SILICA DUST CONTROLS FOR SURFACE MINES

By John A. Organiscak

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2004-2008 MSHA Dust Samples

Mining Commodity	% of Dust Samples Exceeding the Standard Due to Quartz
Coal	11 %
Metal	21 %
Nonmetal	18 %
Stone	13 %
Sand & Gravel	12 %

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

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Surface Mining Equipment

Drills

Bulldozers

Trucks & Loaders

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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

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DRILL DUST COLLECTION SYSTEMS

1. Dry Dust Collector System
2. Wet Suppression

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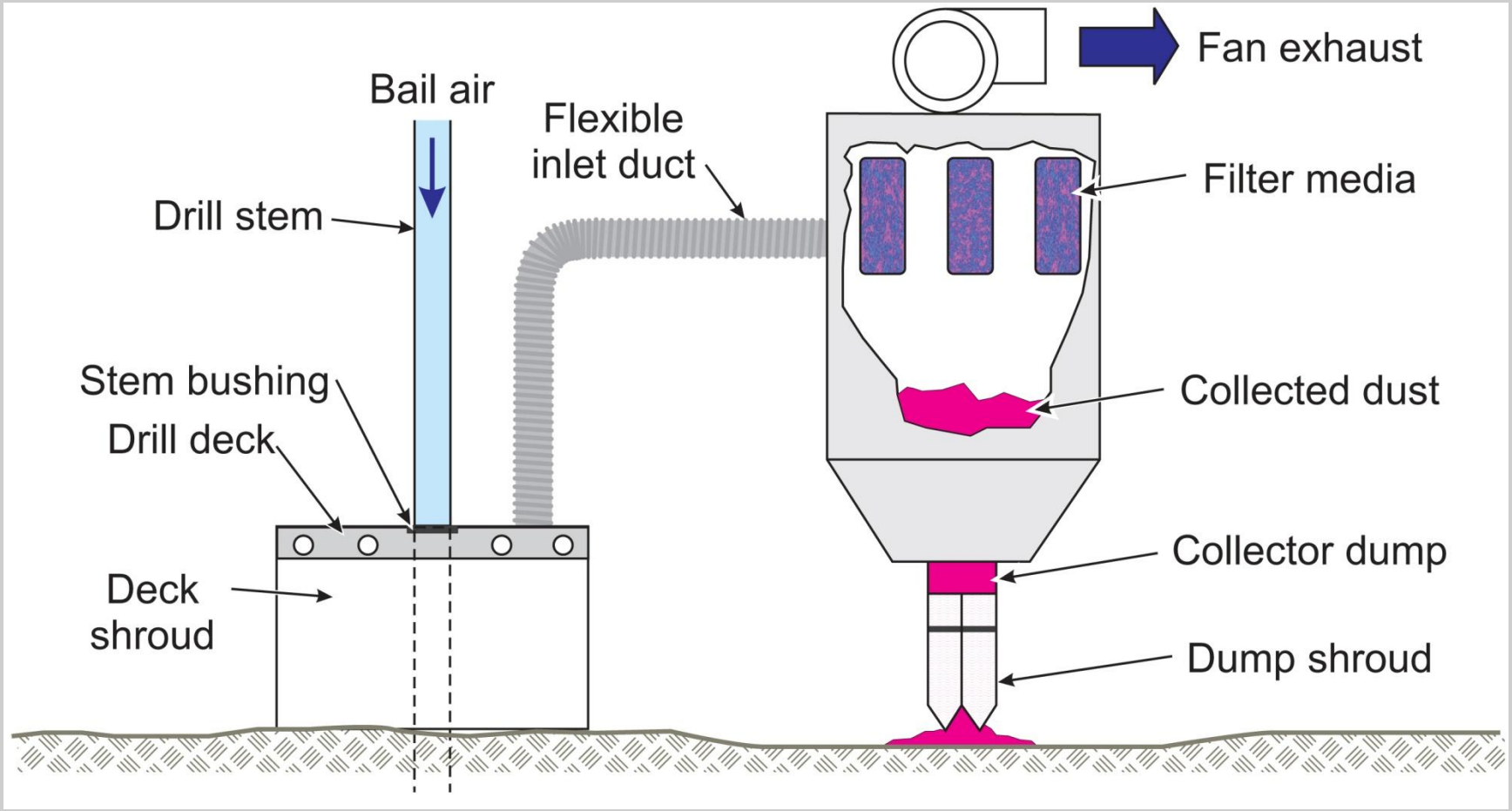
1. Dry Dust Collector Systems



Dust Emissions From Dry Collection Systems

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➢Drill Shroud Leakage

✓Maintain tight shroud enclosure with the ground

✓Maintain at least 3:1 collector-to bailing airflow ratio

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Shroud Height Effects

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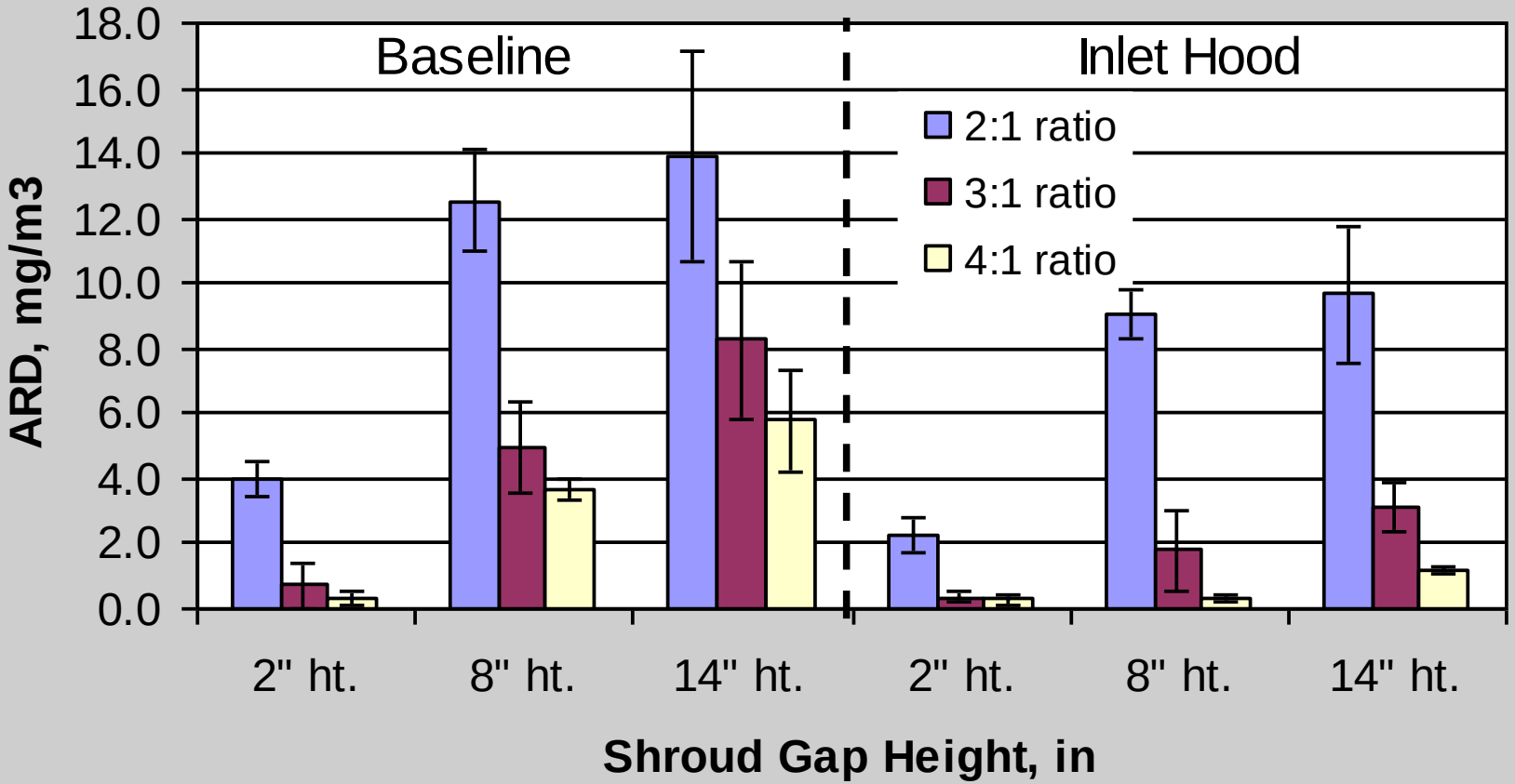
Shroud Height & Airflow Effects



