Approach to Dust Control

- **Minimize dust liberation**
  - Cutting
  - Wetting
  - Enclosures

- **Direct dust clouds away from workers**
  - Air velocity
  - Directional sprays
  - Barriers or avoidance

- **Reduce airborne dust levels**
  - Dilution
  - Capture
Minimize Dust Generation

Drum Design
- water distribution
- water quantity
- bit lacing
- vanes
- rpm
Impact of reduced cutting rpm

Dust reduction, %

70 – 35 rpm

67 – 45 rpm

Longwall

Continuous miner
Improved Cutting Methods
Bit Designs Tested on Continuous Miners
Differences in quartz and coal dust levels
Preferred bit design

- Slender profile
- Small carbide
- High wear rate
- High dust levels

- Intermediate profile
- Large carbide
- Low wear rate
- Low dust levels

- Fat profile
- Irregular transition
- Shank rubs
- High dust levels
Impact of Water Sprays on Dust

- **Suppression** *(volume)*
- **Redirection** *(pressure)*
- **Capture** *(type & pressure)*
SPRAY TYPES

Hollow cone

Full cone

Solid stream

Flat fan

Air atomizing

CDC

NIOSH
Shearer water spray systems

- Drum sprays (wetting)
- External sprays (directional)
Spray Quantity More Important Than Pressure in Drum Sprays

- Operate at maximum of 100psi
- Use larger orifice nozzles to increase spray quantity to drum
- Full-cone or solid stream spray patterns
Stageloader-Crusher Controls:
- confine and wet with sprays
- volume more important than pressure
Confine Crusher-Stageloader Dust

Spray Manifold

Enclosed

CDC

NIOSH
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Higher Velocities Confine Dust Near Face
Added Benefit of Increased Airflow

Uncontrolled or intermittent sources....
Air Velocities on Longwall Faces
(44 vent plans from 2000 – 2003, 9 NIOSH surveys)
Directional Sprays (Shearer Clearer)

A

Headgate splitter arm

Tailgate splitter arm

B

Fresh air

Dusty air

Operator

CDC

NIOSH
Key components of a shearer clearer spray system
Design considerations for an effective shearer-clearer spray system

- Splitter arm length
- Spray angle and pressure (150 psi)
- Physical barriers - belting/plate
- Splitter arm height
Spray manifold in lieu of tailgate splitter arm

Tailgate ranging arm

Face conveyor
Effective directional spray systems
Ineffective directional spray systems
Caution: crescent sprays on headgate ranging arm
Approach to Dust Control

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  – Air velocity
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• Reduce airborne dust levels
  – Dilution
  – Capture
Maximize Air Flow to Longwall Face
Airborne Dust Capture With Sprays

<table>
<thead>
<tr>
<th>Spray Type</th>
<th>100 psi</th>
<th>150 psi</th>
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<tbody>
<tr>
<td>Atomizing</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Hollow Cone</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>Full Cone</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Flat Fan</td>
<td>60</td>
<td>50</td>
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</tbody>
</table>

Relative Effectiveness

Pressures:
- 100 psi
- 150 psi
Scrubbers on stageloader/crusher

Stageloader to belt transfer

Crusher
Primary Dust Controls for Longwalls

- **Ventilating Air**
  - Dilution (quantity)
  - Removal (velocity)
- **Water Sprays**
  - Suppression (volume)
  - Redirection (pressure)
  - Capture (type)
- **Dust collectors**
Maximize benefit of available controls...
Effective Water Management

Utilize available water to optimize dust control
Ongoing Longwall Dust Control Research

Benchmarking Surveys

• Quantify dust from major sources

• Identify controls and level of application

• Provide suggestions for improved dust control

• 9 surveys completed with 1 - 2 more desired
Sampling to isolate and quantify dust sources

Stationary sampling
- Intake
- Belt
- Shield 10
- Tailgate

Mobile sampling
- Outby
- Upwind
- Shearer
- Downwind
Dust contribution from shield advance increasing
Impact of shield advance on shearer operator dust levels

Relative Dust Concentration (mg/m$^3$)

- Head to Tail Pass
- Tail to Head Pass
Dust Entrainment in High Velocity Airstreams

