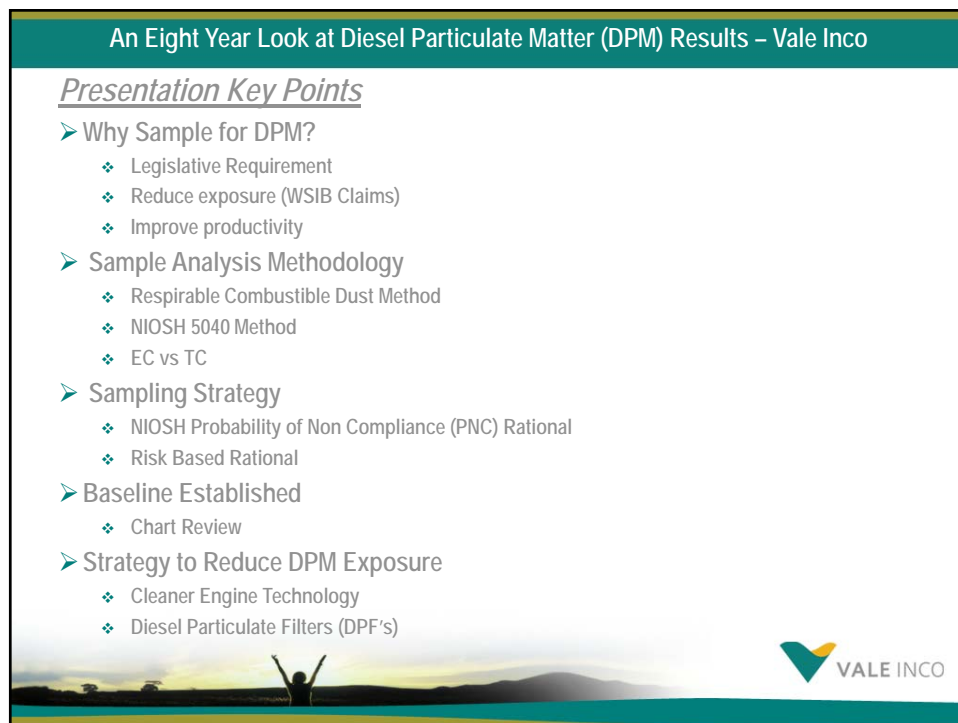




**An Eight Year Look
at Diesel Particulate Matter (DPM) Results
– Vale Inco**

2009 MDEC Conference



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Presentation Key Points

- Why Sample for DPM?
 - ❖ Legislative Requirement
 - ❖ Reduce exposure (WSIB Claims)
 - ❖ Improve productivity
- Sample Analysis Methodology
 - ❖ Respirable Combustible Dust Method
 - ❖ NIOSH 5040 Method
 - ❖ EC vs TC
- Sampling Strategy
 - ❖ NIOSH Probability of Non Compliance (PNC) Rational
 - ❖ Risk Based Rational
- Baseline Established
 - ❖ Chart Review
- Strategy to Reduce DPM Exposure
 - ❖ Cleaner Engine Technology
 - ❖ Diesel Particulate Filters (DPF's)



Why sample for DPM?

- ***Increased Awareness***
- ***Mines are seeing increased Worker Compensation costs due to Occupational Illness.***
- ***Legislative Bodies are reducing the exposure limits***
 - ❖ Ontario Ministry of Labour (MOL) = <1.5 mg/m³ RCD with pending reduction to < 0.4 mg/m³ TC (waiting Legislative approval)
 - ❖ MSHA in United States = < 0.16 mg/m³ TC or 1.3* EC mg/m³ (0.123 mg/m³ EC)
- ***Mines looking at improved productivity which results from healthier environment and workforce.***



Sampling & Analytical Methodologies

- ***Respirable Combustible Dust (RCD)***
- ***NIOSH 5040 Analysis Method***
- ***2001 Vale Inco Samples for DPM using the NIOSH 5040 analytical method***



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Sampling Strategies

- Vale Inco has historically utilized the NIOSH system using Probability of Non Compliance (PNC) rational
- In 2007, Vale Inco moved to utilizing a Risk Based rational
- Semi-Quantitative methodology currently used to conduct our Occupational Risk Assessments.



