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Controlling Diesel Emissions in U/G Mining within an Evolving Regulatory Structure in Canada and the U.S.

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Queensland Mining Industry Health and Safety Conference

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Townsville, Queensland

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History and Background

- 1940's first diesels in mines and first USBM regulations Schedule 22 and 24
- 1962 – Wagner introduces first LHD
- Widespread U/G use by 1970's

Province of Ontario Diesel Usage

Year	Units
1977	2092
1985	1686
1990	2660
1995	2250
2002	1849

History and Background

- 1986 – Formation of Canadian Ad-Hoc Diesel Committee
- Conducted much of the early research
- Led to first U/G tests of ceramic DPF filters
- Developed respirable combustible dust (RCD) method for DPM sampling
- Recommended RCD exposure limit of 1.5 mg/m^3
- Was adopted by several Canadian provinces and remains in effect today for some

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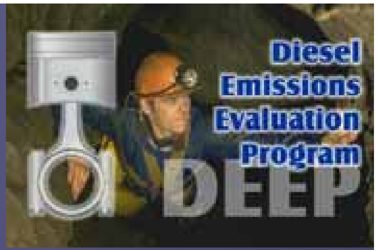
DEEP Chronology



Mar. ‘95 – ACGIH published intention to set DPM TLV at 0.15 mg/m3

Aug. ‘95 – INCO people met and saw no way to sample or analyze at that level

Sept. ‘95 – contacted U.S.B.M., proposed 3 year consortium

Oct. ’95 – MSHA proposal – non-coal RCD at 0.3 mg/m3, very tough numbers

Feb. ’96 – Dr. Conard Presented to ACGIH the shortcomings of evidence used - - ACGIH responded – no concern for practicality and problems

Mar. ’96 – Canadian Ad Hoc Diesel Committee met and set up steering committee

June ’96 – Scope of Work sent out for comment

Jan. ’97 – Detailed program finalized, many presentations made over 5 mo.

DEEP

1. Try to convince ACGIH to raise the DPM TLV before adoption.

2. Start research program to investigate ways of analysis and control options.

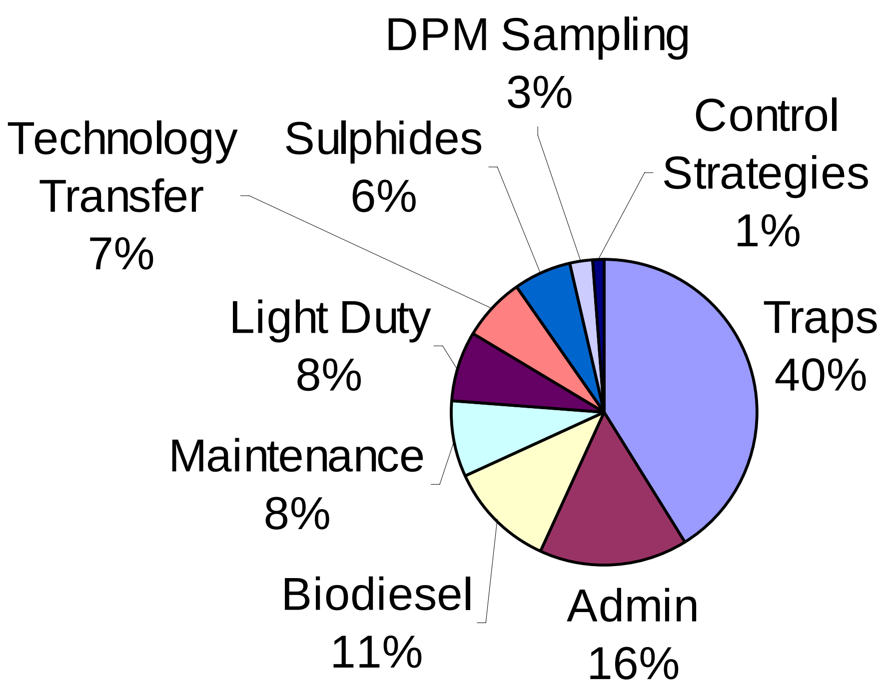
Note that the research must include Provincial Gov't.s because they are the ones that might adopt the TLVs unless they know the problems.

