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:**
  \[0.1 \times 275 \times 8 = 220 \text{ grams}\]

- **Haul Truck:**
  \[0.1 \times 350 \times 8 = 280 \text{ grams}\]

- **Haul Truck:**
  \[0.3 \times 350 \times 8 = 840 \text{ grams}\]

- **Drill:**
  \[0.5 \times 150 \times 4 = 300 \text{ grams}\]
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

- Ventilation
- Environmental Cabs
- Administrative Controls
- Diesel Engines
- Fuels
- Maintenance
- Biodiesel Fuel
- DPM Exhaust Filters

Exposure Controls

Emission Reduction
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

- Loader
- Outside Loader
- Section Exhaust
- Mine Exhaust
- Blaster
- Mine Intake
DPM Estimator

- Equipment
- Engine
- Horsepower
- Emissions
- Hours of Use
DPM Estimator

Spreadsheet Examples
QUESTIONS?