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Risk Based Assessment

- Sampling strategy is based on sampling the identified high risk tasks
- Risk Matrix is used to score Likelihood and Impact of Exposure
- Job Task Assessment Criteria
 - ❖ Job Analysis – define different tasks within each job
 - ❖ Employee Interviews – define individual tasks and perceived level of risk to exposures
 - ❖ Task Analysis – frequency & duration
 - ❖ Historical data – exposure results available – severity
 - ❖ Mitigation Strategy – what is in place to reduce or eliminate exposure



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Impact/Consequence		
Rating	Descriptor	Health
1	Low	No adverse effect, no medical treatment.
2	Minor	Minor irritant, reversible or temporary, minor health effect.
3	Moderate	Possible human carcinogen. Respiratory sensitizer. Permanent partial disabling injury. Irreversible health damage without loss of life.
4	Major	Ill health effects. Fatal diseases. Severe life shortening. Permanent health effect with substantial disability without loss of life.
5	Catastrophic	Extremely harmful, loss of life

Impact/Consequence results		
Based on Health Effect		
Contaminant	Impact value	Source
Heat	3 or 4	Environment/equipment
Noise	3	Fan/equipment
Vibration	3	Equipment
Carbon Monoxide	5	Blasting/equipment
Nitrogen Dioxide	5	Blasting/equipment
Respirable Dust	2	Ore
Silica	4	Ore
Total Carbon	3	Equipment
ICP		
Inhalable Dust	2	Ore
Inhalable Nickel	2	Ore/Depend on area
Insoluble	2	Ore/Depend on area
Inhalable Oil Mist	2	Equipment (hydraulic)
similar sources therefore similar likelihood		



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Likelihood		
Based on the likelihood of exceeding the Occupational Exposure Limit (OEL)		
1	Improbable	Is so unlikely, that it can be assumed that it may never exceed the %OEL. Rare
2	Unlikely	Remote, but exposure exceedance may occur sometime during the life of the operation. Infrequent-annually
3	Possible	Is likely to occur sometime in the life of the operation and may occur during non-routine operation. Occasional-monthly
4	Likely	Is likely to occur several times in the life of the operation. Frequent-weekly
5	Certain	Is likely to occur frequently. Continuous-daily

Inherent Risk - Prior to Mitigation						
Likelihood	Certain	0	0	5	0	0
	Likely	0	0	2	0	0
	Possible	0	2	5	0	0
	Unlikely	0	12	10	4	0
	Improbable	0	44	43	12	32
		Low	Minor	Moderate	Major	Catastrophic
		Impact				

Identify Additional Controls

Based on the risk-rating outcome of the qualitative risk assessment the following criteria and actions are required to control the risk. The level of acceptable risk may change based on agreed objectives, available resources, and policy.

- Low** No action required. Continue to monitor and review activities and hazards.
- Moderate** No additional controls required. Monitor and review on a routine schedule for changes. Improvements may be considered for implementation.
- High** Reduce the risk. Ensure controls are implemented and maintained. Preventative maintenance programs, work practices, and housekeeping procedures must be clearly established, written, and followed. Training on programs, practices, and procedures must be conducted on a regular basis. Collect data to verify and quantify exposure. A mitigation strategy must be developed.
- Extreme** Reduce the risk before continuing or starting the task, or use immediate temporary controls, such as personal protective equipment. A timetable for planning and implementation of additional controls should be included in a risk action plan, with responsibilities assigned, and reasonable due dates for completion. Collecting data to verify and quantify exposure. A mitigation strategy must be developed.



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Vale Inco
Interview: Hugh
Best viewed at 70% zoom