DEEP Philosophy

- There must be collaboration between researchers
- Labour and government must be full partners in planning, execution and interpretation of projects
- Specific interests of certain mines will be taken into account
- Technology transfer and training of industry personnel in the field is a key benefit

DEEP Projects

www.deep.org



Total Budget
$2.5M

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Canadian Provincial Regulations

Province	DPM mg/m^3	CO	CO_2	NO	NO_2	SO_2	Engine Certification
British Columbia	1.5	25	5,000	25	3	2	CSA
Alberta	- -	25	5,000	25	3	2	CSA
Saskatchewan	- -	25	5,000	25	2	2	- -
Manitoba	ACGIH	20	5,000	25	3	2	CSA / MSHA
Ontario	1.5	25	5,000	25	3	2	- -
Quebec	0.6	35	5,000	25	3	2	CSA / MSHA
New Brunswick	1.5	25	5,000	25	3	2	CSA / MSHA
Nova Scotia	1.5	25	5,000	25	3	2	CSA / MSHA
Newfoundland	ACGIH	25	5,000	25	3	2	- -
NWT Nunavut	1.5	25	5,000	25	3	2	- -
Yukon	1.5	50	5,000	25	5	5	CSA

U.S. Regulations - MSHA

DPM Rule

Date	Limit mg/m³	DPM as	Interim / Final
January, 2001	0.4	TC	Interim (not enforced)
July, 2003	0.4	TC	Interim (enforced)
May, 2006	0.308	EC	Interim
January, 2007	0.350	TC	Interim
May 2008	0.160	TC	Final

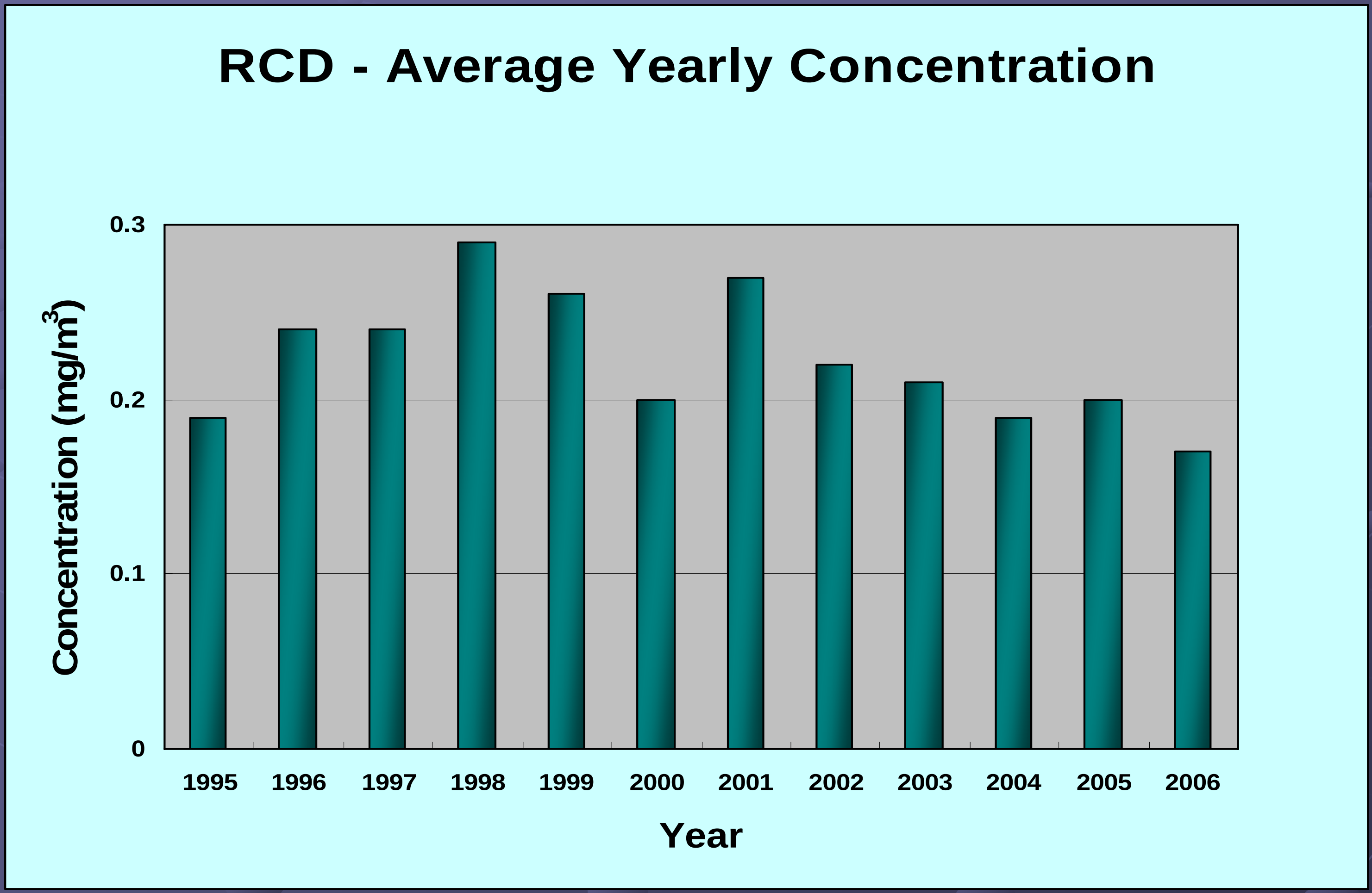
Note:

May 2008 Final Rule will have a conversion factor for and enforcement on EC

Ambient Gas TLV's

- CO – 50 ppm
- CO_2 – 5,000 ppm
- NO – 25 ppm
- NO_2 – 5 ppm (2 ppm for coal)

DPM Concentrations - Canada



B. Rubeli, Natural Resources Canada – CANMET, 2006

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DPM Concentrations – U.S.A.

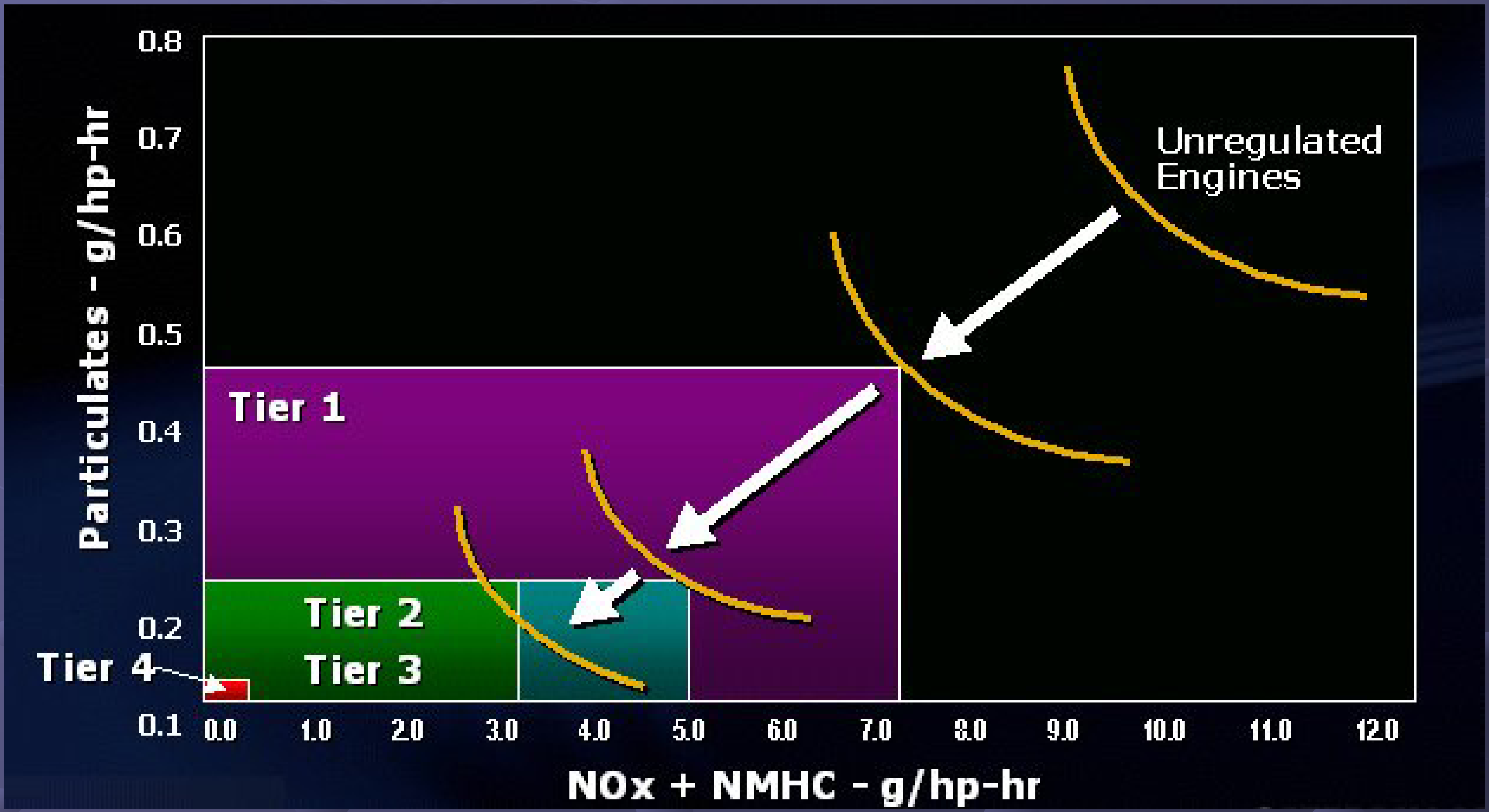
MSHA 31 mine study DPM concentrations (mg/m^3)

