

# Estimation of Diesel Particulate Matter Emissions (DPM)

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# Engine Combustion Design

- ◆ Pre 1993 Direct Injection Engines
  - 0.5 – 1.0 gm/hp-hr.
- ◆ Indirect Injection (Pre Chamber) Engines
  - 0.3 – 0.5 gm/hp-hr.
- ◆ Post 1993 Direct Injection Engines
  - High Pressure Fuel Direct Injection
  - Turbocharged
  - Computerized Electronic Fuel Injection
  - 0.05 – 0.2 gm/hp-hr for the higher horsepower engines

# Total Engine Out Emissions

Emissions x Horsepower x Hours = DPM

## ◆ Loader:

$$0.1 \quad x \quad 275 \quad x \quad 8 = 220 \text{ grams}$$

## ◆ Haul Truck:

$$0.1 \quad x \quad 350 \quad x \quad 8 = 280 \text{ grams}$$

## ◆ Haul Truck:

$$0.3 \quad x \quad 350 \quad x \quad 8 = 840 \text{ grams}$$

## ◆ Drill:

$$0.5 \quad x \quad 150 \quad x \quad 4 = 300 \text{ grams}$$

# Three Strikes and It's Out

## ◆ Strikes:

- High horsepower (greater than 150),
- High emissions (greater than 0.3 gm/hp-hr),
- High use (greater than 6 hours per shift).

## ◆ Target Equipment:

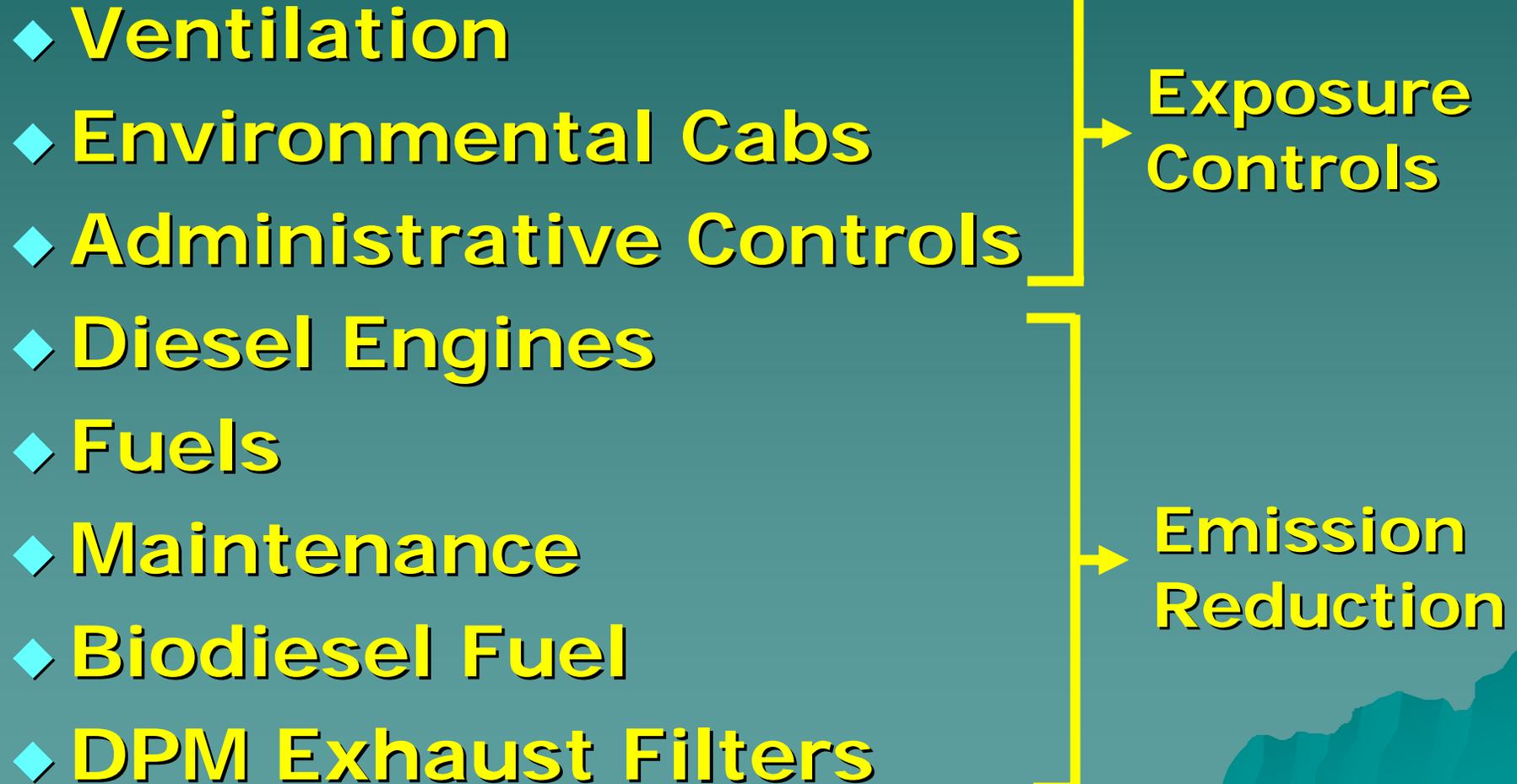
- Production Loaders and Trucks (primary),
- Drills and Scalers (secondary)
- PC engines (specialty mining equipment).