Deep **Development Miner Trackless**
Job Code: 243

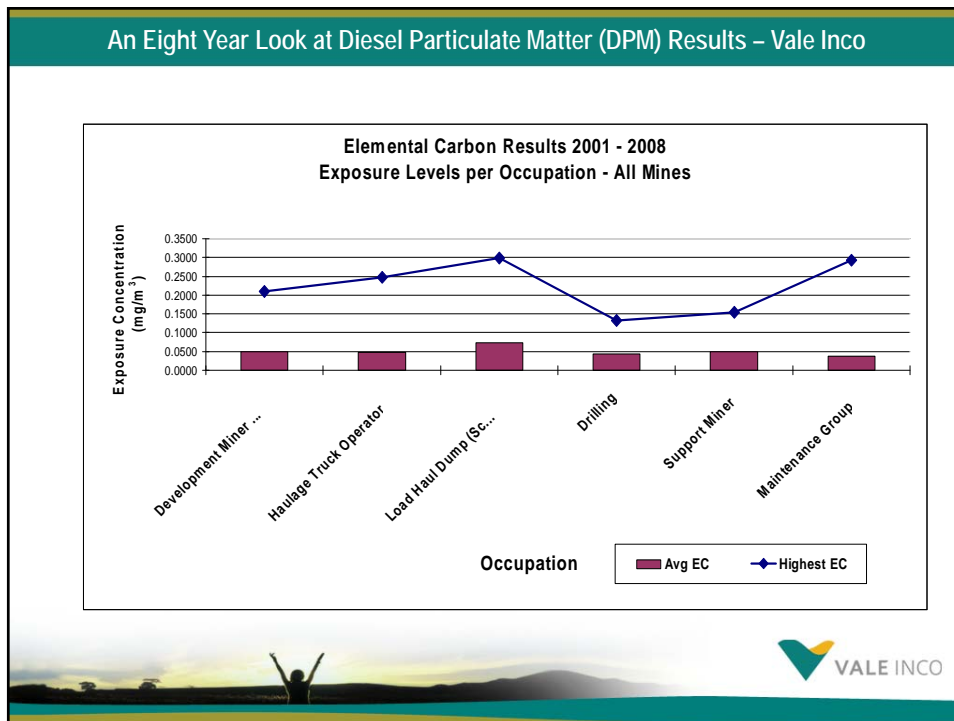
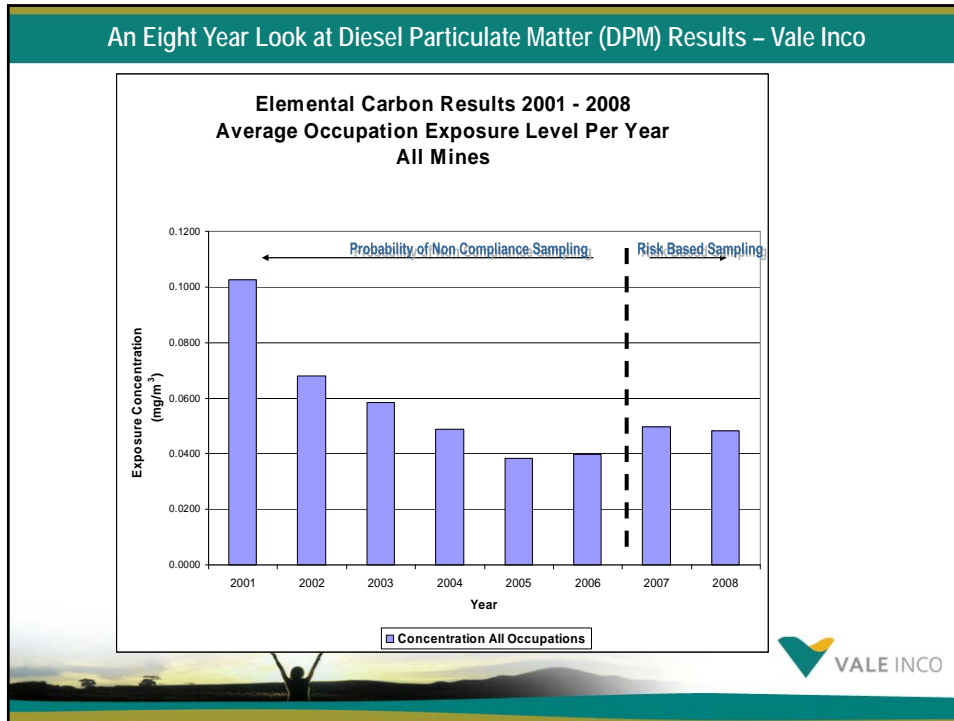
[Summary Matrix \(click here\)](#)