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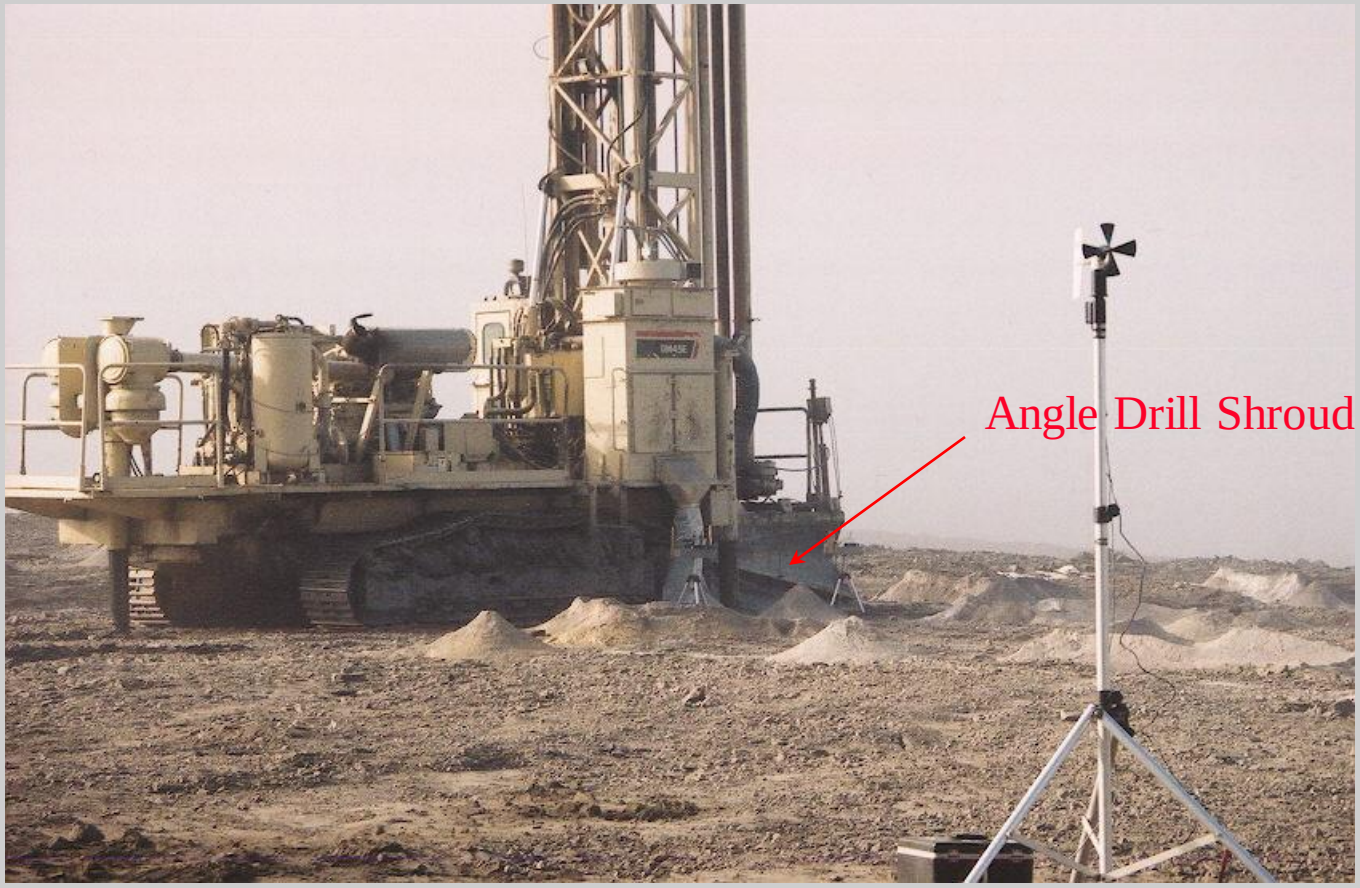
Adjustable Height Shroud



✓Dust emissions below 0.5 mg/m^3

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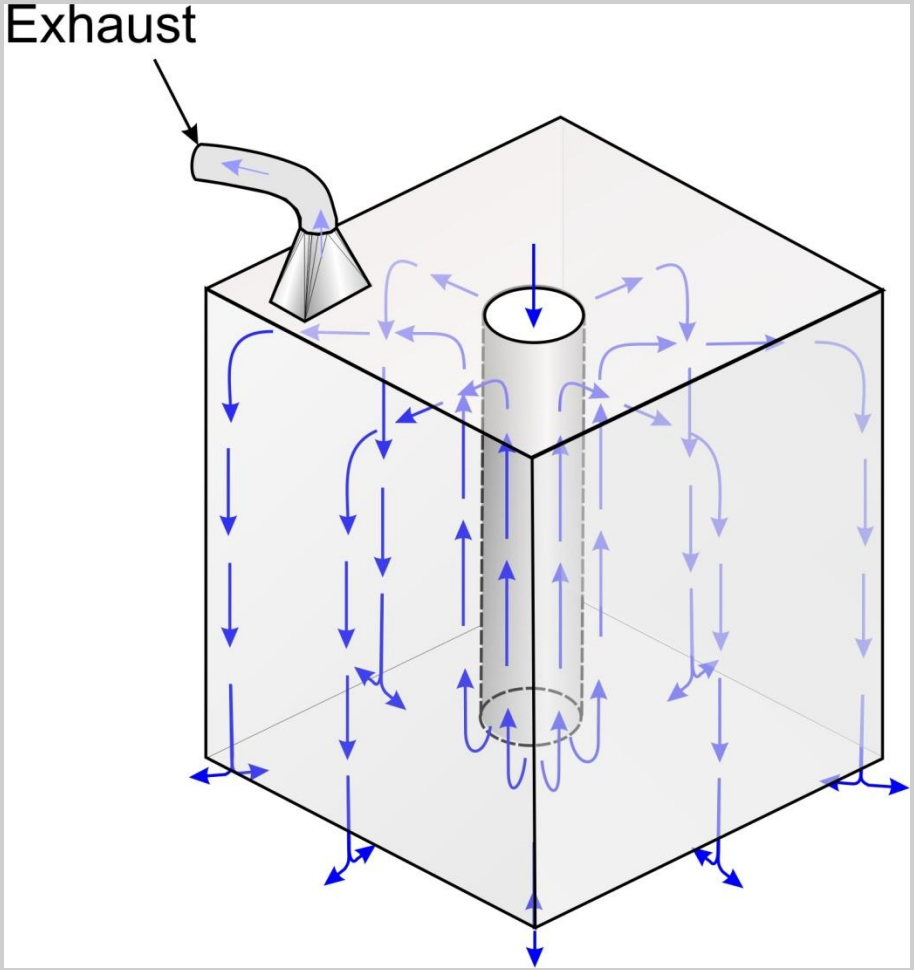
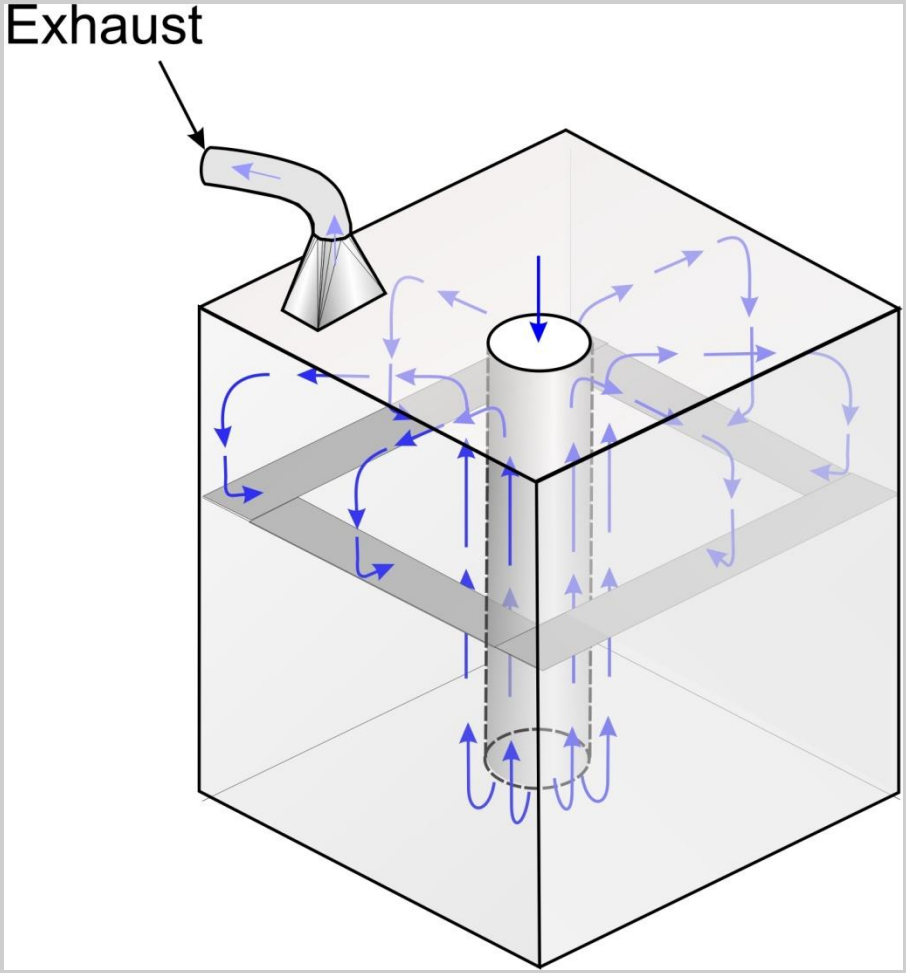
Horizontal Shelf Laboratory Testing





80% Dust Reduction @ 2:1 Collector to Bailing Air Flow Ratio

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Horizontal Shelf Field Testing

