



# MAINTENANCE OF HEAVY-DUTY DIESEL POWERED EQUIPMENT

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## WHAT IS MAINTENANCE ?

- Webster defines maintenance as keeping equipment in existing state, to preserve from decline or failure
- If this interpretation is correct mines can not use maintenance to improve existing conditions!!!

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## MAINTENANCE “+” PROGRAM

- Continue regular preventive maintenance (PM) program
- Plus 100% buy in from management
- Plus emission reduction program
- Plus training
- Plus culture change

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## WHY MAINTENANCE “+”

- To provide our people with the best work environment
- To make our equipment as efficient as possible
- To keep costs as low as possible

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# CANYON FUEL COMPANY'S EMISSION REDUCTION PROGRAM

- Establish a baseline
- Find out where we should be
- Find a way to get there
- Get there
- Improve

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## ANALYZER



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## BASELINE EMISSIONS

- November 1997
  - 1597 ppm Carbon Monoxide
  - 947 ppm NO<sub>x</sub>
- These results were with engines and drive trains set to OEM specifications

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## WHERE SHOULD WE BE?

APPROVAL #	MANUFACTURE	MODEL	RPM	CO PPM
B-003	CAT	3306 PCNA	2200	392
			2100	394
			2000	352
			1900	348
			1800	330
			1700	332
			1600	315
			1500	313
			1400	314

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## WHERE ARE WE NOW?

- Last week
  - 154 ppm CO
  - 402 ppm NO<sub>x</sub>
- A 90% reduction in CO and 50% reduction in NO<sub>x</sub>
- 58% below certification levels
- These results are obtained with NO ENGINE OR DRIVE TRAIN SET AT OEM SPEC'S.

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## HOW DID WE GET THERE?

- 100 % buy in from management!!!
- Asking questions about engines, torque converters and transmissions
- Optimizing the drive train components for the duty cycle and mine elevation
- Having teams of highly trained technicians at each mine site

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## COMPONENT INTERACTION

- Engine with torque converter
- Torque converter with transmission
- Engine, torque converter, and transmission with vehicle

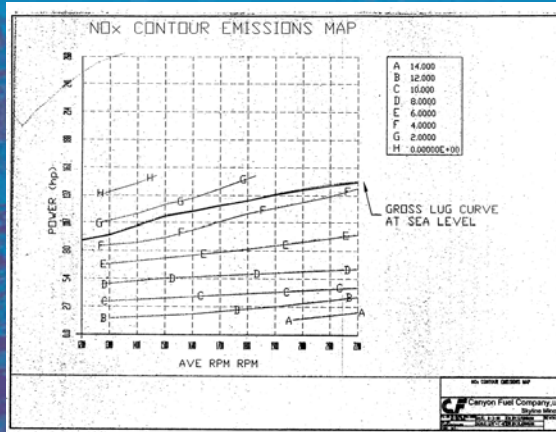
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## NEW TOOLS TO USE

- Emissions contour map
- Torque absorption chart

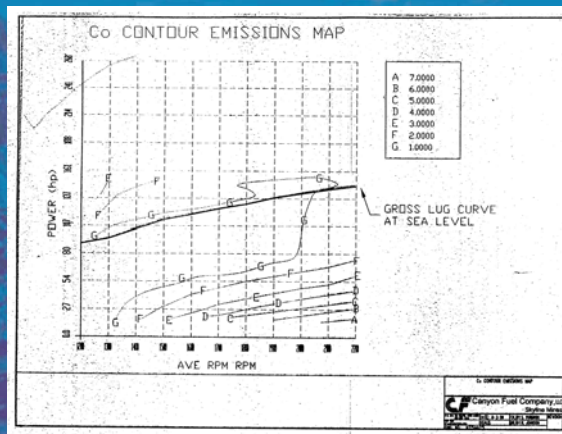
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# NO<sub>x</sub> CONTOUR MAP



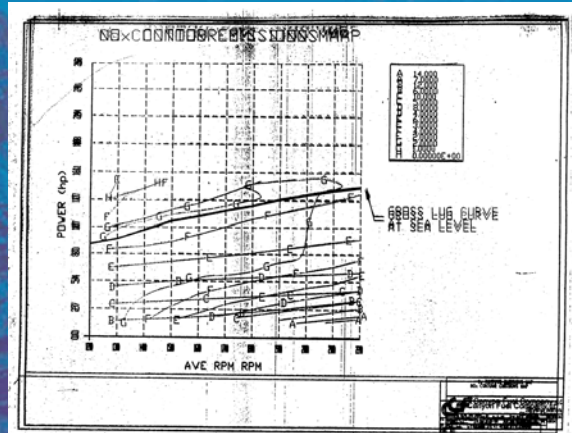
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# CO CONTOUR MAP



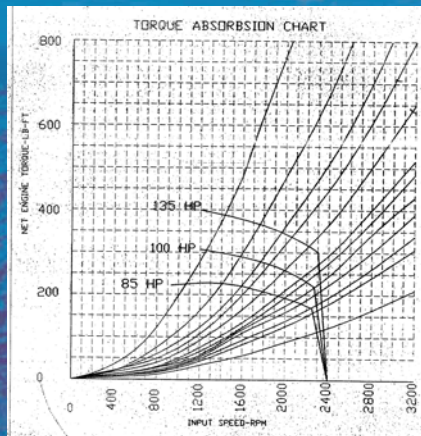
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# NO<sub>x</sub> AND CO MAPS



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# TORQUE ABSORPTION CHART



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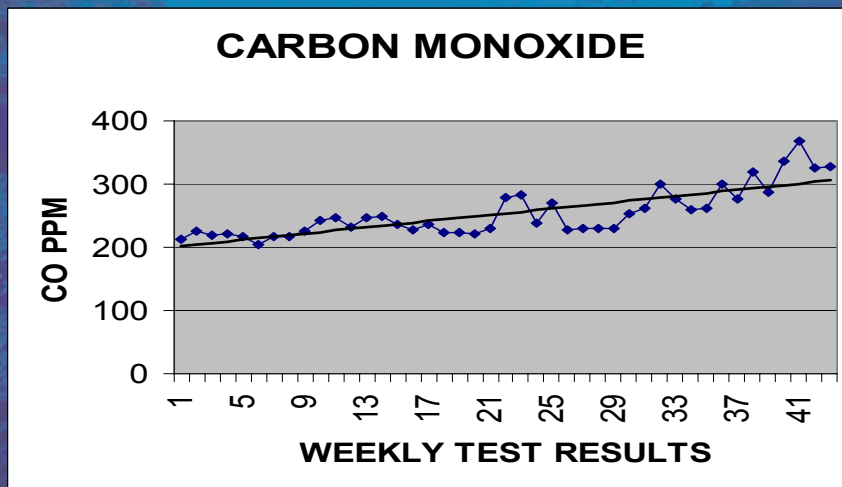
## IMPROVEMENT

- Insanity is: endlessly performing the same procedures, expecting different results.

Albert Einstein

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## IMPROVEMENT



## TRAINING

- Engine training
- Drive train training
- Emission's training
- Vehicle systems training

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## CULTURE CHANGE

- Life will not be the same after July 19, 2003
- It will take more work, time and money
- It will improve the quality of the underground environment
- It can happen

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QUESTIONS?