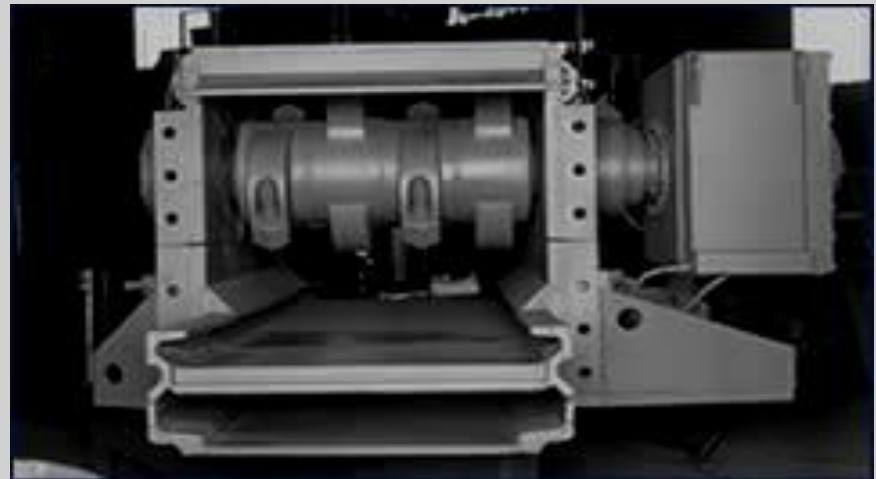
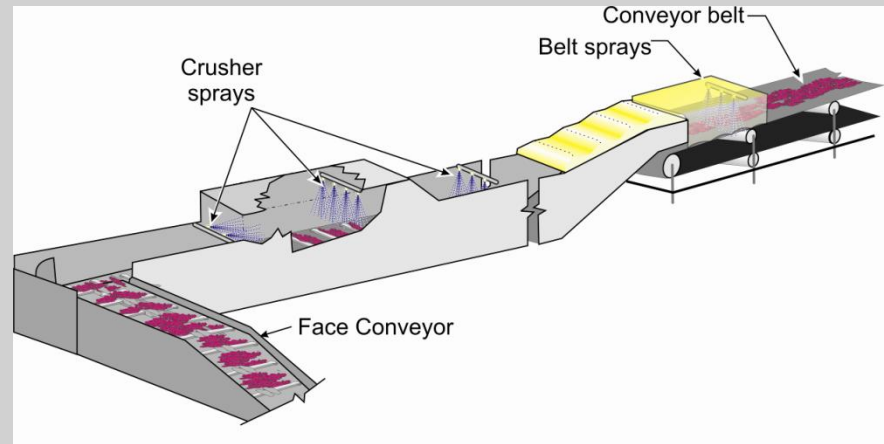
- Stageloader/crusher are fully enclosed
- No universally applied technique
- Combination of steel plates
- Conveyor belting at entrance and discharge area
- Imperative that seals and skirts be maintained
- Scrubbers



Stageloader/Crusher Dust Control

Crusher and Belt Transfer Sprays

- Typical spray locations
 - Entrance
 - Above crusher hammer
 - Discharge area
 - Belt transfer area
- Spray bar spans the width
- 3-4 full cone sprays
- 8-10 gpm
- Water quantity over pressure
- Water pressure ≤ 60 psi



Stageloader/Crusher Dust Control

Scrubbers

- Crusher discharge
- Belt transfer area
- Capacity – 6500 – 8500 ft³/min
- Potential to create negative pressure in the stageloader/crusher to minimize dust from leaking out