Examining More Robust Retrofit Shelf Designs

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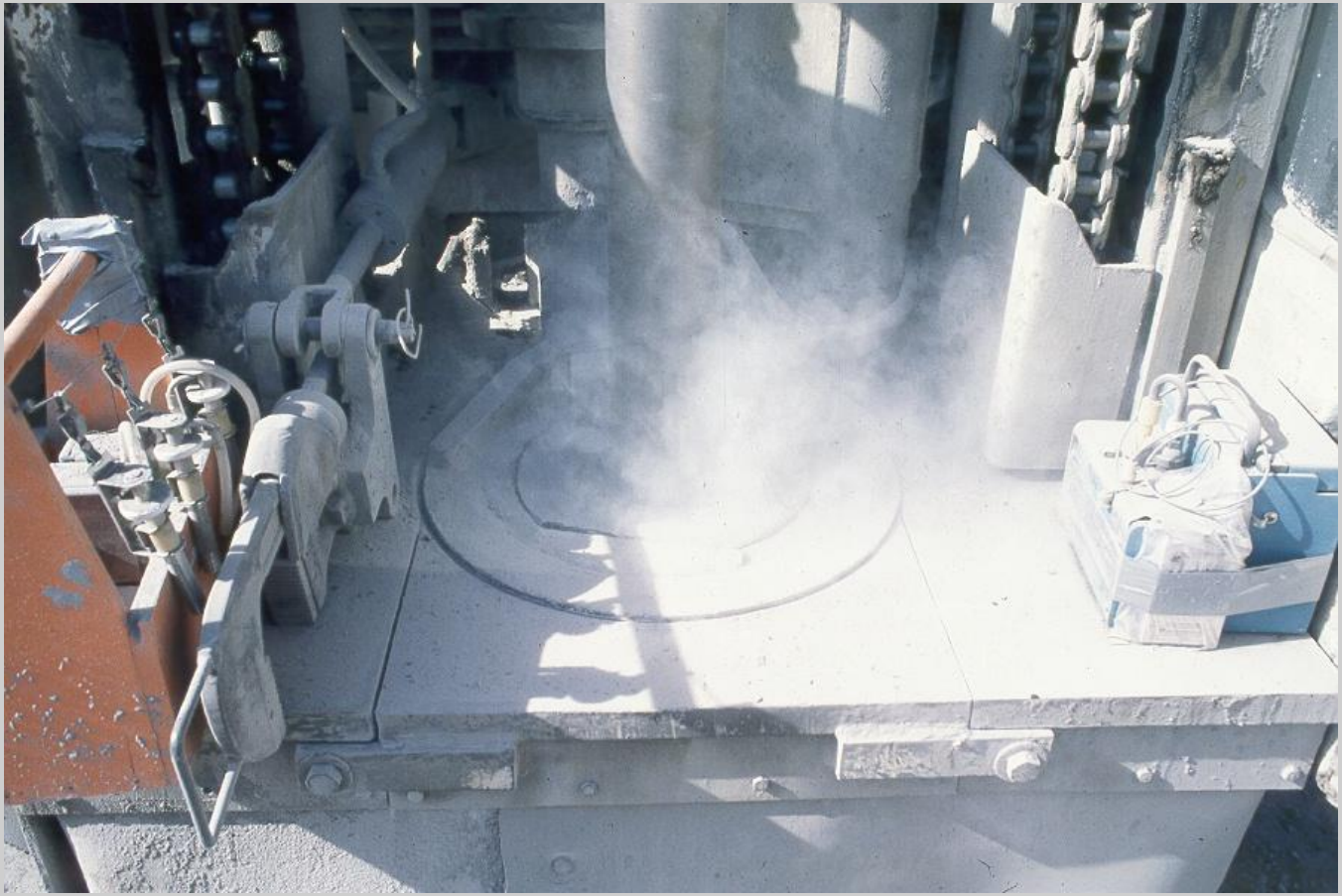
➢Drill Stem Leakage



✓Maintain good seal between drill stem and table

✓Use air ring seal

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Maintain Good Drill Stem and Table Seal

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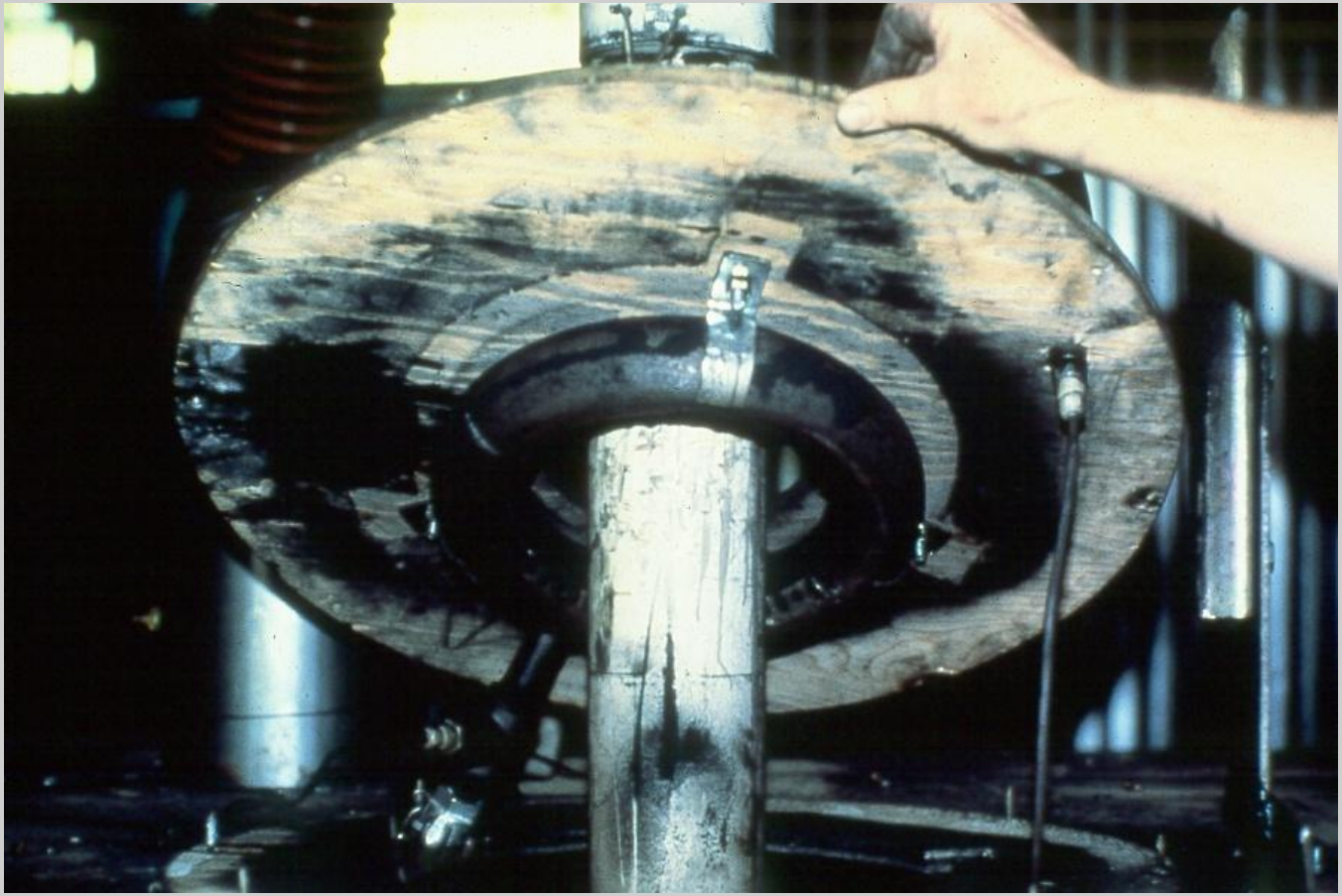
Air Ring Seal



- ✓ 41 – 70 % Dust Reduction
- ✓ Large Chip Elimination

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➢Collector Dump

✓Shroud dump discharge close to the ground

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Maintain Dust Collector as Specified by Manufacturer

- ✓ 51% dust reduction after replacing broken collector fan belt
- ✓ 83% dust reduction from replacing torn deck shroud

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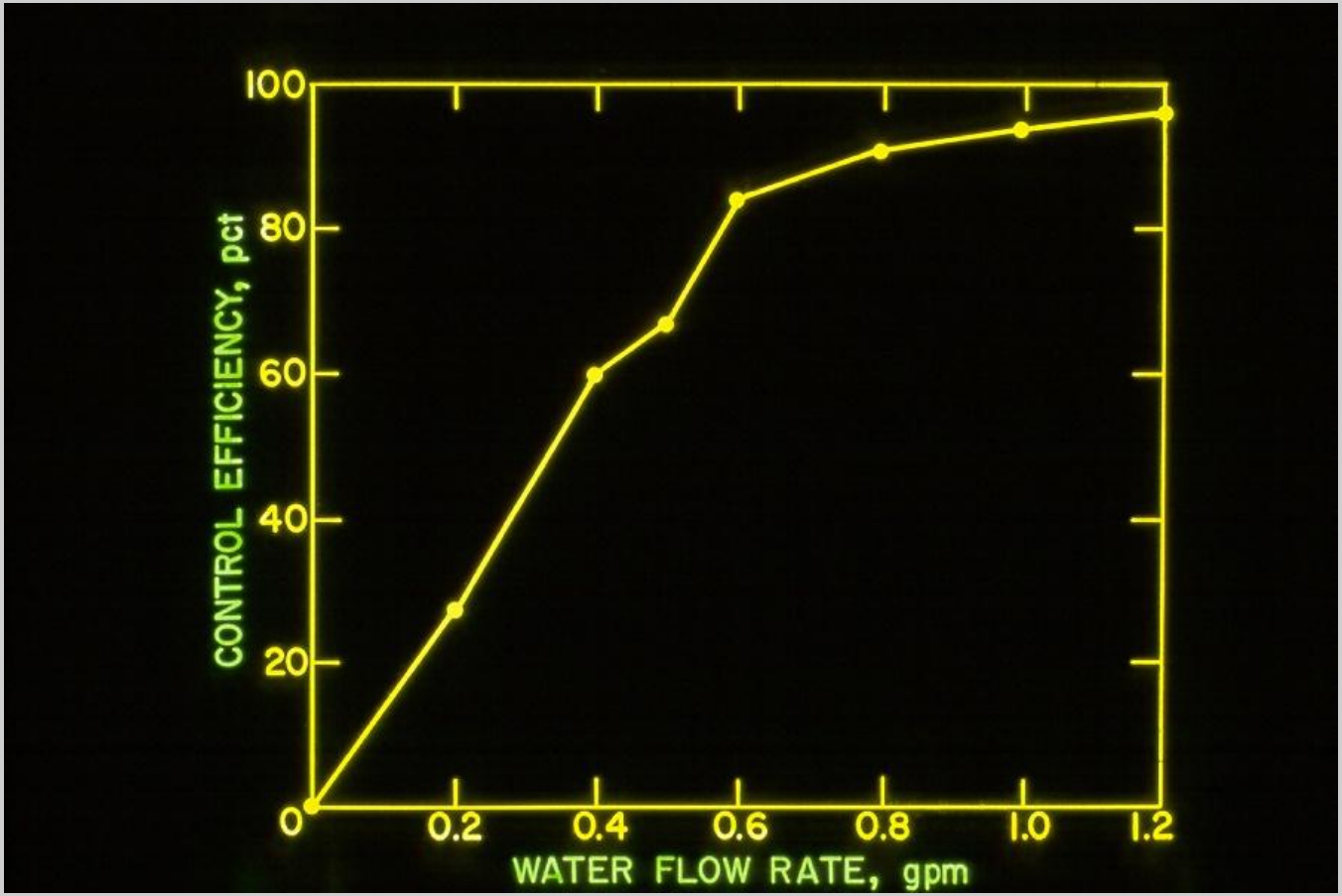
2. Wet Suppression