	Metal	Stone	Trona	Other
No. of samples	116	105	54	83
Minimum	0.46	0.16	0.20	0.27
Maximum	2.581	1.845	0.331	1.210
Median	0.491	0.331	0.82	0.341
Mean	0.610	0.465	0.94	0.359

MSHA baseline study DPM concentrations (mg/m^3)

	Metal	Stone	Other N/M	Trona	Total
No. of samples	284	689	196	25	1,194
Maximum	2.532	3.724	1.20	0.509	3.724
Median	0.339	0.186	0.185	0.102	0.218
Mean	0.444	0.295	0.243	0.132	0.318

Engine Certification – E.P.A.



Note: Tier 1 Non-road initial phase-in was 1996

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Engine Certification – CANMET

Microsoft
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Engine Certification – MSHA

Microsoft
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Emissions Controls

	Typical Emission Reductions (%)				
Constituent	**DOC**	**DPF**	**CDPF**	**SCR**	**Water Scrubber**
CO_2	0	0	0	0	0
CO	60 - 80	0	60 - 80	0	0
HC	60 - 80	0	60 - 80	0	0
NO	0	0	0	60 - 80	0
NO_2	0 or increase	0	0 or increase	60 - 80	0
SO_2	0	0	0	0	0
DPM	20 - 30	85 - 95	85 - 95	0	20 - 30

- DOC = Diesel Oxidation Catalyst
- DPF = Diesel Particulate Filter
- CDPF = Catalyzed Diesel Particulate Filter

Identification - External

- DOC's can be housed alone, built into a muffler body or put in series with a muffler
- DPF's are generally larger and more complex systems than DOC's