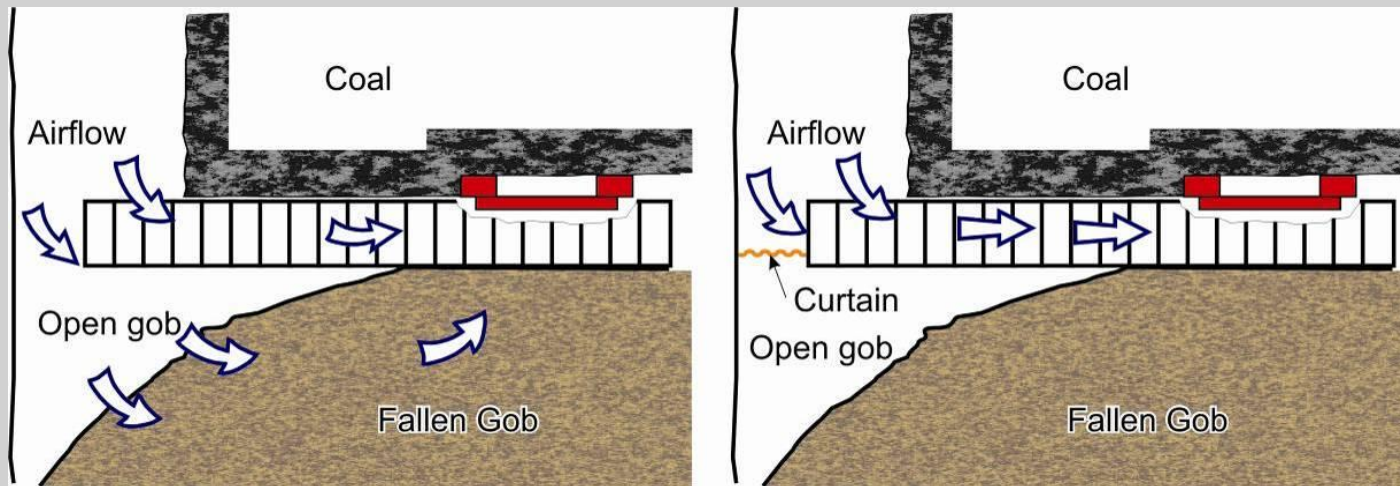


High Pressure Water-Powered Scrubber

-

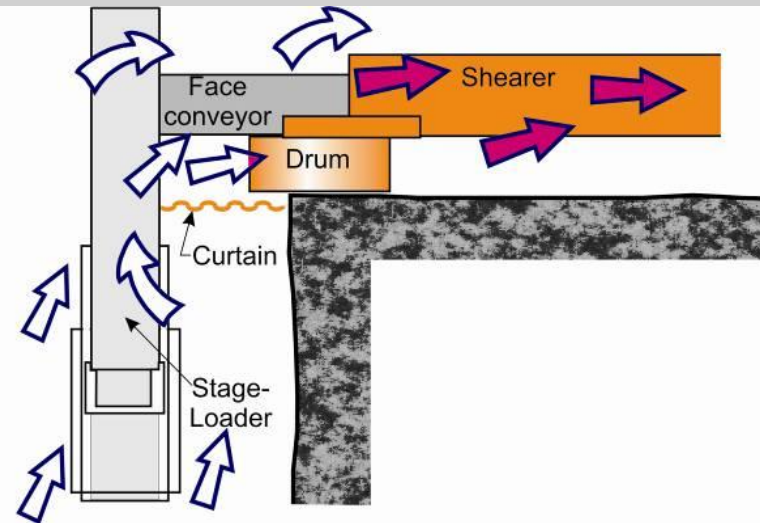
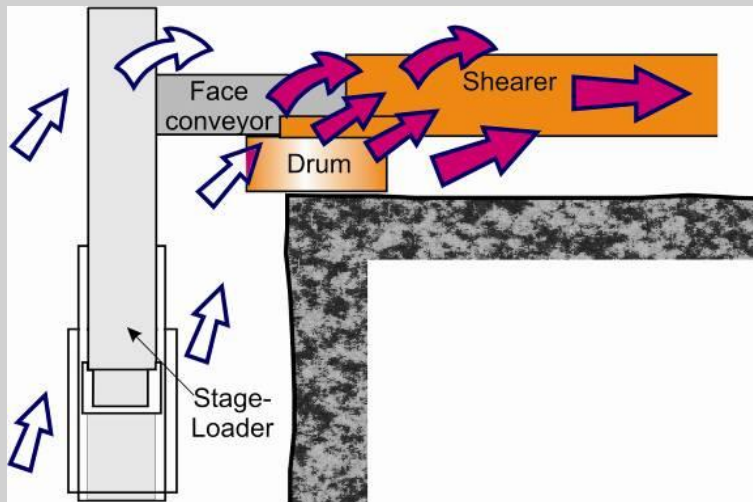
Dust Control in the Headgate Entry

Installation and maintenance of a gob curtain



Dust Control in the Headgate Entry

Installation of a wing or cut-out curtain between and panel-side rib and the stageloader