- ✓Add small amounts of water to reduce visible dust cloud
- ✓Operational problems from excessive water

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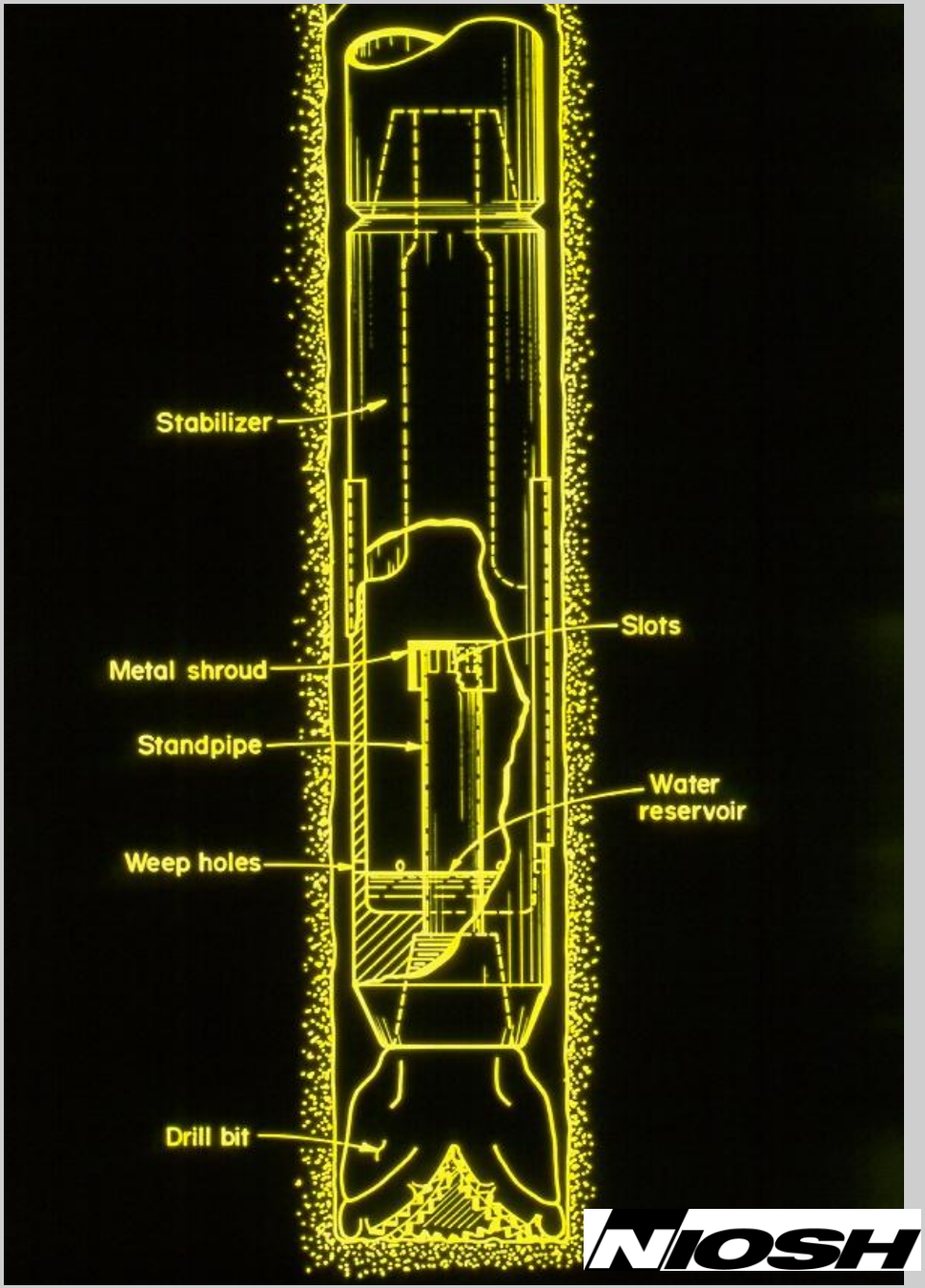
Water Separator Increases Roller Bit Life

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

Limited to large drill stems



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Smaller Drill Stem Water Separator

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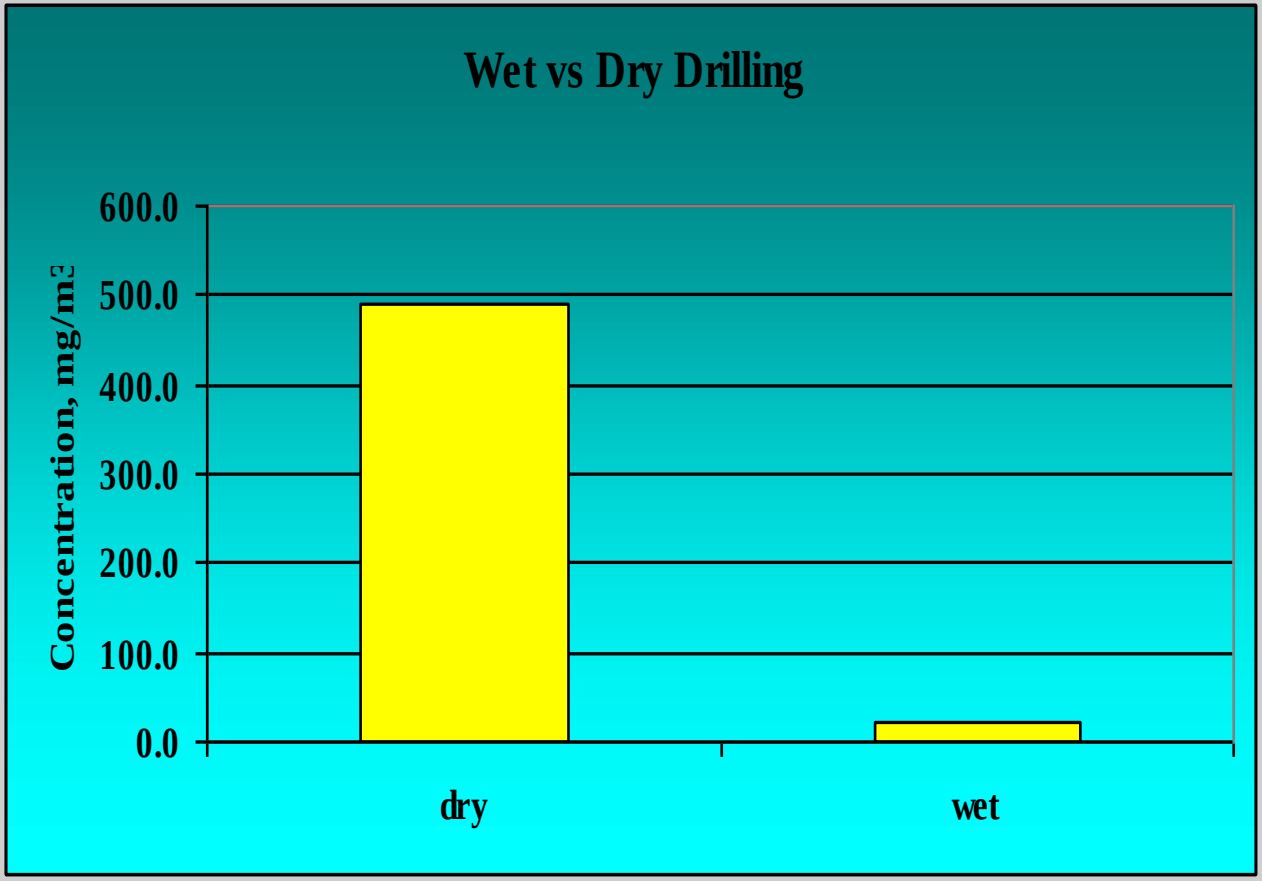
Smaller Drill Stem Water Separator Study