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Identification - Internal

DOC

DPF

Flow Through
Filter

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Interpretation - DOC

SANDVIK

TORO

40D

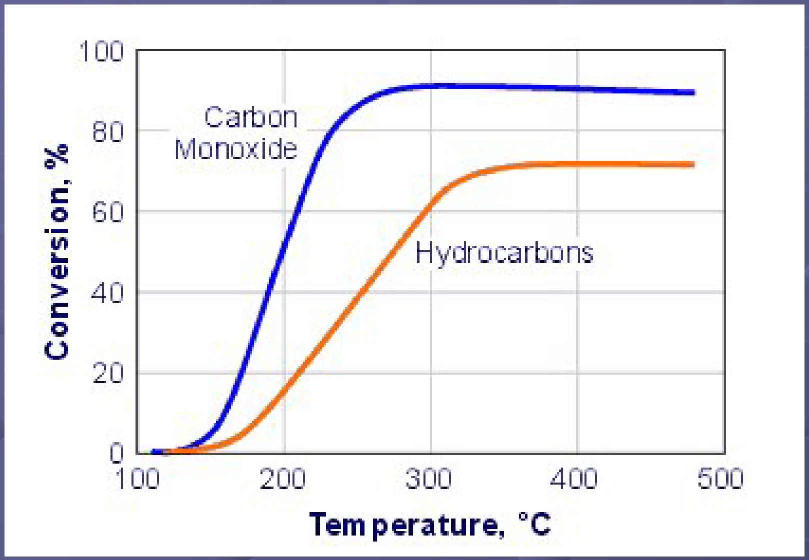
Series 60 12.7 L – 475 HP

Hi Idle 2190 Trans Stall 1863 RPM

	INLET	OUTLET	
CO	65	12	ppm
NO	628	493	ppm
NO_2	19	114	ppm
O_2	11	11	%
CO_2	7	7	%
TGas	768	736	°F

Turbo Boost Press	28	psi
Intake Restriction	7	inches water
Backpressure	10	inches water
Fuel Pressure	65	psi

Interpretation - DOC



- Understand your application – what do you need to accomplish?
- Benefits vs Drawbacks
- "Glass full of water" analogy
- DOC's are beneficial on some applications but are **NOT** for **EVERY** diesel engine working U/G

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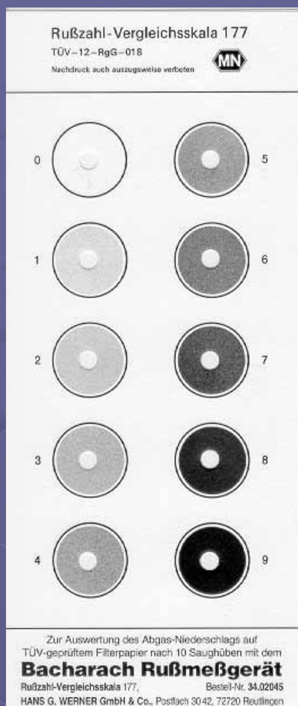
Diesel Particulate Filters



- Capable of >90% efficiency
- Expensive and maintenance intensive
- Dependent on duty cycle and mtce
- NO_2 slip can be a problem

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DEEP Brunswick DPF Project

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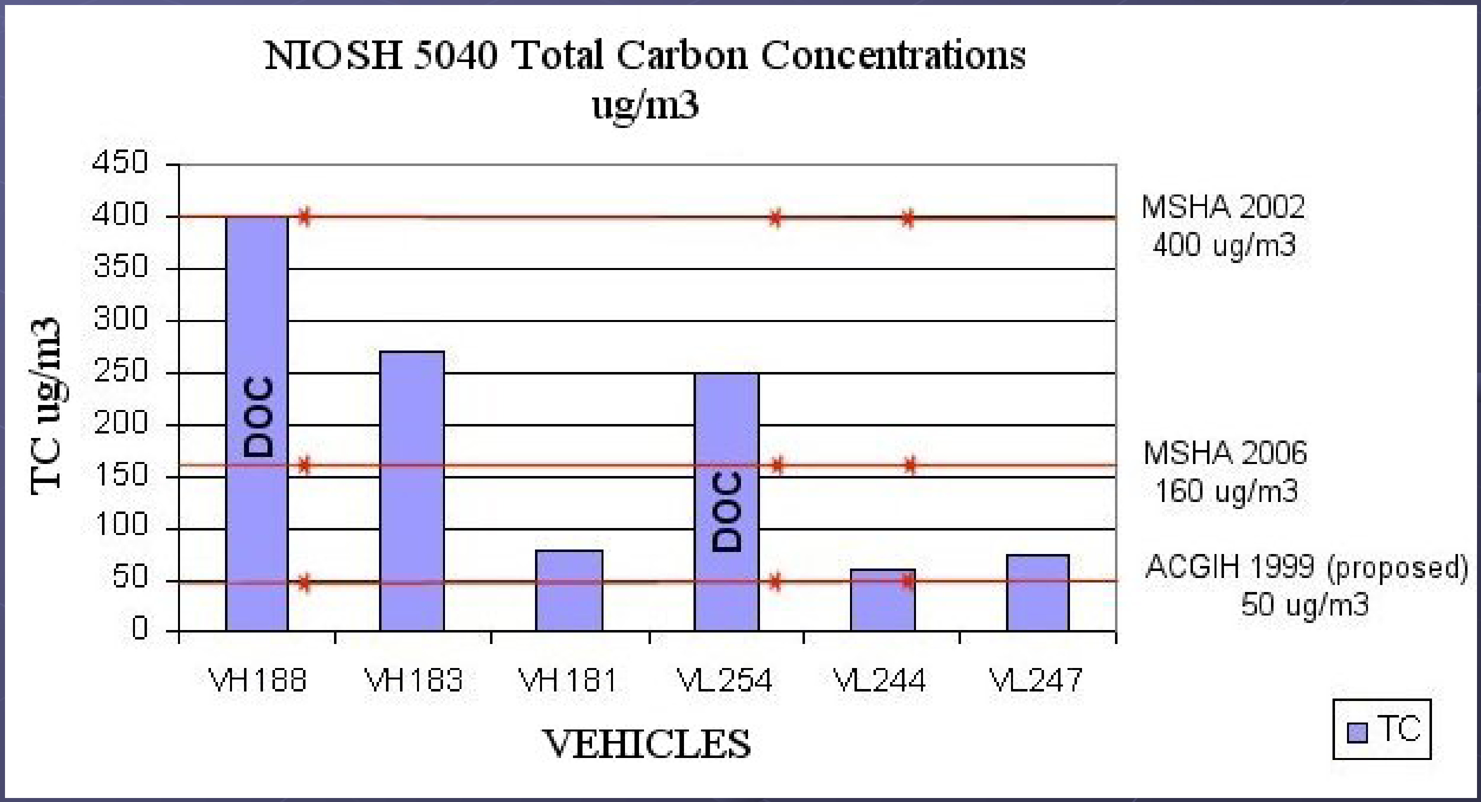
Isolated Zone Study