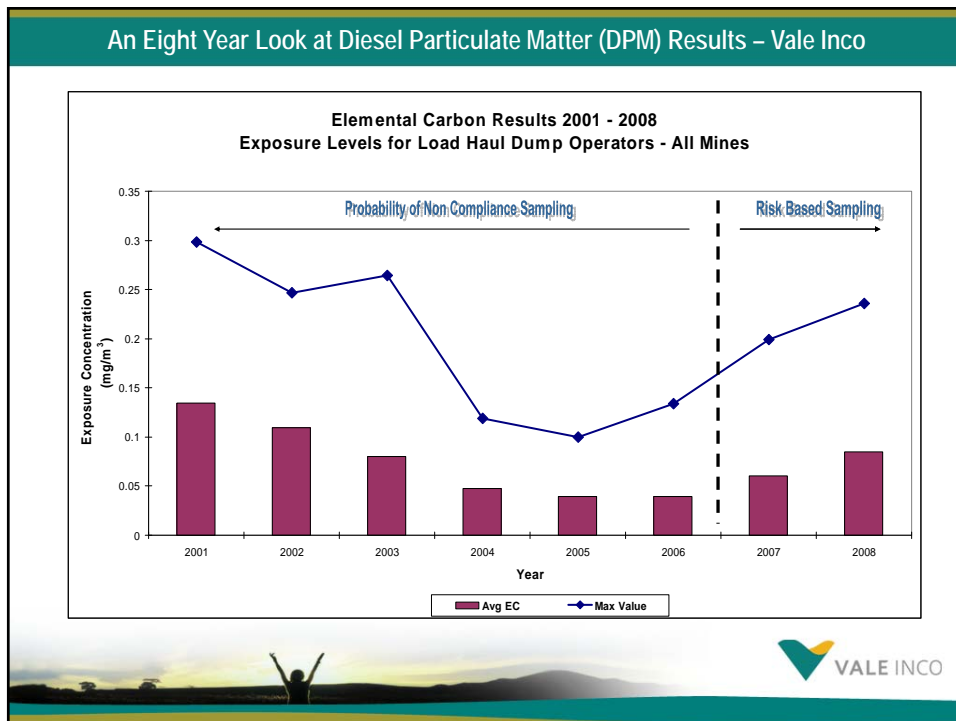
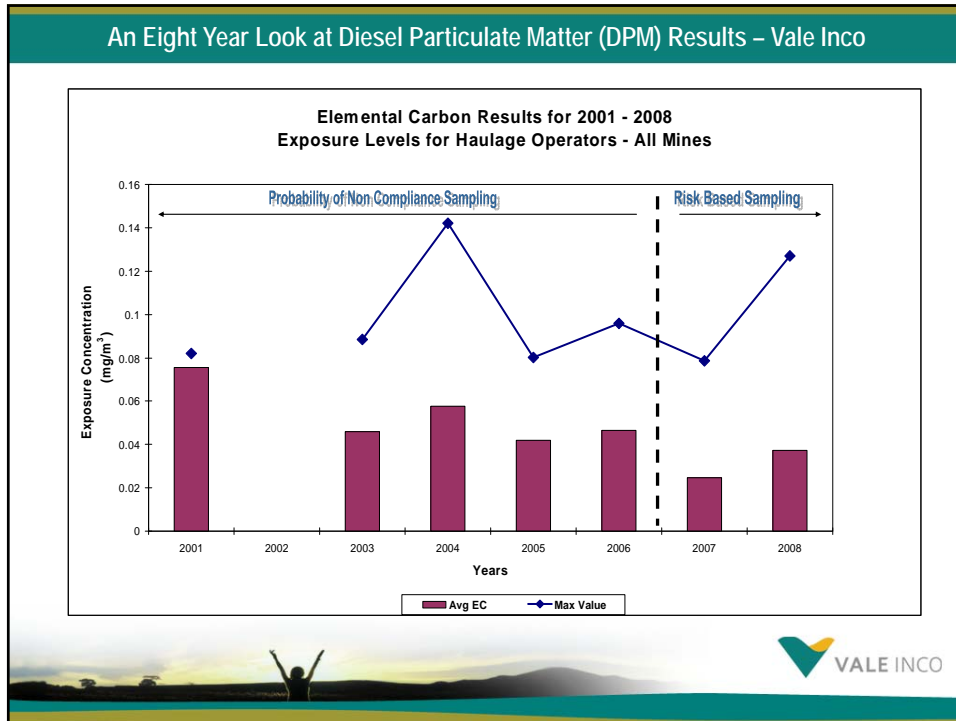
Risk	Task or Process Description	Sub Task Description	Qualitative				Mitigation Strategy
			Current Impact 1-5	Current Likelihood 1-5	Current Risk Score	Current Risk Category	
Total Carbon	Pre-op check of equipment	Mobile and Fixed	3	1	3	Low	ventilation/maintenance
	Face Prep	Wet down and Scale	3	1	3	Low	ventilation/
		Mark up face	3	1	3	Low	ventilation/
	Mucking	Muck to truck bag/ Truck	3	3	9	High	ventilation/maintenance/enclosed
		Muck to pass (ore / waste)	3	3	9	High	ventilation/maintenance/enclosed
	Ground Support	Bolt with Jackleg/screening	3	1	3	Low	ventilation/
		Bolt with Stopper/screening	3	1	3	Low	ventilation/
		Bolt with Mclean/screening	3	1	3	Low	ventilation/
		Shotcrete	3	3	9	High	ventilation/
		Screening	3	1	3	Low	ventilation/
	Services	Swellex-Jumbo or boltex	3	3	9	High	ventilation/
		Services (installation or repair air, water, vent)	3	1	3	Low	ventilation/air motor
	Drilling	Drill with Jackleg	3	1	3	Low	ventilation/
		Drill with Stopper	3	1	3	Low	ventilation/
		Drill with Jumbo	3	3	9	High	ventilation/maintenance/enclosed
		Drill with Plugger	3	1	3	Low	ventilation/
	Loading	Clean Holes	3	1	3	Low	ventilation/
		Explosive Delivery	3	1	3	Low	ventilation/
	Blasting	Load Holes	3	1	3	Low	ventilation/
		Wire Blast	3	1	3	Low	ventilation/
		Clear Areas for Blast Gases	3	1	3	Low	ventilation/