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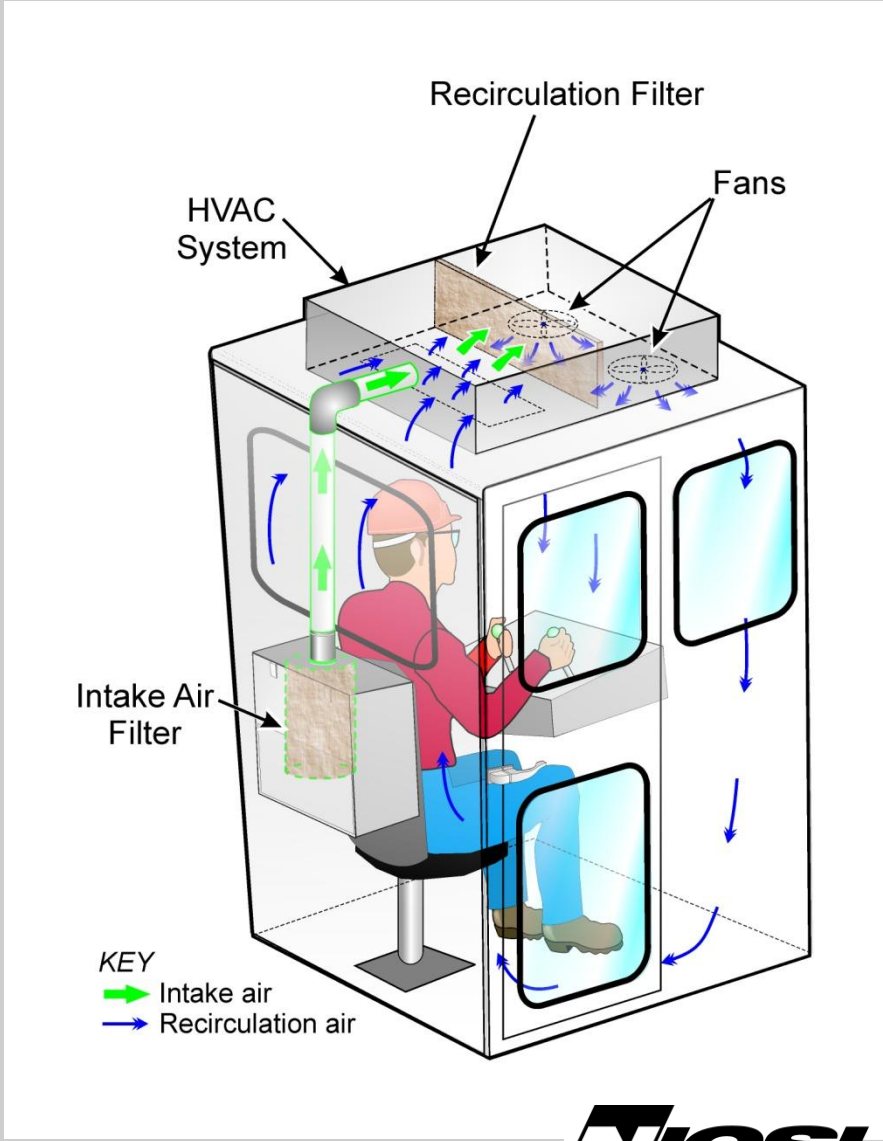
ENCLOSED CAB FILTRATION SYSTEMS

- 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



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Refurbish Cabs

- Ceiling mounted heating and AC units
- External filter and fan units
- Improve cab enclosure seals

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Enclosed Cab Field Studies

Cab Evaluation	Cab Pressure Inches w.g.	Equivalent Wind Vel. mph	Inside Dust Level mg/m^3	Outside Dust Level mg/m^3	Protection Factor Out/In
Rotary Drill	None Detected	0	0.08	0.22	2.8
Haul Truck	0.01	4.5	0.32	1.01	3.2
Front-End Loader	0.015	5.6	0.03	0.30	10.0
Rotary Drill	0.20 – 0.40	20.3 – 28.7	0.05	2.80	56.0
Rotary Drill	0.07 – 0.12	12.0 – 15.7	0.07	6.25	89.3

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Ensure Good Cab Integrity & Positive Pressurization

Hard to Seal Gaps

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Utilize High Efficiency Respirable Dust Filters

- ✓Intake filter ≥ 95% on respirable-sized dusts
- ✓Use an efficient recirculation filter

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Key Results of Laboratory Cab Testing

Filters		Average Cab Performance Parameters						
Intake	Recircu-lation ?	*PF* C_{out}/C_{in}	Q_{intake} cfm	Δp_{filter} "w.g.	L % Q_i	Q_{recir} cfm	Δp_{cab} "w.g.	Stability min
Low E_I *38%*	No	1.7	37.3	0.30	2.0	366	0.17	17
Low E_I *38%*	Yes	13.4	41.0	0.47	2.6	328	0.19	8
High E_I *99%*	No	13.3	18.1	0.52	3.6	386	0.07	29
High E_I *99%*	Yes	168.4	23.2	0.70	4.9	338	0.08	8

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

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Cab Mathematical Model

$$PF = \frac{C_{outside}}{C_{inside}} = \frac{Q_I + Q_R \eta_R}{Q_I\left(1 - \eta_I + l\eta_I\right) + Q_w}$$ (Ideal Conditions)

Where:

Q_I - Intake air quantity into the cab ($Q_I > 0$), volume per unit time

η_I - Intake filter efficiency ($\eta_I < 1$), fractional

l - Intake air leakage, fractional portion of intake air quantity

Q_R - Recirculation filter airflow, volume per unit time

η_R - Recirculation filter efficiency, fractional

Q_W - Wind quantity infiltration into the cab, volume per unit time

Organiscak JA and Cecala AB. Doing the Math: The effectiveness of enclosed-cab air-cleaning methods can be spelled out in mathematical equations. **Rock Products, October 2009, pp. 20-22.**

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Cab Model Calculations

1) Baseline Design: Q_I = 40 ft^3/min, Q_R = 200 ft^3/min, η_I = 0.95, l = 0, and η_R = 0; PF = 20

2) With a 5% air leak around the intake filter gasket: l = 0.05; PF =10

3) Adding a 75% efficient recirculation filter: η_R = 0.75; PF = 49

4) A 75% efficient recirculation filter without a 5% leak: l = 0; PF = 95

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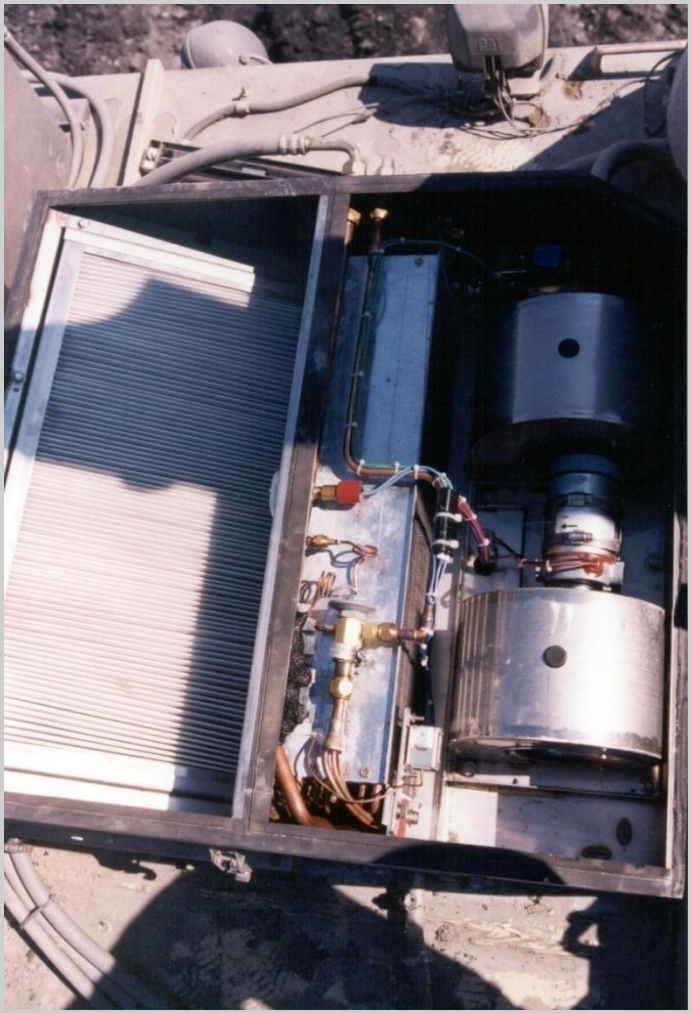
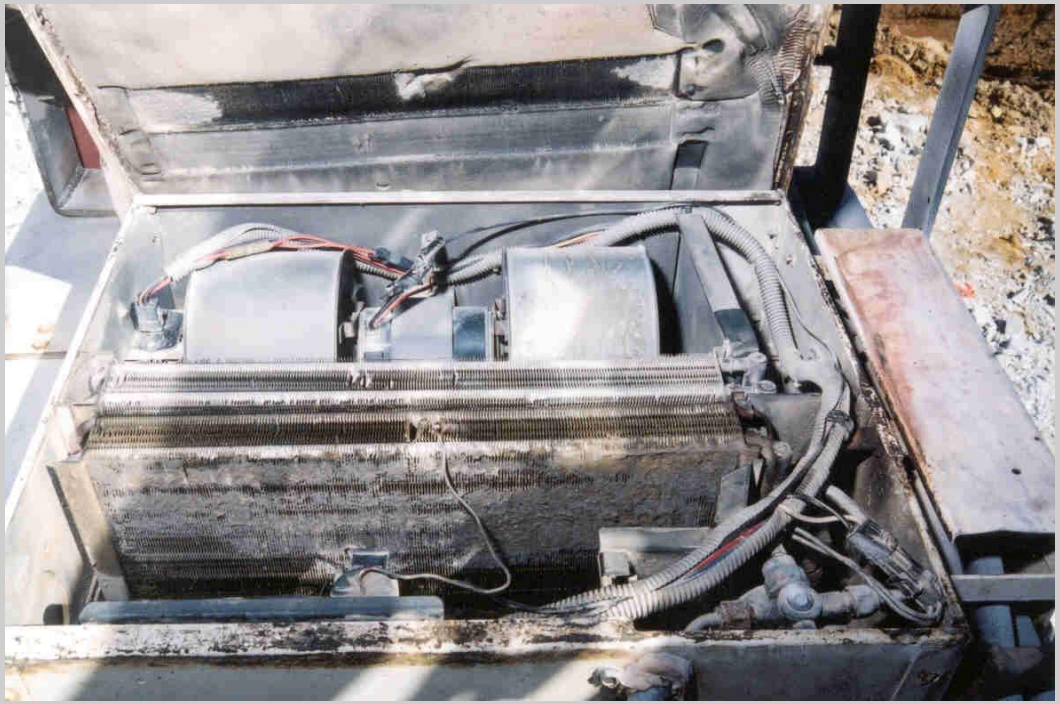
Additional Benefits of Good Filtration



Clean HVAC



Dirty HVAC

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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

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Keep Doors Closed During Equipment Operation

- ✓0.81 mg/m^3 when briefly opened to add drill steels
- ✓0.09 mg/m^3 with door closed