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DEEP Maintenance Project

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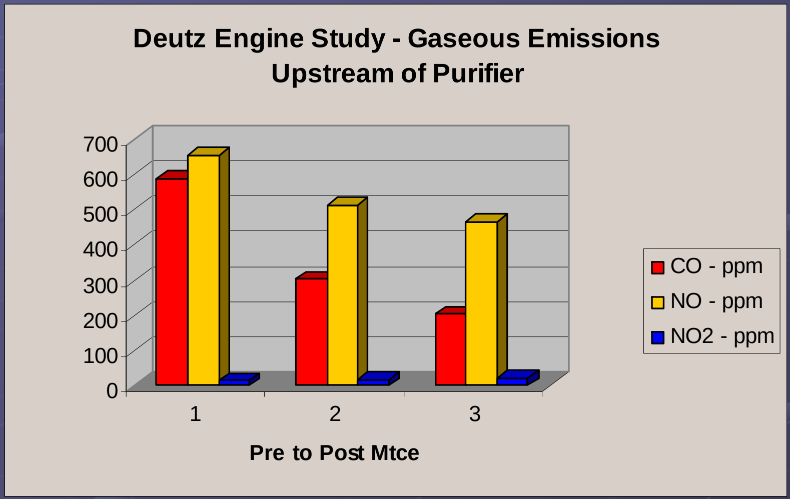
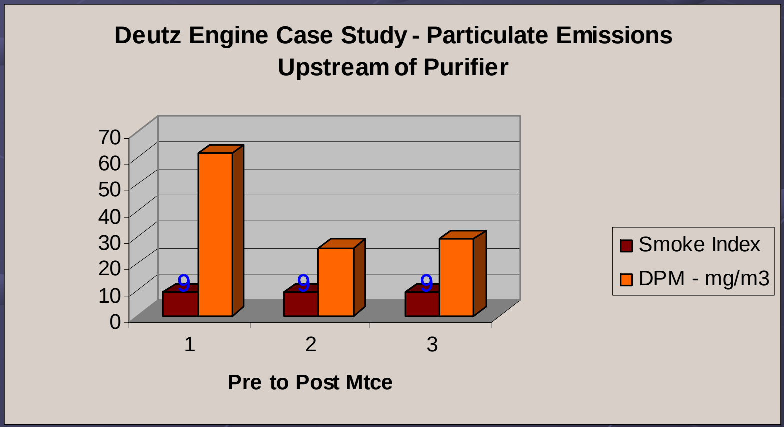
- Deutz BF4M1013
- Leaks in charge side of intake
- CO Reduction 66%
- DPM Reduction 53%





