

# DPM Controls used in Underground Coal Mines.

By

Steve “Skinner” Forbush

Arch Western Bituminous Group

# Tools you can use to control DPM.

- 1. Maintenance.
- 2. Cleaner Engines.
- 3. Alternate Fuels.
- 4. Ventilation.
- 5. Filters
  - A. Disposable.
  - B. Ceramic.
- 6. DOC's

# How do you pick your engines?

## Fact based or emotion based?

1. Reputation.
2. Service.
3. Knowledge of engine family.
4. Know the dealer.
5. Brother in-law works there.
6. Parts availability.
7. Warranty.

# Cleaner Engines. MSHA Web Site.

HP @ RPM at 1000ft Elevation

Ventilation Rate CFM

DPM grams/hr weighted

87 @ 2800	6000	3.7
100 @ 2200	4500	4.14
99 @ 2300	6000	5.57
87 @ 2800	7000	5.95
87 @ 2300	4500	6.66
99 @ 2500	6500	6.8
102 @ 2500	6500	6.8
116 @ 2500	6500	12.74
103 @ 2200	7500	15.27
108 @ 2400	9000	15.29
85 @ 2600	4500	16.14
85 @ 2600	4500	16.14
94 @ 2300	4000	19.54
116 @ 2500	4500	19.54
97 @ 2500	7000	22.09
111 @ 2400	7000	22.09
94 @ 2300	5500	25.49
100 @ 2200	5000	25.49
116 @ 2500	7000	30.59

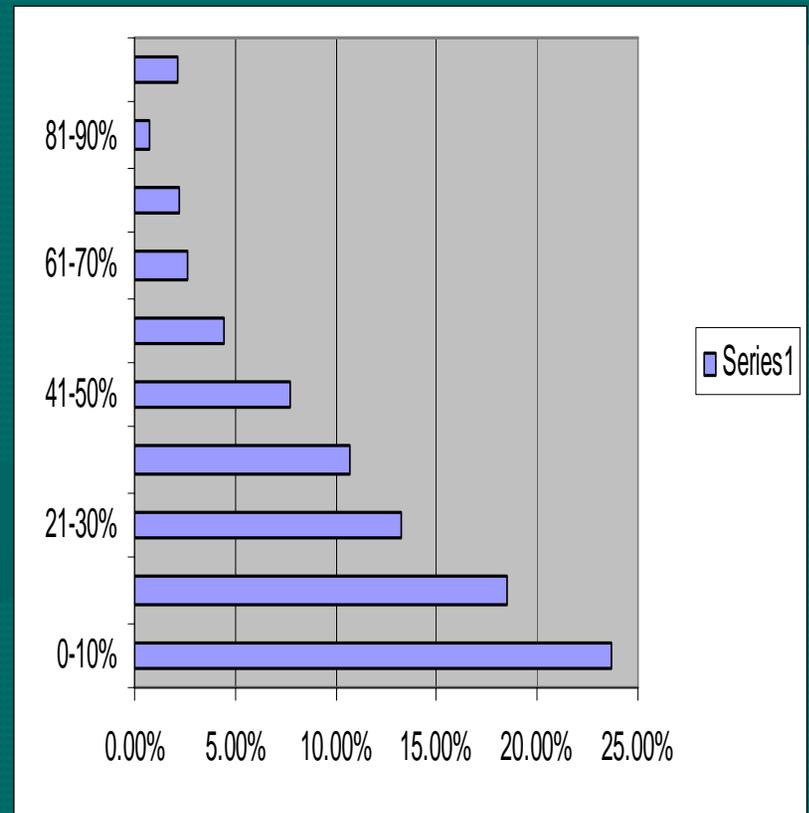
# Ventilation.