CONTROLLING HAULAGE ROAD DUST

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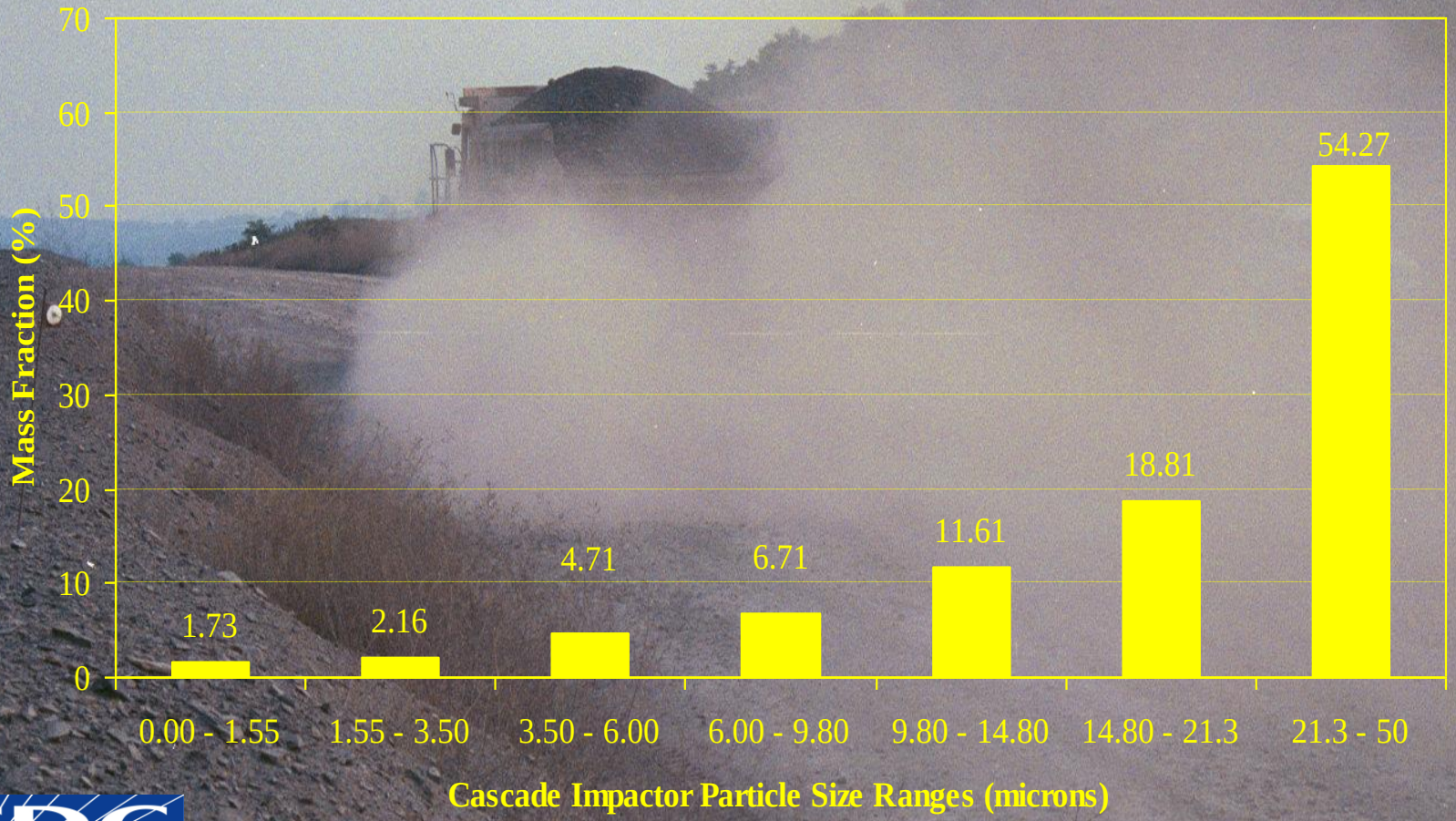
Average Airborne Particle Size Distribution



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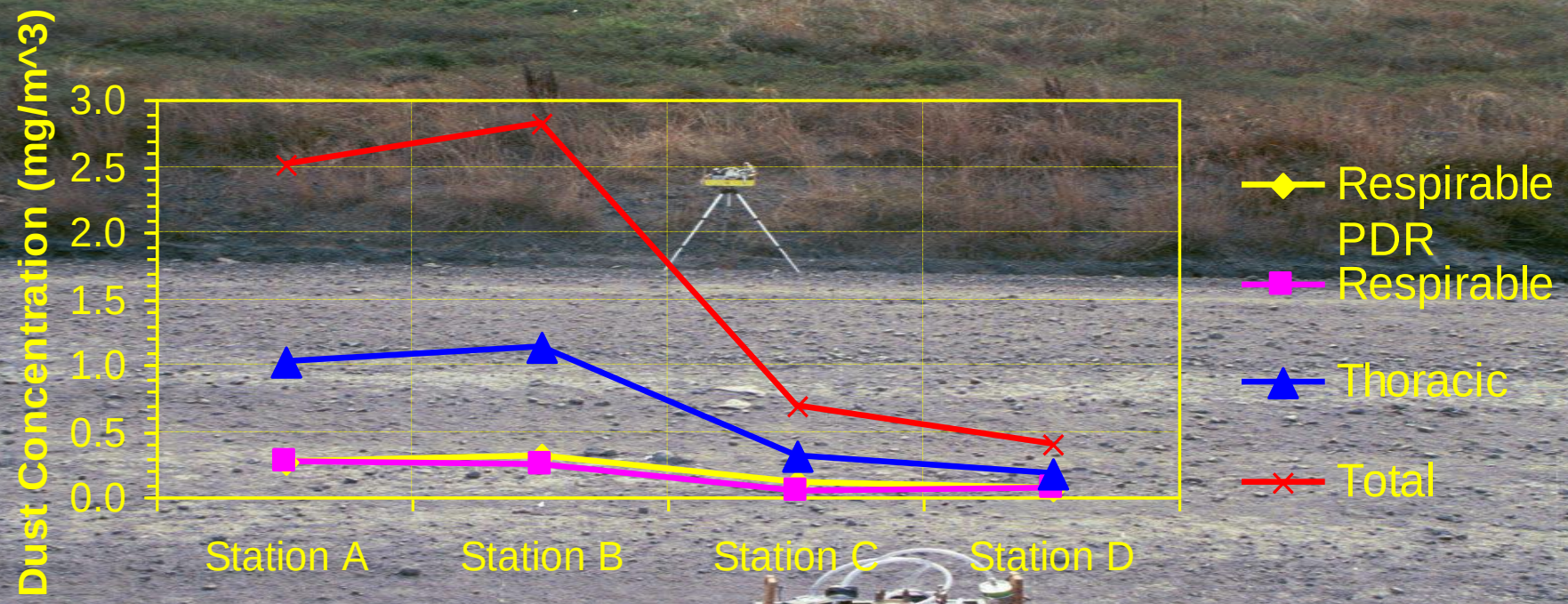
Typical Gravimetric Dust Concentrations



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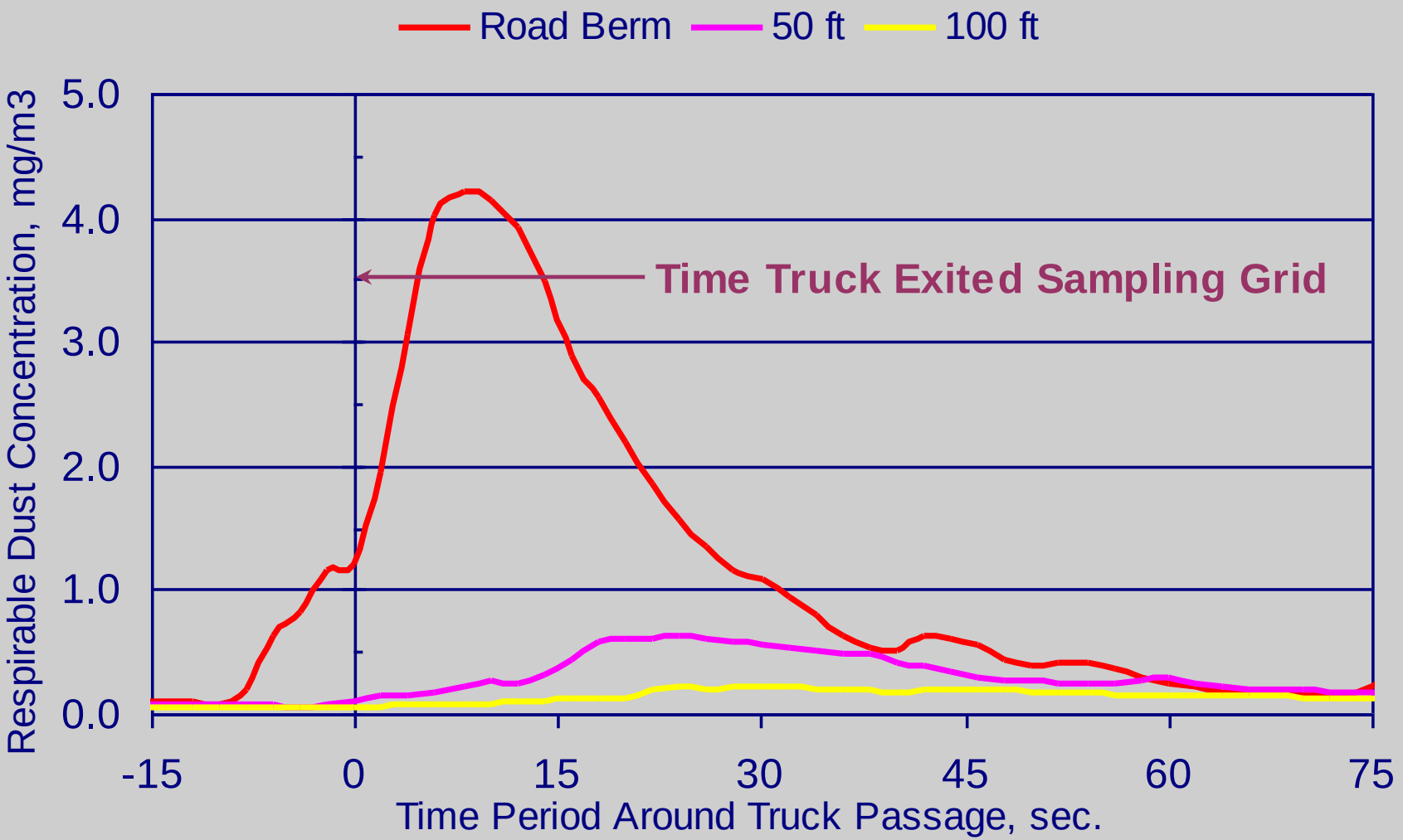
Dust Dissipation Effect



