SILICA DUST CONTROLS FOR SURFACE MINES

By John A. Organiscak
2004-2008 MSHA Dust Samples

<table>
<thead>
<tr>
<th>Mining Commodity</th>
<th>% of Dust Samples Exceeding the Standard Due to Quartz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>11 %</td>
</tr>
<tr>
<td>Metal</td>
<td>21 %</td>
</tr>
<tr>
<td>Nonmetal</td>
<td>18 %</td>
</tr>
<tr>
<td>Stone</td>
<td>13 %</td>
</tr>
<tr>
<td>Sand &amp; Gravel</td>
<td>12 %</td>
</tr>
</tbody>
</table>

***Equipment operators most frequently exceed the standard.***
Surface Mining Equipment

Drills

Bulldozers

Trucks & Loaders
BEST PRACTICES FOR SURFACE MINE DUST CONTROL

• Drill Dust Collection Systems
• Enclosed Cab Filtration Systems
• Controlling Haulage Road Dust
• Controlling Dust at the Primary Hopper Dump
1. Dry Dust Collector System
2. Wet Suppression
1. Dry Dust Collector Systems

Diagram showing the components of a dry dust collector system, including:
- Drill stem
- Stem bushing
- Drill deck
- Deck shroud
- Bail air
- Flexible inlet duct
- Filter media
- Collected dust
- Collector dump
- Dump shroud
- Fan exhaust
Dust Emissions From Dry Collection Systems
Drill Shroud Leakage

- Maintain tight shroud enclosure with the ground
- Maintain at least 3:1 collector-to bailing airflow ratio
Shroud Height Effects

CONTROL EFFICIENCY, pct

SHROUD HEIGHT, in

BE45R

BE60R
Shroud Height & Airflow Effects

Baseline

Inlet Hood

ARD, mg/m3

Shroud Gap Height, in

2:1 ratio

3:1 ratio

4:1 ratio

Baseline Inlet Hood
Adjustable Height Shroud

✓ Dust emissions below 0.5 mg/m³
Drill Stem Leakage

- Maintain good seal between drill stem and table
- Use air ring seal
Maintain Good Drill Stem and Table Seal
Air Ring Seal

☑ 41 – 70 % Dust Reduction
☑ Large Chip Elimination
Collector Dump

0.53 – 1.34 mg/m³

0.16 – 0.24 mg/m³

✓ Shroud dump discharge close to the ground
Maintain Dust Collector as Specified by Manufacturer

- 51% dust reduction after replacing broken collector fan belt
- 83% dust reduction from replacing torn deck shroud
2. Wet Suppression

- Add small amounts of water to reduce visible dust cloud
- Operational problems from excessive water
Water Separator Increases Roller Bit Life

✓ 98% With Separator
✓ 96% Without Separator
✓ Bit life increased 4.5 times

Limited to large drill stems
Smaller Drill Stem Water Separator
Smaller Drill Stem Water Separator Study

Wet vs Dry Drilling

Concentration, mg/m²

Wet

Dry
ENCLOSED CAB FILTRATION SYSTEMS

- Integrated into HVAC Systems
- Protection Factors Vary
  - Drills 2.5 to 84
  - Bulldozers 0 to 45
- Field Studies of Refurbishing Old Cabs
- Laboratory Study of Cab Filtration systems
Refurbish Cabs

- Ceiling mounted heating and AC units
- External filter and fan units
- Improve cab enclosure seals
## Enclosed Cab Field Studies

<table>
<thead>
<tr>
<th>Cab Evaluation</th>
<th>Cab Pressure Inches w.g.</th>
<th>Equivalent Wind Vel. mph</th>
<th>Inside Dust Level mg/m³</th>
<th>Outside Dust Level mg/m³</th>
<th>Protection Factor Out/In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary Drill</td>
<td>None Detected</td>
<td>0</td>
<td>0.08</td>
<td>0.22</td>
<td>2.8</td>
</tr>
<tr>
<td>Haul Truck</td>
<td>0.01</td>
<td>4.5</td>
<td>0.32</td>
<td>1.01</td>
<td>3.2</td>
</tr>
<tr>
<td>Front-End Loader</td>
<td>0.015</td>
<td>5.6</td>
<td>0.03</td>
<td>0.30</td>
<td>10.0</td>
</tr>
<tr>
<td>Rotary Drill</td>
<td>0.20 – 0.40</td>
<td>20.3 – 28.7</td>
<td>0.05</td>
<td>2.80</td>
<td>56.0</td>
</tr>
<tr>
<td>Rotary Drill</td>
<td>0.07 – 0.12</td>
<td>12.0 – 15.7</td>
<td>0.07</td>
<td>6.25</td>
<td>89.3</td>
</tr>
</tbody>
</table>