1. What does 1 CFM / Year cost?
2. Recent reports show that \$4.50 is the cost of 1 CFM / Year.
3. A 85-116 hp engine can cost between \$20,250 and \$40,500 per year to operate. This is for gasses.
4. For DPM the costs are higher. PI times 5.
  - a.  $3.7 \text{ g/hr @ } 160 \text{ ug/m}^3 = 12,500 \text{ cfm}$
  - b.  $30.59 \text{ g/hr @ } 160 \text{ ug/m}^3 = 90,000 \text{ cfm.}$

# Dodge Trucks

## 65% of the time below 4.2 g/hr.

Approval Number	07-ENA040015	07-ENA040015-1
Engine Manufacturer	CUMMINS	CUMMINS
Model	ISB-325	ISB-215
HP @ RPM	325 @ 2900	215 @ 2900
Ventilation Rate CFM	13000	9000
DPM grams/hr weighted	21.32	15.56



# Alternate Fuels & Additives.

1. How do you separate the truth from the B.S.?
2. Always require lab test results using the ISO 8178 non-road test cycle. Keep everything on the same playing field.
3. Testimonials are good for toothpaste and tires but not for alternate fuels or additives.

# Last line of defense.

## Filters and DOC's.

1. Filters. Highly efficient in trapping DPM. Costly and labor intensive.
  - a. Disposable.
  - b. Ceramic.
2. Diesel Oxidation Catalyst. Less efficient in removing DPM. Less costly and labor intensive.
  - a. Old style.
  - b. New and improved style.

# Disclaimer!!!

I am sure there are other devices out there. I am speaking on what we at AWBG are using now.

# Requirements For After Treatment Devices At AWBG.

1. Must not increase secondary gasses (NO<sub>2</sub>). Device must have data showing this.
2. Must be efficient enough to get vehicle into compliance.
3. Must not add any additional risk for fire.
4. Must be able to run at least 50 hours before any maintenance or replacement is required.
5. Must be robust in design and last at least 5000 hours.

# Mac's Package for disposable filters.



# Mac's Package for disposable filters.

1. Two heat exchangers.
  - a. 12 volt fan for lower horse power engines.
  - b. Hydraulic driven fan for higher horse power engines.
2. Shut down sensor set to 600F for filter protection.

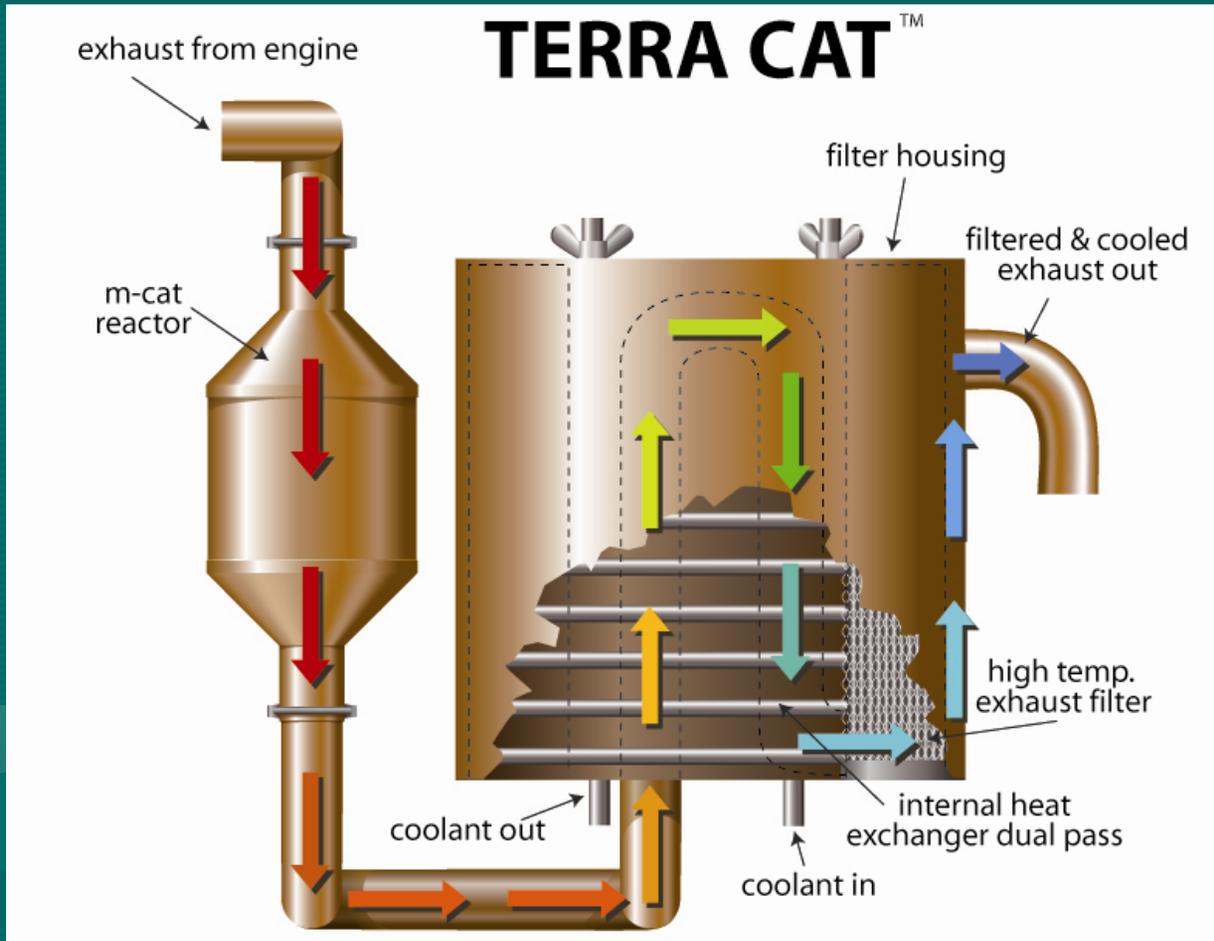
# Donaldson High Temperature.