## ◆ One bad engine can spoil the entire fleet.

# Problem to Solve??

- ◆ MSHA's Enforcement Sample has shown an Overexposure
- ◆ Mine Operators Environmental Monitoring under 57.5071 has shown an Overexposure

# Available Control Strategies



# Administrative Controls

- ❖ Control DPM exposures through operating procedures, work practices, etc.
- ❖ Job rotation prohibited as DPM administrative control [§57.5060(e)]

# Examples of Work Practices

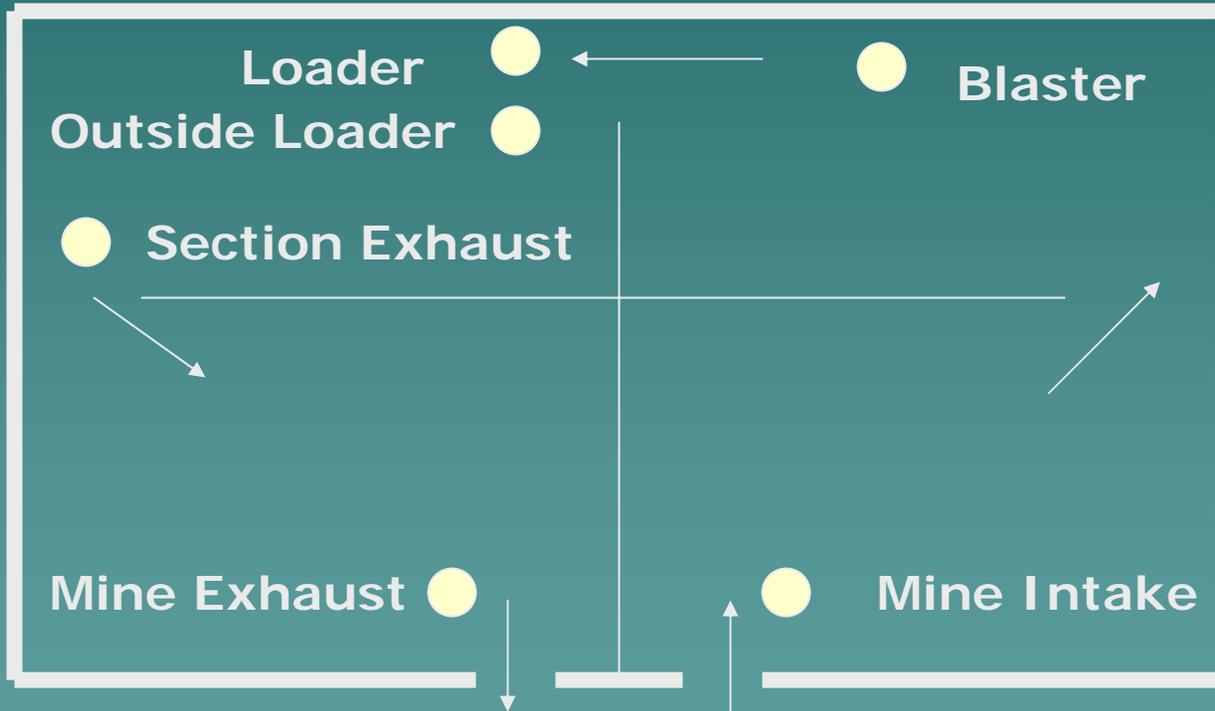
## ❖ Work Practices Can Affect Emissions And DPM Concentrations

- Minimize engine idling
- Avoid lugging engines (low RPM - high load)
- Keep fuel and lube oil clean
- Traffic control
  - Route traffic away from areas where miners work outside cabs
  - Route haul trucks in return air, especially when ascending ramps loaded
  - Limit HP in work area based on available CFM's
- Schedule blasters on non-production shifts

# DPM Exposure Estimator

- ◆ Conduct simulation to assist in developing control strategy.
- ◆ Need to measure exposures.
- ◆ Need to assess engines and use.
- ◆ Need to determine air flows.

# Area Sampling Locations



# DPM Estimator

- ◆ Equipment
- ◆ Engine
- ◆ Horsepower
- ◆ Emissions
- ◆ Hours of Use

# DPM Estimator

Spreadsheet Examples

QUESTIONS?