- Simulate entrainment of dust during shield advance
- Testing at air velocities from 400 to 1600 fpm
Percent of Respirable Dust in Airborne Samples

![Graph showing the percentage of respirable and total dust in airborne samples at different air velocities.](image)

- **Respirable Dust:**
  - 400 fpm: 7.9%
  - 800 fpm: 9.1%
  - 1200 fpm: 14.5%
  - 1600 fpm: 16.9%

- **Total Dust:**
  - 400 fpm: 14.8%
  - 800 fpm: 18.2%
  - 1200 fpm: 29.0%
  - 1600 fpm: 33.8%

**Dust concentration, mg/m³**

**Air velocity, fpm**
- Examine spray applications for shield dust
- Develop improved external sprays for high coal faces
Respirable Dust Control for Continuous Mining Operations

NIOSH
Pittsburgh Research Laboratory
MSHA Data
2001 to 2004
17,000 personal samples

- 11% exceed the federal dust standard at the cm and roofbolter occupations
- 20% exceed a silica dust concentration of 100µg/m³
Water sprays on continuous miners

Function:
- Suppress/wet
- Redirect
- Capture

Effectiveness:
- Flow rate
- Pressure
- Spray type
Wetting/Suppression

- flat-fan sprays on top of boom
- deluge sprays under boom
- throat sprays
- Flow rate most important
Sprays close to cutting head
Redirecting/Moving Air

- Shovel sprays
- Blocking sprays
- Spray-fan system
  - methane control
  - reduced effectiveness on dust control
- Pressure/location important
Blocking Sprays

- Contains dust beneath boom
- Lower dust levels at operator and around machine
Airmoving Effectiveness

Spray type

<table>
<thead>
<tr>
<th>Spray Type</th>
<th>75 psi</th>
<th>150 psi</th>
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<tbody>
<tr>
<td>BD3-3</td>
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<tr>
<td>BD8-1</td>
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<tr>
<td>GG-3</td>
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<td>GG-3009</td>
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<td>VV-1510</td>
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<tr>
<td>VV-2510</td>
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</tbody>
</table>
The best front spray puts water only where it is needed, and induces minimum air movement.
Airborne Dust Capture

Spray Type

![Graph showing the relationship between water flow and dust knockdown for different spray types.]

- Dust knockdown, %
- Water flow, gpm
- BD3-3
- BD8-1
- GG-3
- GG-3009
Flooded-bed Scrubbers Capture and Remove Airborne Dust
Filters Tested

30-layer
20-layer
10-layer
Bottle brush
15-layer
Bondina
Clean and maintain scrubber filter
Clean the demister and sump
Continuous Miner Dust Control Research
Evaluate impact of sprays and scrubber on dust and gas for different operating parameters.
Wet head cutting technology

- Locates water sprays directly behind cutting bits
- Benefits – reduce frictional ignition frequency and reduce dust
Most boom sprays plugged for wethead machine
Test conditions

- baseline sprays
- wet head sprays with scrubber
- wet head sprays without scrubber
Wet Head Miner Sprays

- 1 machine (wethead vs regular)
- 73 small orifice solid stream sprays at 95 psi
- 27 external sprays at 150-185 psi
- 50 gpm
Respirable dust, mg/m³

- Regular sprays+scrubber
- Wet head sprays+scrubber

- Intake
- Miner op
- Return
Redirected scrubber exhaust - Colorado operation
Roof Bolter Dust Control
Operator Overexposures

- Poor maintenance of vacuum dust collector
- Cleaning out collector compartment
- Working downwind of miner
Eliminate Leaks in Vacuum System
Clean the dust box:
- frequently
- carefully (avoid exposure)
Cleaning the filter
Predump Dust Shroud
Reusable brattice bag controls dust during box cleaning

- Bag fills with dust during bolting
- Dump bag against rib
- Controls silica exposure
Silica dust levels when cleaning dust box

Ave. Tray = 712 ug/m³

Ave. Bag = 302 ug/m³
Disposable collector bag

- Manuf. By Wildwood Industries
- Used with Fletcher bolters
- Must be used with predump
Bolter Bag Lab Study