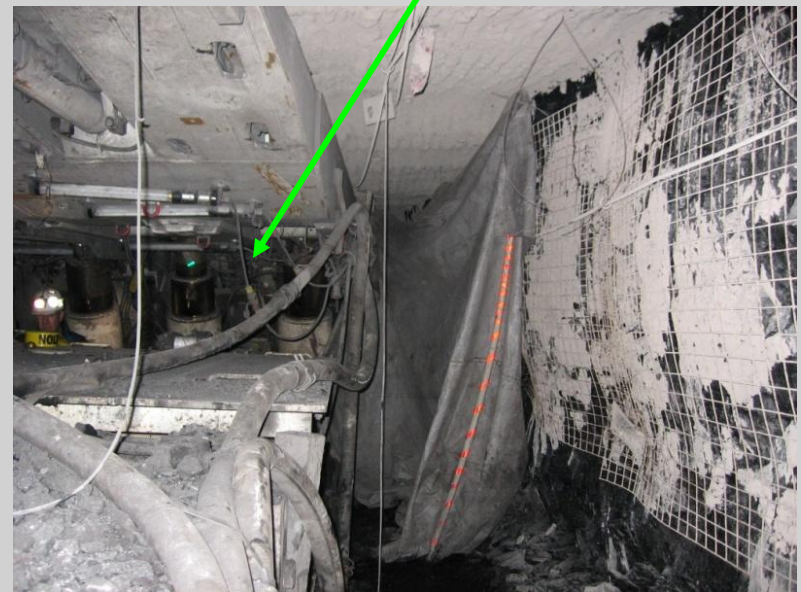


Dust Control in the Headgate Entry

Position face personnel outby as headgate drum cuts out into headgate entry

- Drum is exposed to the primary airstream
- Dust levels as high as 20.0 – 30.0 mg/m³ for a short duration
- Position face personnel near shields 1 and 2 and further outby
- Recent surveys – Concerted effort to move outby cutout area

Location of face workers



Dust Control in the Headgate Entry

Deflection barriers in headgate area

- Belting attached to underside of shields 1-4
- Belting attached to top of conveyor drive
- Aids in turning air down the face
- Protects face personnel from flying rock

Location of deflection barriers



Recent Longwall Surveys

- T → H Upwind Dust Levels
 - Ranged between 0.38 – 1.87 mg/m³
 - Average – 1.12 mg/m³
 - Increase of 0.43 mg/m³ compared to dust levels at shield 10
- Possible Cause
 - Face spalls, conveyor dust, dust migrating from gob area
 - Ensure sufficient wetting of coal as air velocities increase



Recent Longwall Surveys

- H→T Shield Advances
 - Shearer activated
 - Advanced 2-5 shields outby HG drum
 - Only major dust source between stageloader/crusher and shearer
 - H→T upwind samples increased 1.05 mg/m³ when compared to T→H upwind samples



Shields Advanced Outby Shearer Upwind Dust Levels

H→T - 2.17 mg/m³

T→H - 1.12 mg/m³



Recent Longwall Surveys

- Isolating HG Drum Dust
 - Difference between upwind and shearer dust levels
 - H→T increase - 0.32 mg/m³
 - T→H increase - 0.51 mg/m³
 - HG drum is exposed to airflow on T→H cuts which may increase turbulence and elevate dust levels



Average Dust Levels (mg/m³)

	Upwind	Shearer
H→T	1.91	2.23
T→H	1.13	1.64



Recent Longwall Surveys

- Shearer Generated Dust
 - Difference between upwind and downwind dust levels
 - H→T – 1.80 mg/m³
 - T→H dust levels could not be calculated because of the close proximity of shield advances
- Isolating TG Drum Dust
 - Difference between shearer and downwind dust levels
 - H→T increase - 1.48 mg/m³



Average Dust Levels (mg/m ³)			
	Upwind	Shearer	Downwind
H→T	1.91	2.23	3.71
T→H	1.13	1.64	

Controlling Shearer Dust

Face Ventilation – Principal method of controlling respirable dust on longwall faces

Previous studies :

- 400 - 450 ft/min minimum velocity to control respirable dust
- 700 – 900 ft/min velocity shown to be effective when moisture content of dust is 5 to 8 %



Controlling Shearer Dust

Drum Mounted Water Sprays

- Dust suppression directly at the point of coal fracture
- Adds moisture to minimize dust liberation
- Optimum pressure 80 -100 psi
- Full cone or solid stream spray pattern
- Larger orifices increase water quantity while decreasing pressure