# Donaldson Filter.

- Reinforced & wire backed filter media
- Filter materials are high temperature &
- non-combustible
- Water resistant
- High temperature gasket insures
- proper sealing
- Open-ended design allows for multiple filter operation
- Filter size maximized performance and minimized cost

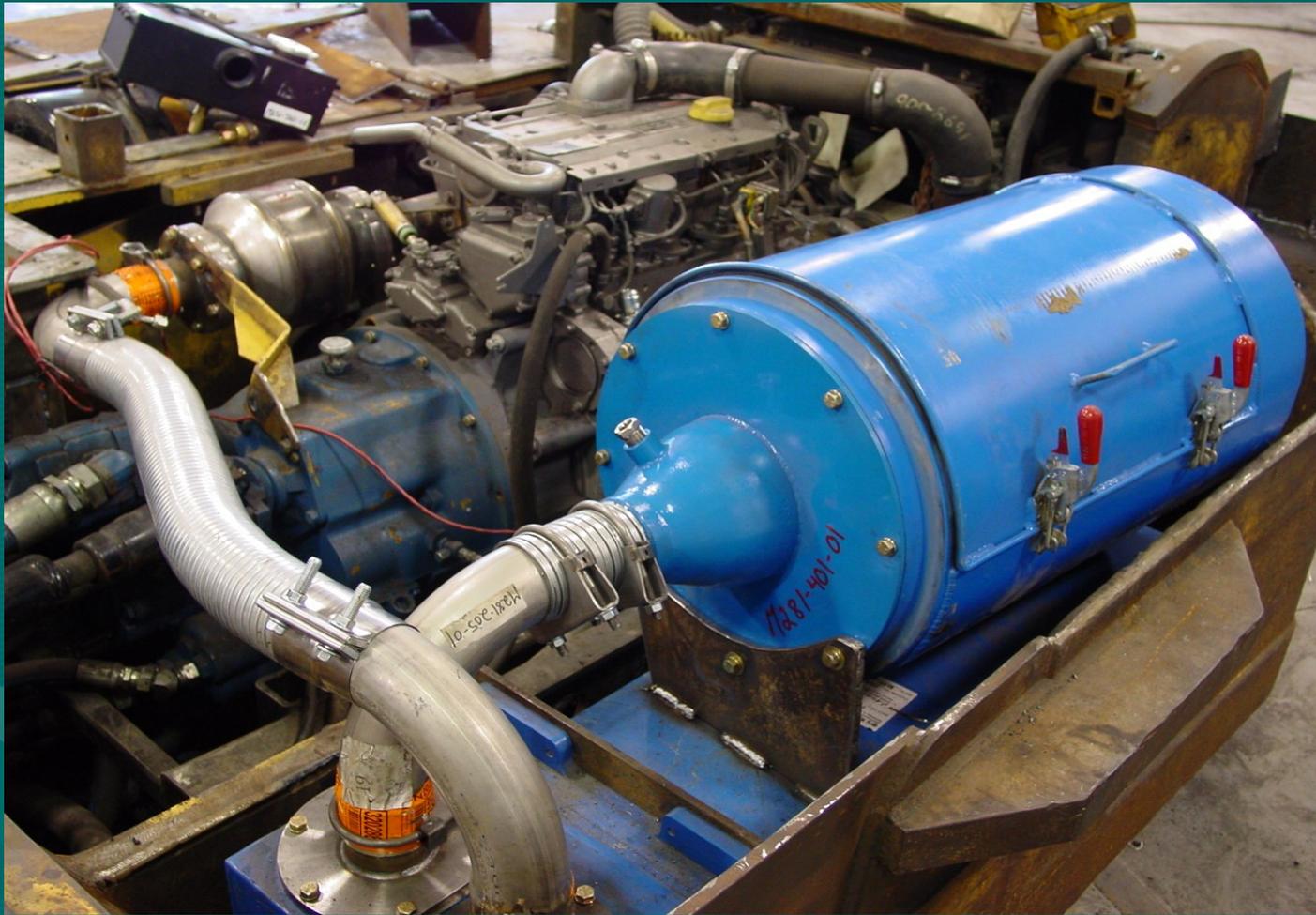
# Bunderson Terra Cat



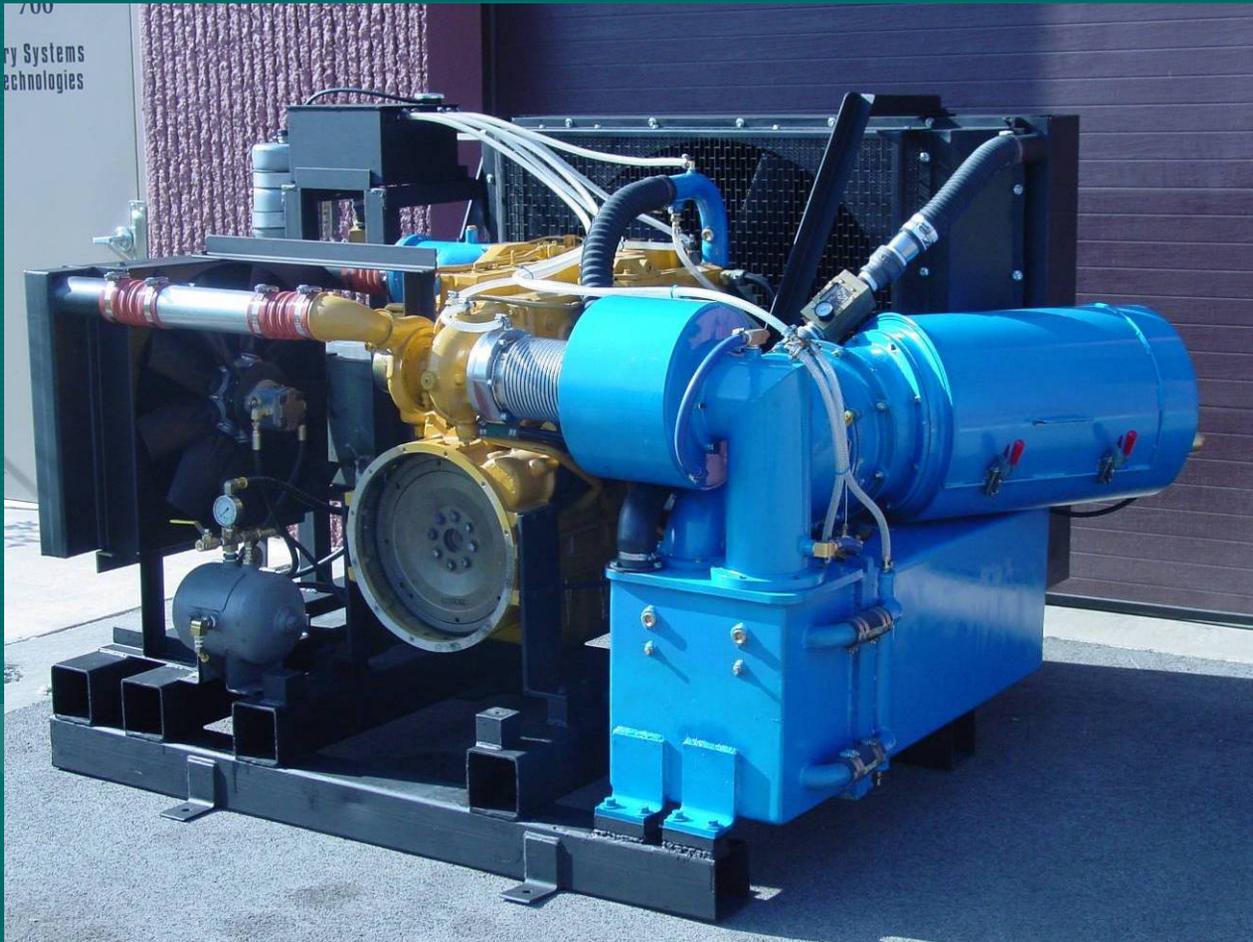
# Bunderson Terra Cat

1. Compact/Custom fit for each vehicle
2. Integrated catalyst/Liquid Cooled Canister & High Temp Filter.
3. Works with D2 fuel, synthetic fuel & ULSD.
4. Reduces (Whole) Diesel Particulate Matter (DPM) by 90%.
5. Greatly reduces CO & HC.
6. Not Duty Cycle dependent.

# Dry Systems Technology “DST”.



# Dry Systems Technology “DST”. Permissible.



# Dry Systems Technology “DST”.

- Dry System<sup>®</sup> reduces Diesel Particulate Matter (DPM) > 95%
- Dry System<sup>®</sup> reduces Carbon Monoxide (CO) as much as 90%
- Dry System<sup>®</sup> does not increase the Oxides of Nitrogen (NO<sub>x</sub>). Modular design for ease of installation
