Controlling Respirable Dust on Longwall Mining Operations
Impact of Overexposure to Respirable Coal Dust

1970 – 2004
Direct or contributing cause of death for 69,377 underground miners

1980 – 2005
Over $39,000,000,000 in CWP benefits paid to miners and their families
MSHA Inspector Samples Exceeding PEL, 2004 - 2008

Occupation (number of samples)

- Shearer Operator (Headgate)
  - Coal: 923
  - Silica: 208
- Shearer Operator (Tailgate)
  - Coal: 231
  - Silica: 1007
- Jacksetter
  - Coal: 457
  - Silica: 2048

Samples Exceeding PEL %
Longwall Production

2004 – 187.9 million tons
2005 – 188.1 million tons
2006 – 180.5 million tons
2007 – 176.1 million tons
2008 – 179.2 million tons
Longwalls

Panel Widths

1994 -- 750 ft
2002 -- 940 ft
2007 -- 984 ft
2008 -- 1043 ft

Panel Lengths

1994 -- 7000 ft
2002 -- 10,000 ft
2007 -- 10,206 ft
2008 -- 10,749 ft
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
• Alternate Dust Control Technology
• Summary - Guidelines
Controlling Dust on Intake Roadways

**Air Quantity**
Average – 67,000 ft$^3$/min

65 % increase when compared to the 1995 longwall study

**Last Open Crosscut**
Average – 0.2 mg/m$^3$
Maximum – 0.42 mg/m$^3$
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

Apply water or hydroscopic compounds to control road haulage dust

- Moisture content - Approximately 10%
- Operators - Diligent in monitoring moisture content
- Hydroscopic compounds such as calcium and magnesium chloride increase surface moisture
Controlling Dust on Intake Roadways

Utilize Surfactants

- Beneficial in maintaining proper moisture content
- Decrease surface tension
- Better and more uniform wetting of the dust particles
Controlling Dust from the Belt Entry

Complements Intake Air – Provides for the potential for better dust and methane dilution

Recent Longwall Surveys

- 40% utilized belt air
- Average - .47 mg/m$^3$
- Maximum - .72 mg/m$^3$
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 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 psi
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
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.
- Waters sprays in conjunction with scrapers have the potential to reduce dust level along the belt.
Controlling Dust from the Belt Entry

Rotary Brush – Clean the conveying side of the belt
Stageloader/Crusher Dust Control

Recent Longwall Surveys - 0.26 - 0.99 mg/m$^3$ from outby sources
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
- Scrubber technology
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 ft$^3$/min
- Potential to create negative pressure in the stageloader/crusher to minimize dust from leaking out
Stageloader/Crusher Dust Control

High Pressure Water-Powered Scrubber

- Alternative to fan-powered scrubber
- Contaminated air drawn through five tubes with sprays attached
- Demisted through a wave blade demister
- Operating pressure at least 1000 psi
- Water powered therefore intrinsically safe and minimal maintenance
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 the 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 – 30 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
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 motors
- Aids in turning air down the face
- Protects face personnel from flying rock

Location of deflection barriers
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 surveyed 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 forces 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 the 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

- Belting 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

![Graph showing adjusted PDR concentration over time](image)

- **OUTBY SHIELD MOVEMENT**
- **UPWIND of HEADGATE DRUM**
- **MID-SHEARER**
- **DOWNWIND of TAILGATE DRUM**
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
**Alternate Dust Control Technologies**

**Ventilated Drums**
- Design to reduce dust at the fracture point
- 12 water-powered capture tubes built into the hub of the shearer
  - High pressure water (at least 1000 psi) released from face side ring manifold
  - Induces dust laden-air
  - Deflector plate attached to the cowl prevent water from operator

**Foam Discharge from Shearer Drum**
- Discharge compressed-air foam through 10 to 12 large diameter nozzles located in the shearer drum
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 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