Controlling Shearer Dust

Drum Mounted Water Sprays

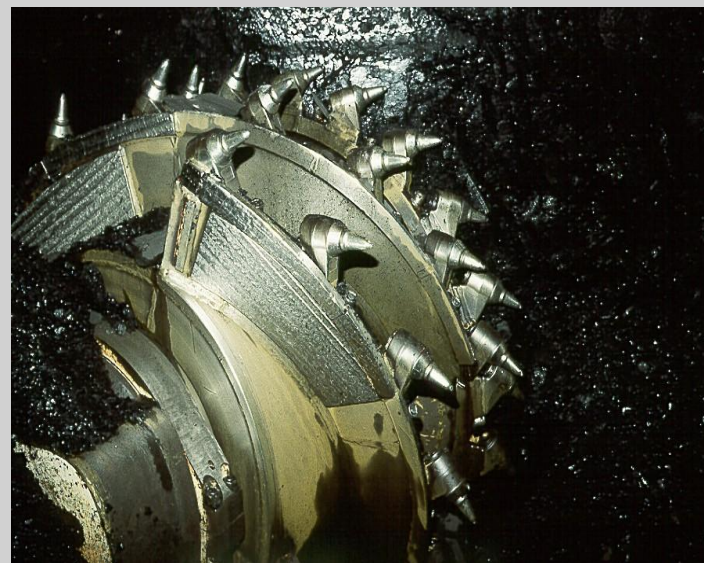
- Observed spray pressure ranged between 100 – 160 psi
- Number of sprays per drum ranged between 35 - 62
- Water spray pressure greater than 100 psi can increase dust levels as much as 25 %



Controlling Shearer Dust

Cutting Drum Maintenance

- Bits with large carbon inserts and a smooth transition between shank and carbide reduce dust levels
- Replacing damaged, worn or missing bits can not be over-emphasized
- Dull bits result in shallow cutting and greatly increases dust generation



Controlling Shearer Dust

Crescent Sprays

- Located on the top and end of ranging arms
- Sprays oriented toward face
- Observed on 50% of recently survey longwalls 8 – 10 sprays



Controlling Shearer Dust

Crescent Sprays

- Use caution if sprays are utilized on the headgate ranging arm
- Sprays on the end of ranging arm are oriented into the face airflow
- Can create turbulence that force dust toward the walkway



Controlling Shearer Dust

Directional Water Spray Systems

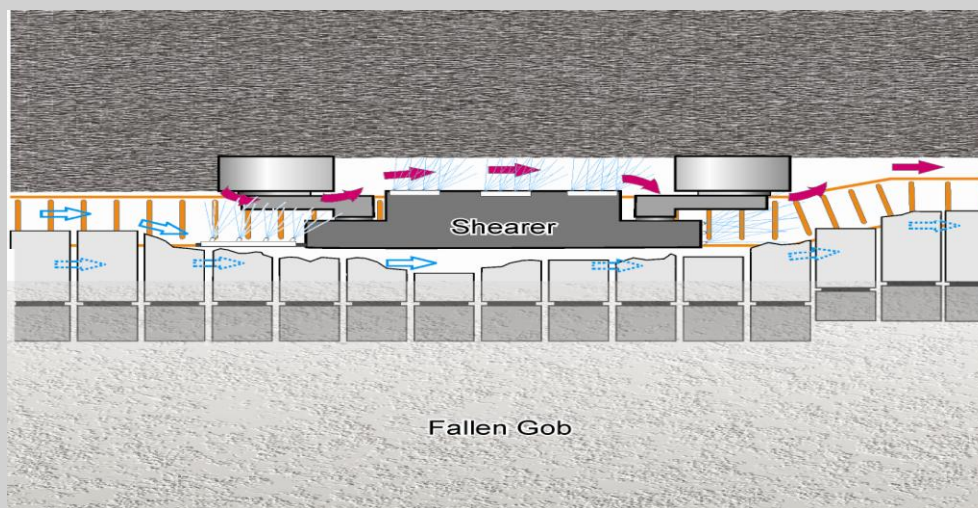
- Water sprays are very effective air movers
- If applied properly can compliment primary airflow to reduce shearer-generated dust
- Spray systems with nozzles directed upwind may force dust away from the face and into the walkway