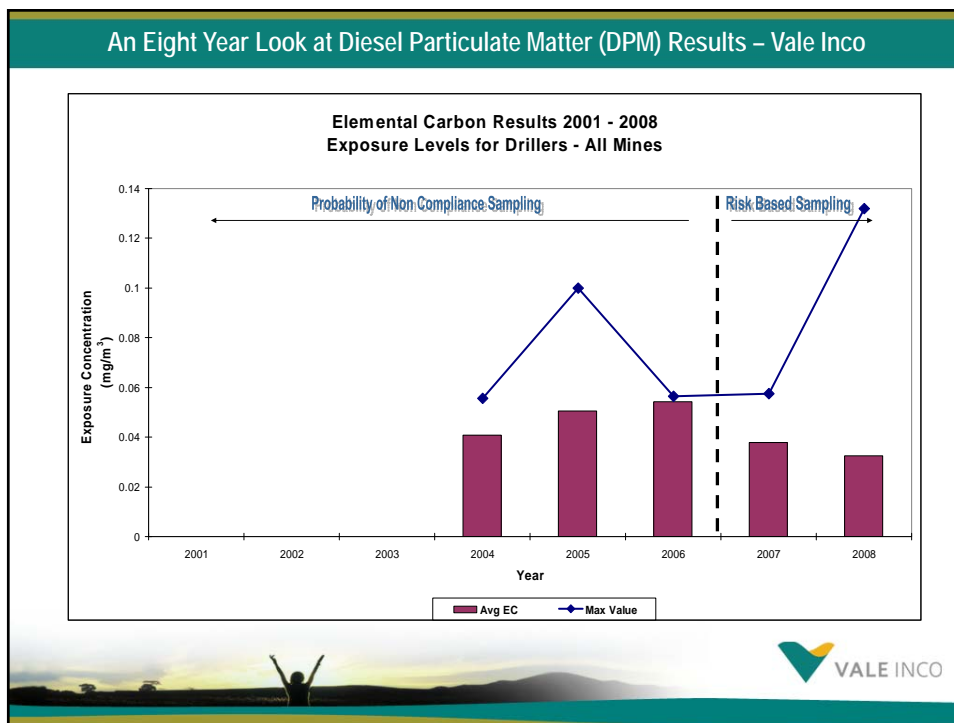
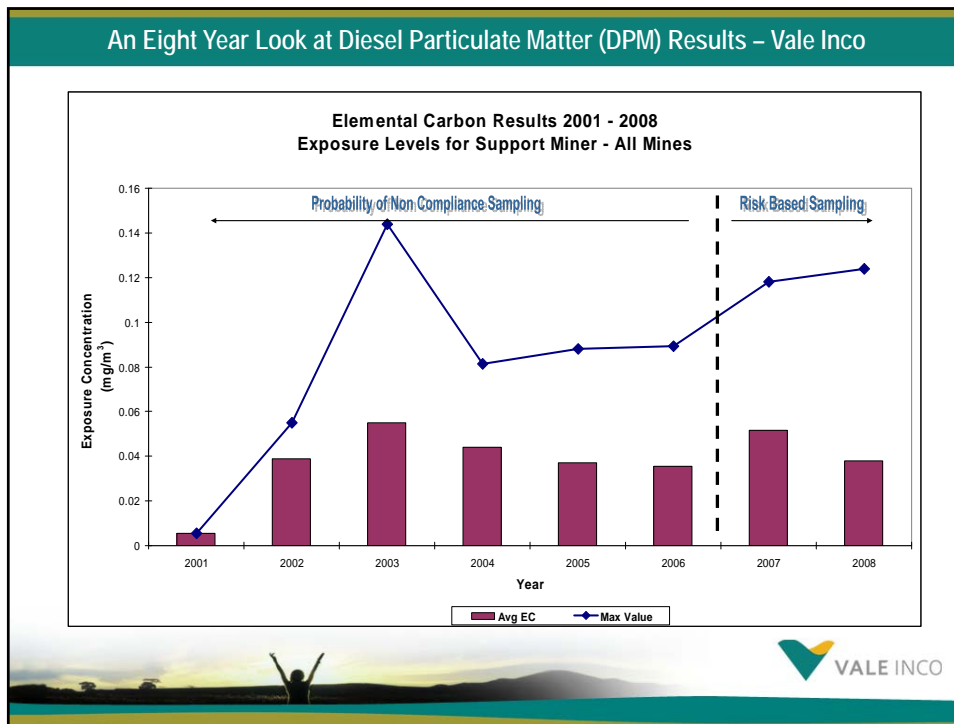