Total:Resp. ≈ 8 to 10:1 Thoracic:Resp. ≈ 3 to 4:1

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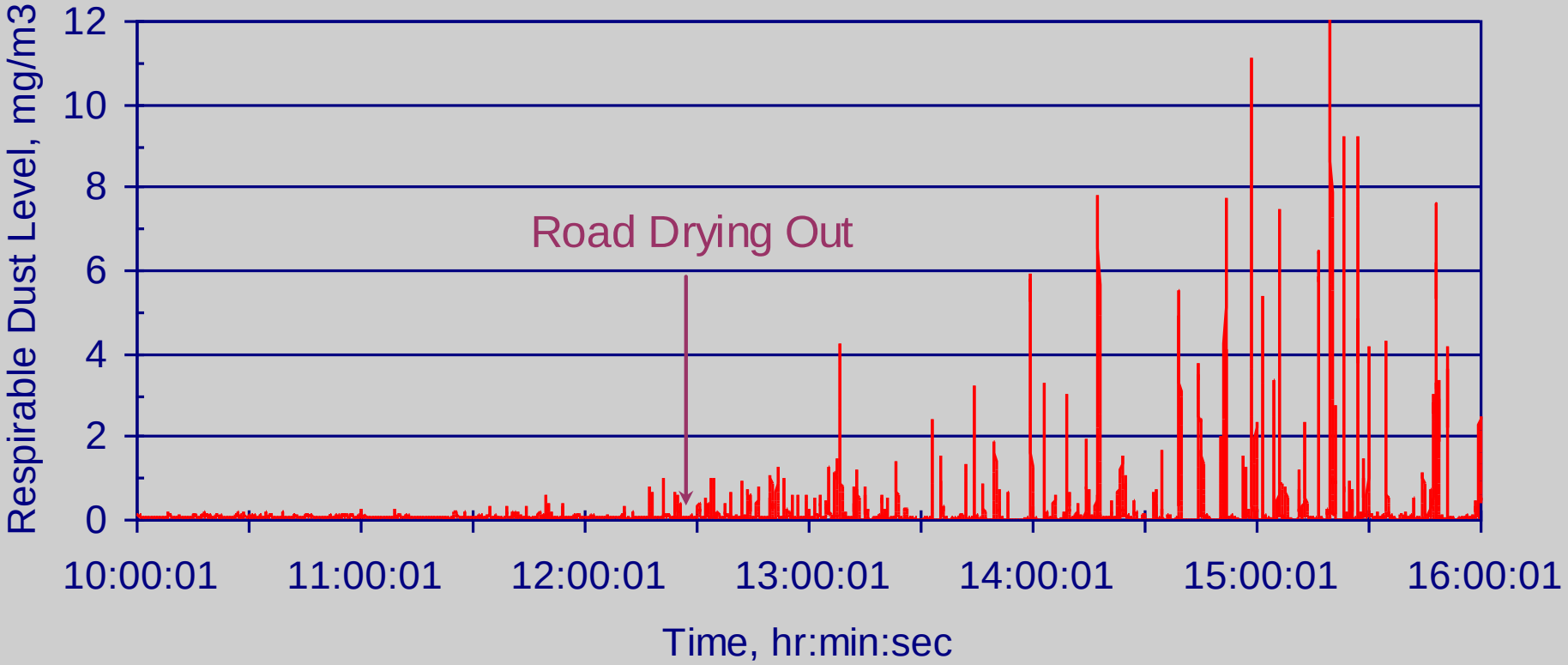
Treatment of Unpaved Road Services



- ✓Water effective with reapplications
- ✓Salts, surfactants, soil cements, bitumens films (polymers) extend time of effectiveness

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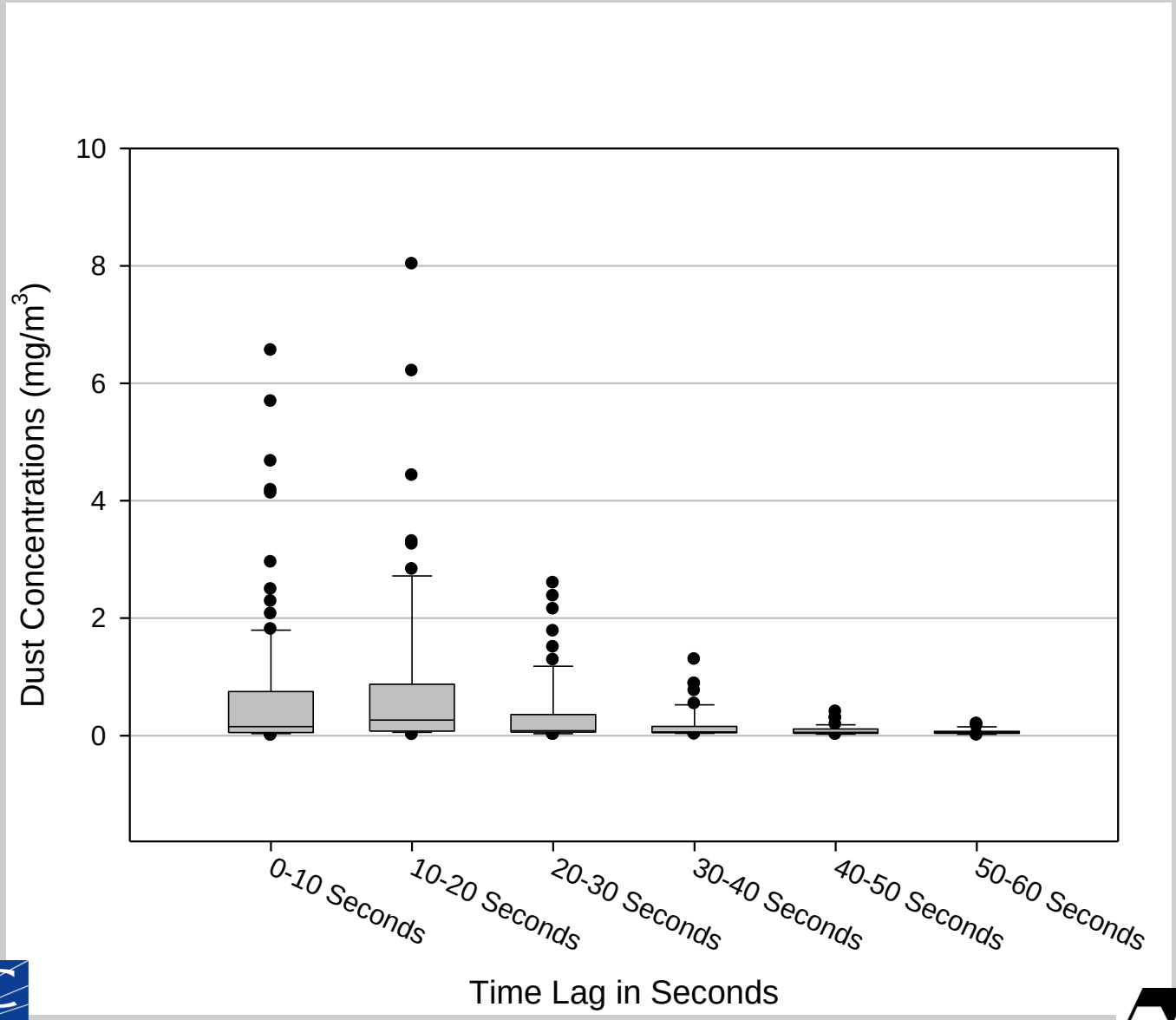
Increase Distance Between Vehicles