- Systems available for engines from < 50hp to > 350hp
- Low temperature paper filter technology
- Performs at all duty cycles
- No regeneration process required
- No fuel additives needed
- Performs with minimal routine maintenance

# Getman Chiller.



# Getman Chiller.

- Features
- Easily replaced fire retardant, synthetic composite filter that has a low cost prefilter element
- Exhaust gas cooling package using an air-glycol heat exchanger so easily replaced, relatively low cost filters can be utilized.
- The exhaust gas heat exchanger uses durable finned tubes extract heat from the exhaust stream for a low back pressure, and extended filter life system. Primary goal is a low maintenance, uninterrupted productivity system.
- Separate glycol radiator provides system heat dissipation independent from the engine cooling system.
- Exhaust temperature is monitored, shutting down the engine between 275°-280°F, to prevent damage to the filter.
- Exhaust back pressure monitoring package, consisting of; electronic control module and warning lights (yellow/red) that first indicate moderate back pressure - intermittent yellow illumination and then higher back pressure condition exists.
- Hydraulic powered water pump requiring 2 - 4 gpm
- Exhaust sampling ports for undiluted gas.
- Engines Reviewed for Coal Applications
- Caterpillar 3306 DITA, 200 hp
- Caterpillar 3306 PCNA, 150 hp
- Detroit Diesel OM906, 200 hp
- Detroit Diesel OM904, 147 hp

# Engine Control Systems-AZ

## Diesel Oxidation Catalyst



# ECS-AZ

- Flow-through system: no soot trapping or regeneration
- PM reduction by oxidizing SOF of the DPM
- California ARB verified (>25%PM reduction)
- US EPA verified (minimum 20-40%PM, 40%CO & 50%HC reduction)

# ECS Combifilter



# ECS

## Combifilter

- >25% above 380°C for Regeneration
- 87% efficiency rating
- Off-Board Regeneration

# ESW MCAT



2007/01/15

# ESW M-CAT

1. High performance Diesel Oxidation Catalyst.  
Hybrid!!
2. Flow Through design.
3. No NO<sub>2</sub> increase.
4. Compact design.
5. Not duty cycle dependent.
6. Fits engines from 30HP to 600HP.

# DCL With the AIT.



# Questions?