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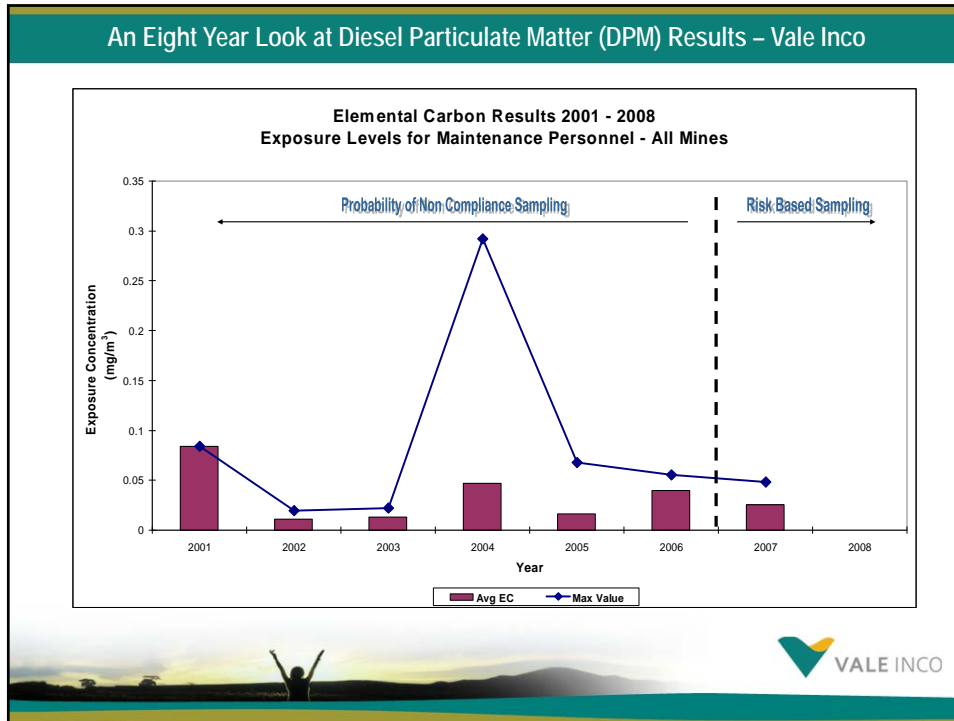
Vale Inco Baselines Established