Controlling Shearer Dust

Initial directional spray system → shearer clearer spray system

- Shearer mounted sprays oriented downwind
- One or more passive barriers help split the airflow around the shearer
 - Air split initiated by the splitter arm
 - Splitter arm sprays induce airflow and dust toward face
 - Conveyor belt forms a physical barrier



Controlling Shearer Dust

Splitter Arms

- Extend as far beyond the headgate drum as possible
- Sufficient number of sprays to prevent dust from migrating into walkway
- Hollow cone or venturi sprays
- Water pressure at least 150 psi



Controlling Shearer Dust

Splitter Arms (recent surveys)

- Unique to each mine operation
- Length – 5 to 14 ft
- 3 – 20 sprays
- 2 splitter arms utilized venturi sprays
- Spray orientation
 - Perpendicular
 - 30 - 45 degrees toward panline
 - 30 – 45 degrees up



Controlling Shearer Dust

Splitter Arms (recent surveys)

- Built to withstand coal and rock impact from face spalls
- Splitter arm extensions oriented at a 30 - 45 degrees toward face
 - Length – 2 to 4 ft
 - 3 – 5 sprays



Controlling Shearer Dust

Splitter Arm Belting

- Conveyor should be suspended the length of the splitter arm
- Provides a physical barrier



Controlling Shearer Dust

Splitter Arm Belting

- Tears and gaps in the conveyor belting greatly compromise the effectiveness of the splitter arm



Controlling Shearer Dust

Splitter Arm Gob-Side Spray Bar

- Locate sprays on the walkway side of splitter arm
- Direct sprays down the side of the belt
- High capacity low pressure flat-fan sprays evenly spaced the length of the splitter arm



Controlling Shearer Dust

Splitter Arm Underside Sprays

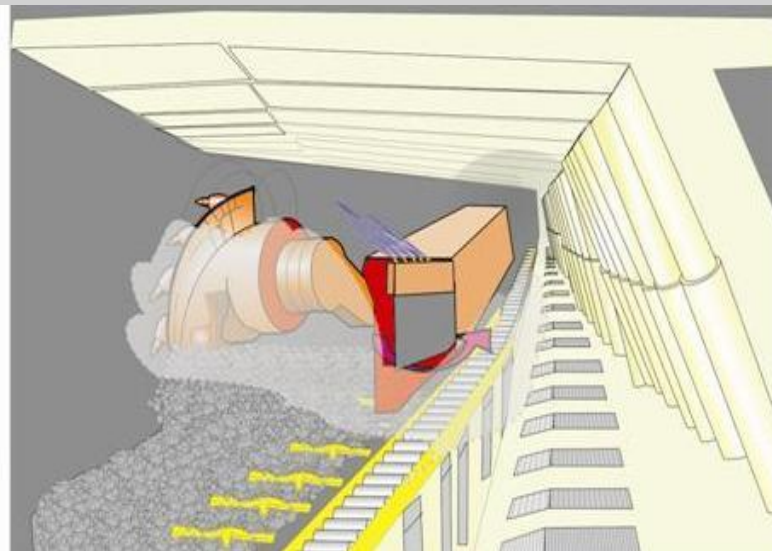
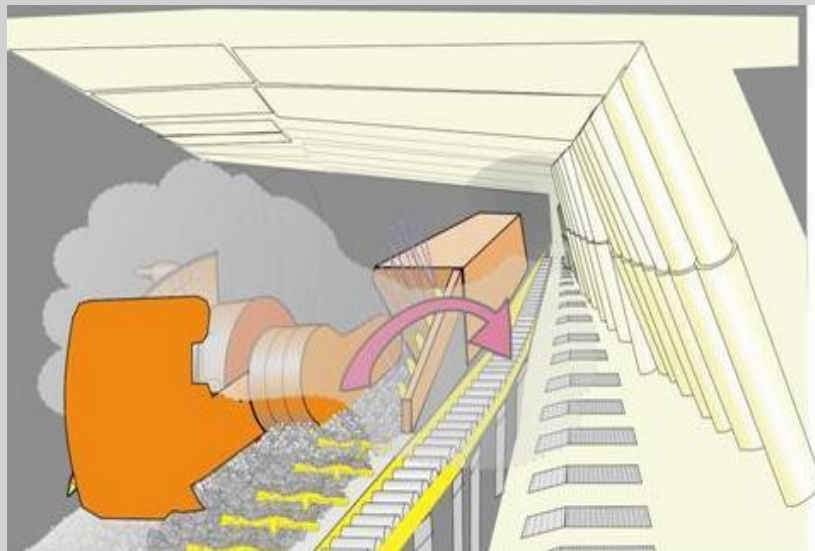
- Locate sprays on underside of the splitter arm
- Direct sprays down the face side of the belt
- Reduce dust rolling under or through the splitter arm
- Adds more water to the coal to reduce conveyor dust
- Because of turbulence in the area spray pressure is critical