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Maintenance – Six Systems

- Engine specific PM's
- Quantified results
- Emissions
- Power, pressures, temperatures, etc.
- Measure-Measure-Measure
- Baseline and Control

- INTAKE
- EXHAUST
- FUEL INJECTION
- COOLING
- LUBRICATION
- FUEL HANDLING

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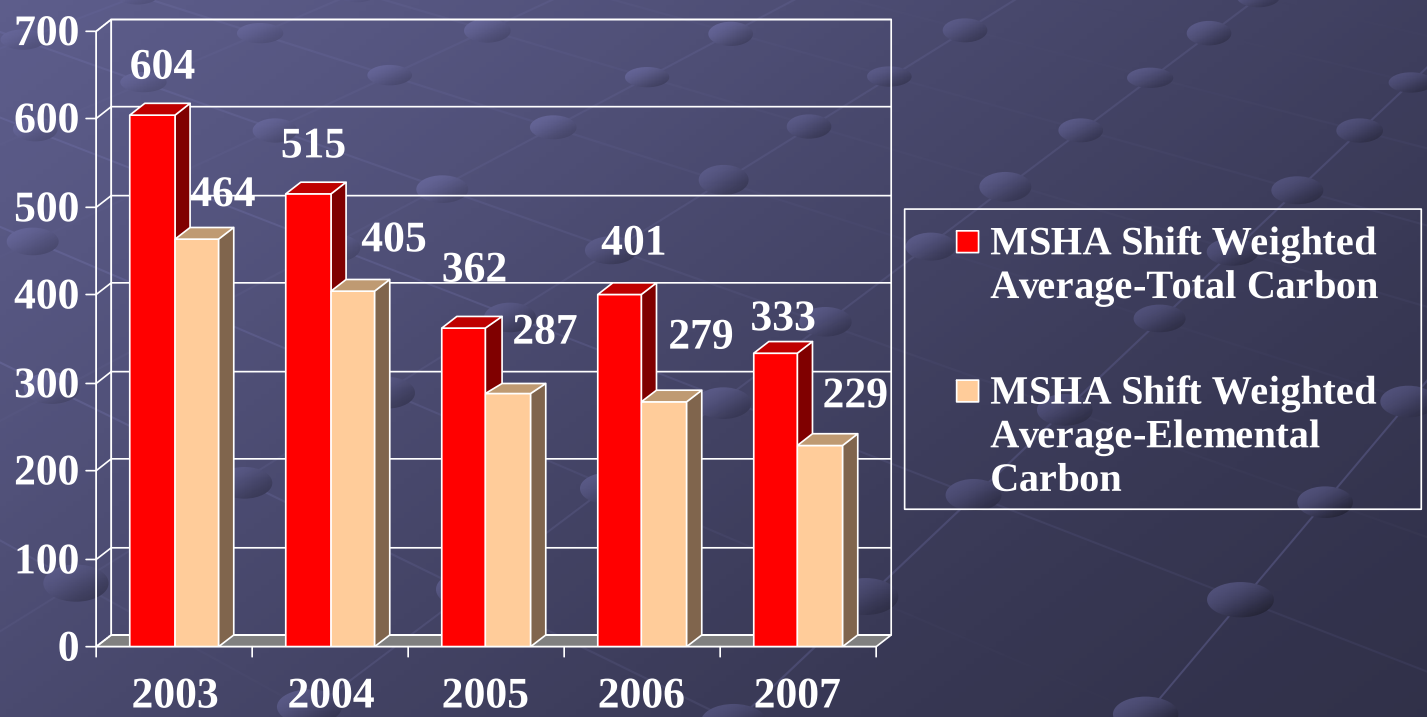
Summary – MSHA and the U.S.

- Non-compliance can close you down
- Success based on ability to adapt to change – not technology!
- Emissions has top priority
- The Stillwater experience



Summary – Canada

- Regulations are less strict than U.S.
- Vent rates are higher
- Industry is more proactive – less confrontational
- Ethical issue rather than regulatory
- DEEP has had a positive impact encouraging mines to embrace new technologies and best practices

Thank you!

- www.deep.org
- www.dieselnet.com
- http://www.cdc.gov/niosh/mining/topics/topicpage2.htm
- http://www.msha.gov/01-995/Dieselpartmnm.htm