Protection Factor Out/In ascending order
Ensure Good Cab Integrity & Positive Pressurization

Hard to Seal Gaps
Utilize High Efficiency Respirable Dust Filters

- Intake filter > 95% on respirable-sized dusts
- Use an efficient recirculation filter
# Key Results of Laboratory Cab Testing

<table>
<thead>
<tr>
<th>Filters</th>
<th>Average Cab Performance Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake</td>
<td>Recirculation ?</td>
</tr>
<tr>
<td>Low $E_I$ 38%</td>
<td>No</td>
</tr>
<tr>
<td>Low $E_I$ 38%</td>
<td>Yes</td>
</tr>
<tr>
<td>High $E_I$ 99%</td>
<td>No</td>
</tr>
<tr>
<td>High $E_I$ 99%</td>
<td>Yes</td>
</tr>
</tbody>
</table>

90% Efficient Recirculation Filter Improved Both Cab Protection Factor & the Time to Reach It After the Door is Closed
Additional Benefits of Good Filtration

Clean HVAC

Dirty HVAC
Minimize Dust Sources in Cab

- Seasonal dust level increased from 0.04 to 0.68 mg/m$^3$
- Floor heater use increased dust levels from 0.03 to 0.26 mg/m$^3$

- Use good housekeeping practices
- Remove floor heaters
- Rubber mats better than carpeting
- Gritless sweeping compounds
  *non-petroleum based*
Keep Doors Closed During Equipment Operation

- 0.81 mg/m³ when briefly opened to add drill steels
- 0.09 mg/m³ with door closed
CONTROLLING HAULAGE ROAD DUST
Average Airborne Particle Size Distribution

Cascade Impactor Particle Size Ranges (microns)

Mass Fraction (%)

0.00 - 1.55  1.55 - 3.50  3.50 - 6.00  6.00 - 9.80  9.80 - 14.80  14.80 - 21.3  21.3 - 50

18.81  11.61  2.16  1.73  4.71  6.71  54.27

Average Airborne Particle Size

Distribution

[NIOSH]
Typical Gravimetric Dust Concentrations

Dust Concentration (mg/m^3)

- Respirable
- PDR
- Respirable
- Thoracic
- Total

Station A
Station B
Station C
Station D

Typical Gravimetric Dust Concentrations

[Graph showing dust concentration levels at different stations.

CDC

NIOSH]
Dust Dissipation Effect

- RESPIRABLE DUST CONCENTRATION, mg/m³

- Time Period Around Truck Passage, sec.

- ROAD BERM 50 ft

- Time Truck Exited Sampling Grid

- Total: Resp. ≈ 8 to 10:1  Thoracic: Resp. ≈ 3 to 4:1
Treatment of Unpaved Road Services

- Water effective with reapplications
- Salts, surfactants, soil cements, bitumens
  films (polymers) extend time of effectiveness
Increase Distance Between Vehicles
PRIMARY CRUSHER HOPPER DUMP
Enclose the Primary Hopper Dump

✔ Staging Curtains Reduce Dust Billowing Out
Use Water Sprays to Suppress the Dust

- Start by adding 1% moisture by weight
- Use photo cell or mechanical controlled sprays
Prevent Dust Roll Back Under Vehicle

- Tire stop reduces rollback underneath equipment
- Water sprays knockdown and redirect dust
CONCLUSIONS

- Dry and Wet Drill Dust Collection Systems Very Effective
  - Tightly sealed shroud around drill hole critical for dry systems
  - Wet systems can increase bit wear, problematic in cold climates
  - Assumes quality control and maintenance programs

- Cabs Can Provide a 10- to 50-Fold Dust Reduction
  - Good filtration system
  - Tightly sealed cab for achieving positive pressurization
  - Assumes quality control and maintenance programs

- Road Dust Can Effectively be Mitigated by Routine Wetting

- Enclosed Hopper Dumps Contain Dust → Spray Capture
Questions or Comments?

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