Controlling Shearer Dust

Positioning of the Splitter Arm

- Position of the splitter arm may allow dust to migrate into the walkway
- Maintaining the splitter arm near parallel is critical to keep dust from boiling into the walkway



Controlling Shearer Dust

Shearer Sprays

- Spray manifolds positioned between the drum
- Promotes movement of dust-laden air close to the face and prevents migration toward the walkway
- Oriented with airflow



Controlling Shearer Dust

Shearer Sprays

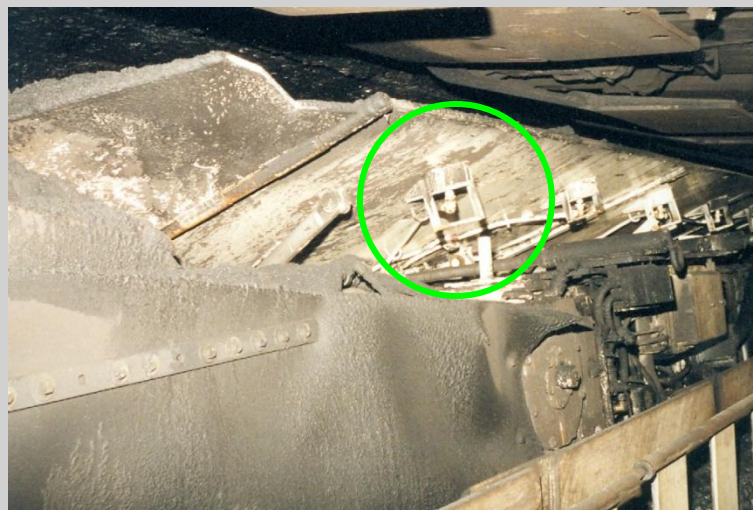
- 3 or 4 manifolds evenly spaced the length of the shearer
- 3 to 5 sprays per manifold
- Manifolds location
 - Face side of shearer
 - Top of shearer



Controlling Shearer Dust

Deflector Plates

- Observed at western mines
- Primary function is to protect operators from flying debris
- Provide a physical barrier that can enhance the effectiveness of the directional spray system
- Equipped with water sprays
 - Evenly spaced the length of the deflector plate



Controlling Shearer Dust

Deflector Plates

- Operators have to be diligent in turning off the sprays when in the down position
- If sprays operational, spray plume is directed upward, strikes the underside of the shields creating turbulence
- Potentially allowing dust to migrate into the walkway