- Simulated roof bolter drilling dust collector
- 60 tests (30 with bag installed and 30 without bag)
- 50 lbs of ground limestone per minute for each test
- Sampling: RAM1, APS, Canister filter loading, Pressure drop across filter
Collector Box Tests Without Bag

Before

After

Pittsburgh Research Laboratory
Collector Box Tests With Bag

Before

After
Filter Weight Gain per Test

Filter Weight Gain, Bag vs. Bagless

- Bag
- Bagless

Test number
Canister Filter Loading

Total weight on filter, Bag vs Bagless

- **Bag**
- **Bagless**
Lab Results – Collector Emissions

- Dust concentration: 2 times higher when bag not installed
- Total dust particle counts 2 times greater without bag in place
- Canister filter loading greatly reduced with bag in place
- Pressure drop across filter: 3.0 to 3.3 with bag in place, 4.0 to 8.4 without bag
Instrument Locations

Collector Box Exhaust Ports

NIOSH Personnel wearing PDM's

Bolter

Line Brattice

Check curtain

Return

Intake
Gravimetric Samples, Collector Emissions

Bolter Gravimetric Samplers Bag vs Bagless

Dust Concentration, mg/m³

Bagless

Bag
Percent Silica on Sampler Filters

Silica content averages on gravimetric filters

Silica, %

Return

Bolter

Bagless

Bag

CDC

NIOSH
Field Results

- **Gravimetric samplers:** respirable dust improved from 0.96 mg/m³ to 0.14 mg/m³ when the bag is in use.

- **Personal samples from the PDMs:** left side (exhaust side) of the bolter experienced nearly 2 times the amount of respirable dust than the right side.

- **Collector box cleaning time reduced from 4 minutes to 30 seconds.**
The canopy air curtain draws in filtered air and blows it down over the operator while drilling from beneath the canopy.
Canopy Air Curtain Components

- System consists of a filter, fan, tubing and plenum
- Filtered air is blown over the operator from beneath the canopy
Laboratory Study of CAC

- Tests of prototype showed dust reductions of 40% to 60% at an entry air velocity of 0.3 m/s (60 ft/min)
Field Testing of CAC

Machine mounted components for CAC for field testing in cooperation with J. H. Fletcher & Company

Air curtain on stiffeners

Tubing from fan

Tubing to air curtain

Tubing to filter

Pittsburgh Research Laboratory
Mine Study Results

Nearly a 50% reduction in dust levels under the air curtain

Graph showing dust levels in mg/m^3 at different locations:
- Beneath Air Curtain: Low dust levels
- Outside Air Curtain: Higher dust levels

Sampling Locations:
- Beneath Air Curtain
- Outside Air Curtain
Findings from field evaluation

- Reduced dust under air curtain
- Must keep operator under air curtain
- Must increase air curtain size and shape to increase area of protection
Continued Laboratory Testing

Modifications: Reconfigured air curtain has same dimensions and profile as roof bolter canopy for increased coverage and protection
Anticipated Benefits

- Dust exposure reductions for roof bolt operators during bolting and when down wind of CM
- Existing components can be retrofitted to current roof bolting machines
- Cooperation with J. H. Fletcher will allow for integration of system on newly produced roof bolters
Operator under air curtain
Mist Drilling

- Transmits a combination of water and compressed air through the drill steel
- Drill bit injects water/air mixture directly on cutting surface
- Utilizes an on-board air compressor and on-board water reservoir or supply hose

“Dust Hog” bit (left) vs mist drilling bit (right)
Mist Drilling

Onboard water tanks holds 110 gallons

Onboard air compressor supplies 20 cfm
Mist Drilling Mine Study

- Two roof bolting machines: one with conventional vacuum system and one with mist system
- Machines did not operate simultaneously
- Mist bolting machine worked downwind of the continuous miner
- Sampled three shifts of operation
Mist Drilling Mine Study

- Dust levels were elevated around mist drilling machine (even after accounting for increased intake dust levels)
- Mist system relies on proper balancing of air/water mixture
- Further testing required to confirm field observations

![Graph showing respirable dust levels for Mist and Vacuum bolters.](image)
Commitment to Dust Control

- Worker and management involvement
- Knowledge and attitude (safety is immediate vs. health is long term)
- Maintenance is critical
Questions or Information

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