- Analysis for this presentation focuses on EC exposure for 6 main tasks:
 - ❖ Development Miner
 - ❖ Haulage Truck Operator
 - ❖ Load Haul Dump Operator
 - ❖ Drilling
 - ❖ Support Miner
 - ❖ Maintenance
- Data is from full shift personal samples
- Changed sampling strategy in 2007 from Probability of None Compliance to Risk based approach.









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EC Sample Distribution

Task	Number of Samples	No. of Samples by Range of EC - mg/m3						Average mg/m3
		0.0 to 0.082	0.082 to 0.098	0.098 to 0.123	0.123 to 0.2	0.2 to 0.308	> 0.308	
Development Miner	75	61	5	5	3	1	0.0495	
Haulage Operator	51	43	4	1	3		0.0473	
LHD Operator	131	97	3	11	13	7	0.0737	
Drillers	30	27		2	1		0.0432	
Support Miner	68	61	3	2	2		0.0496	
Maintenance Personnel	90	85	1	1	2	1	0.0372	
Totals	445	374	16	22	24	9	0	0.0501
Percentage of Total		84	4	5	5	2	0	



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Strategy to Reduce EC Exposure

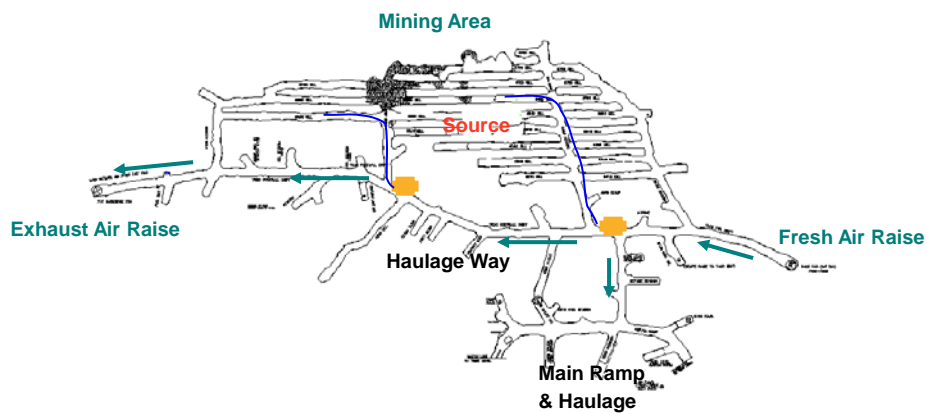
Vale Inco has been working towards reducing DPM to improve the air quality of the underground environment through the following initiatives:

- *Dilution: Focus on the design, installation and maintenance of good auxiliary ventilation systems.*
- *Maintenance: A good program resulting in high engine performance is key to reducing DPM at the source.*
- *Fuel: The use of ultra low sulphur diesel fuel.*
- *Diesel Particulate Filters: Investigation of reliable cost effective diesel particulate filters.*



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Example of Level Ventilation System



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Summary

1. Current Regulation limit in Ontario is 1.5 mg/m³ Respirable Combustible Dust (RCD) with a proposed limit of 0.4 mg/m³ TC (or EC x 1.3 < 0.4 mg/m³) pending legislative approval.
2. EC concentrations can be managed with good ventilation
3. Investigations show that exceedence can be expected if engines and ventilation is not well maintained.
4. Vale expects to see the EC exposure trends reduce over the next several years.
5. To meet exposure limits such as 0.16 mg/m³ TC *without exposure exceedence* requires further engine development or the application of exhaust after treatment technology.