Controlling Shearer Dust

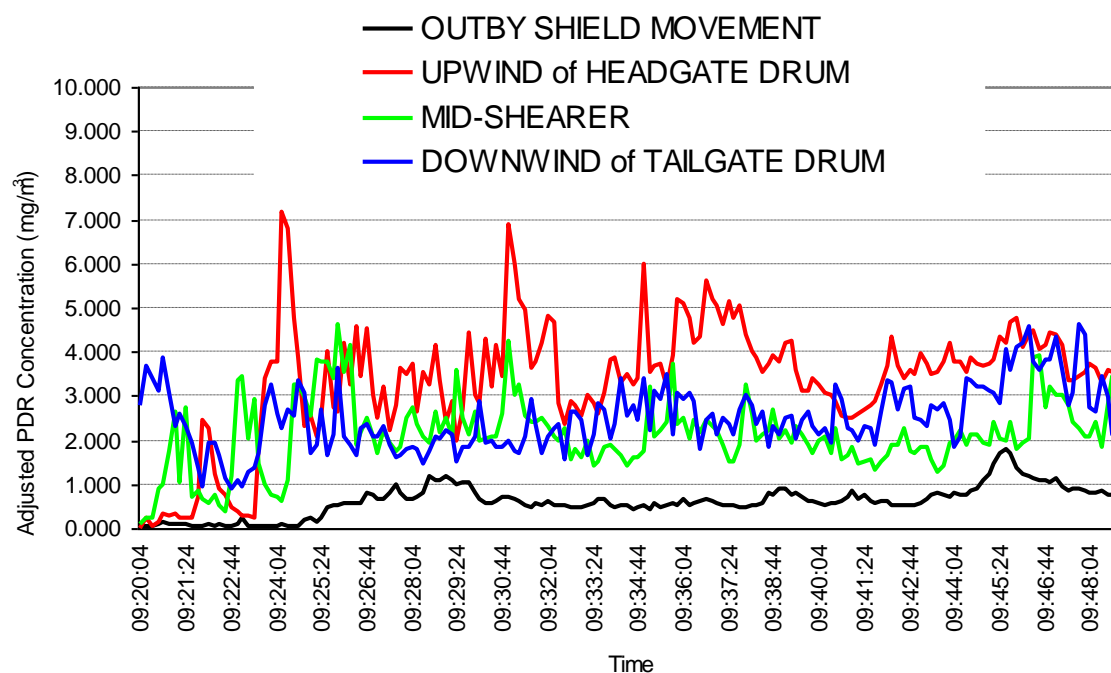
Tailgate Side Sprays

- Spray manifold mounted on tailgate end of shearer
- Oriented parallel to ranging arm and angled slightly toward drum
- Confines dust-laden air to face and carries it beyond the tailgate drum



Controlling Shield Dust

- Automated and usually are initiated within 3-5 shields of trailing drum
- Can be a significant source of dust exposure when shields are advanced upwind of shearer
- Concerted effort to rotate jacksetter operators outby



Controlling Shield Dust

- Canopy-Mounted Sprays Systems
 - Activated on top of shields
 - Hard to maintain
- Air Dilution
 - High velocities should increase dilution of shield dust
 - Has the potential to entrain more dust because of the relatively dry shield dust
 - Advance as far upwind as possible when advancing shields on head to tail cuts
 - May allow for dilution
- Depending on roof conditions consider using uni-directional cutting sequence



Controlling Shield Dust

Shield Sprays on the Underside of the Canopy

- Observed on recent longwall surveys
- Automatically activated by shearer to create a moving water curtain
- 1 or 2 rows of sprays per shield
- Located between the tip of the shield to an area above the spill plate
- Spray activation and de-activation sequencing was mine specific



Controlling Shield Dust

Shield Sprays on the Underside of the Canopy

- Proper sequencing is critical
- Observed shield sprays interacting with splitter arm sprays creating turbulence
- Dust and mist cloud rolled into walkway
- Properly aligned sprays directed toward the face with sufficient water pressure and volume have the potential to be an effective method at controlling dust levels



Control Guidelines - Outby

- Minimize intake/belt dust
- Confine stageloader/crusher dust
- Quantity of water in crusher
- Gob curtain at HG and beyond
- Locate face personnel outby during HG cutout
- Shield advance/cutting sequences to minimize exposures of high risk workers

Control Guidelines - Shearer

- Optimize cutting parameters (bits, rpm)
- Maximize water quantity to drums (larger orifice nozzles)
- Drum spray pressures @ 100 psi or less
- External sprays @ 150 psi or higher
- Caution using crescent sprays on HG drum

Control Guidelines - Shearer

- HG splitter arm
 - Extend beyond HG drum as far as possible
 - Align sprays with airflow
 - Maintain belting
 - Splitter arm parallel with HG drum
- Maintain shearer sprays
- Deflector plate as high as possible
- Utilize TG side manifold sprays
- Shearer operators positioned as far upwind as possible

Control Guidelines - Shields

- Underside canopy shield sprays
 - Potential to be an effective method at reducing shearer dust
 - Proper sequencing of sprays
 - Proper alignment
 - Spray water pressure and volume
- Advance shields as far away from shearer as possible depending on roof conditions
- Consider uni-directional cutting sequence
- Concerted effort to rotate jacksetter operators outby

Commitment to Dust Controls

- Worker and management involvement
 - Knowledge and attitude
 - Safety => immediate / Health => long term

Maintenance is critical



Questions?

Jim Rider

412-386-4727

jrider@cdc.gov

Jay Colinet

412-386-6825

jcolinet@cdc.gov