PRIMARY CRUSHER HOPPER DUMP

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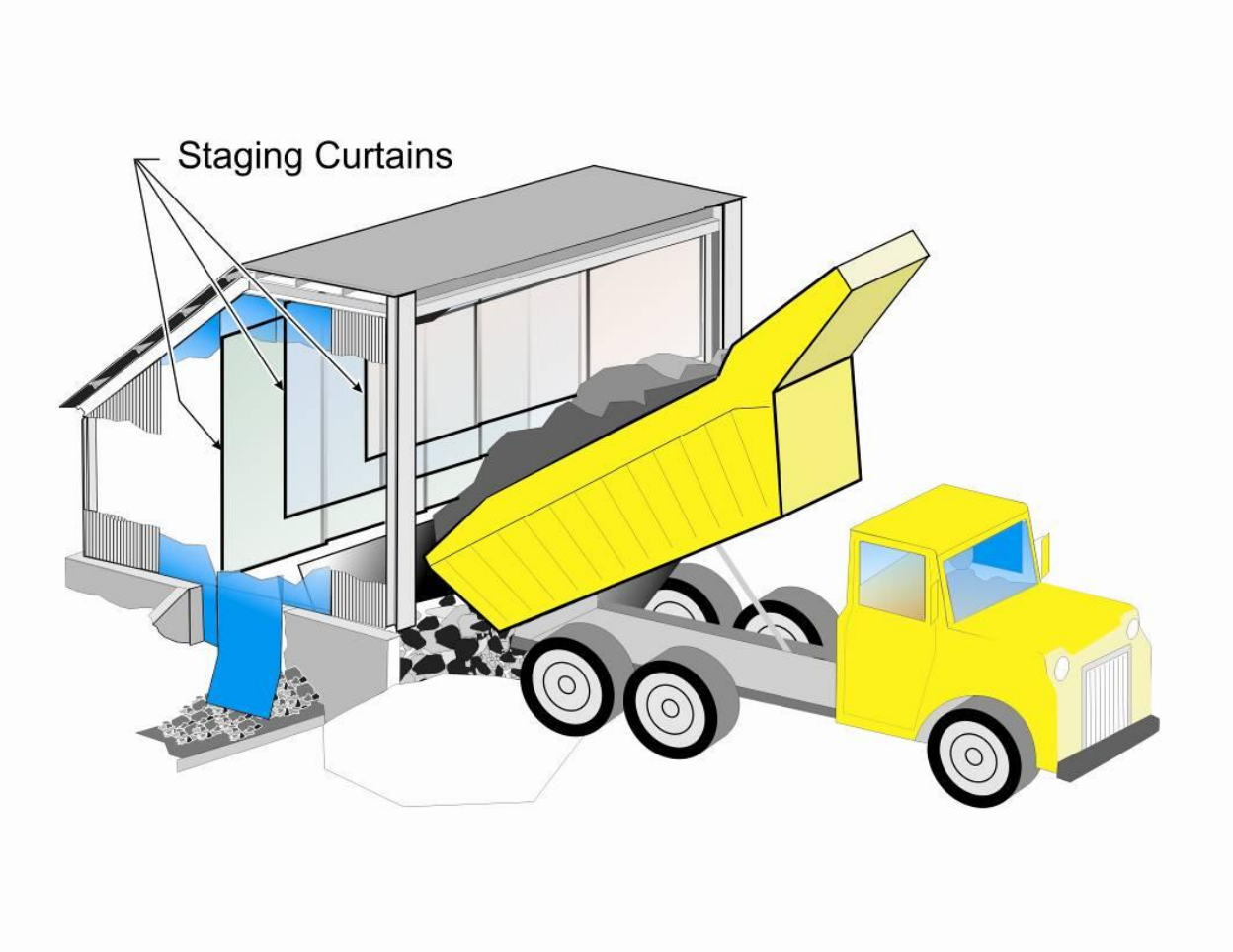
Enclose the Primary Hopper Dump



✓Staging Curtains Reduce Dust Billowing Out

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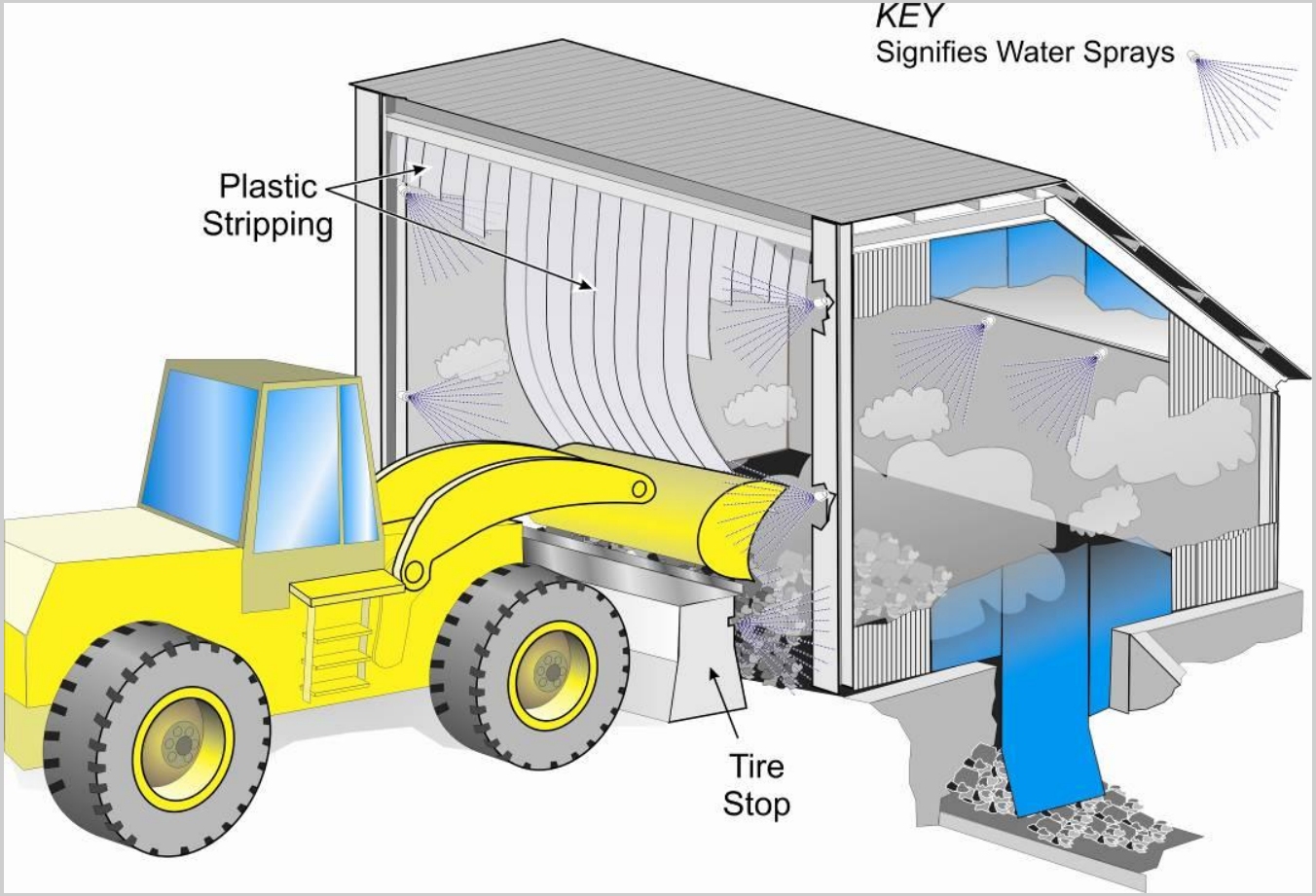
Use Water Sprays to Suppress the Dust



- ✓Start by adding 1% moisture by weight
- ✓Use photo cell or mechanical controlled sprays

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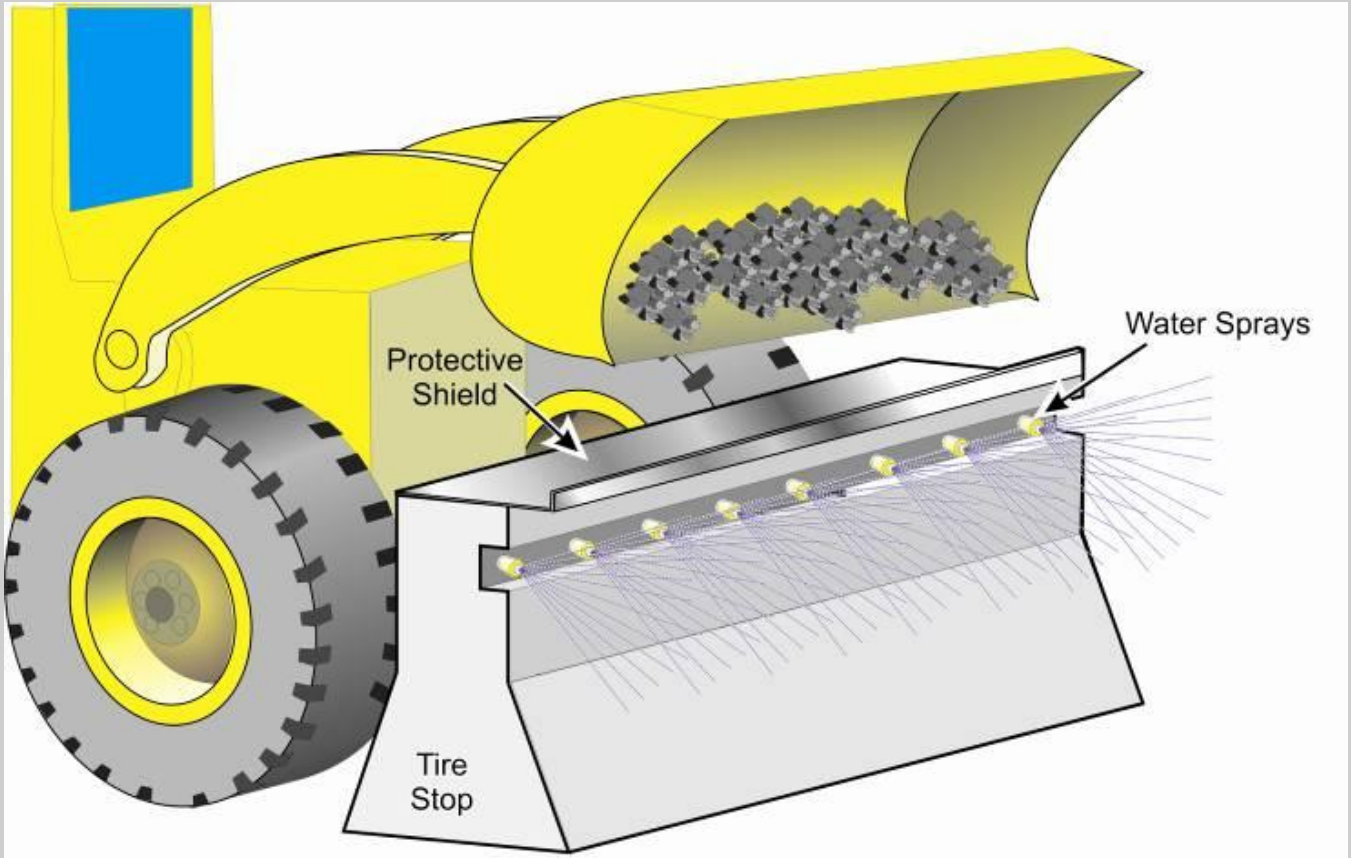
Prevent Dust Roll Back Under Vehicle



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

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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

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Questions or Comments?

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