



Occupational Health Clinics for Ontario Workers Inc. (OHCOW).

Presented at
MDEC 2017



Is setting a suitably protective
occupational exposure limit
(OEL) for diesel particulate
matter (DPM) a “key driver”
to reduce exposure?

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Workplace Health Without Borders ([WHWB](http://www.whwb.ca))

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Weight of the evidence or Wait for the Evidence?
Protecting Underground Miners from Diesel Particulate
Matter



So what is the big deal?

Organisation	Year	Comments
HEI ¹	1999	Evidence not strong enough
ACGIH ²	2002	Recommended 0.02mg/m ³ (measured as REC)
ACGIH ²	2003	Recommended limit withdrawn
MSHA ³	2008	Evidence becoming stronger - Effective date for Occupational exposure limit (OEL) in the US for underground metal / non-metal 0.16mg/m ³ (TC) ~ 0.12 (REC)
IARC ¹	2012	Strong evidence – IARC monograph – confirmed carcinogen.
NCI / NIOSH ⁴	2010 - 2013	Study findings support a much lower OEL which may have a significant impact on UG mining.
HEI ¹	2013	Expert panel established
HEI ¹	2014 6 March	Workshop held in Boston – open to public, academia, regulators, industry and engine manufacturers.
HEI ¹	November 2015	Expert panel review released. Strong evidence! Likely significant impact especially in UG mining!

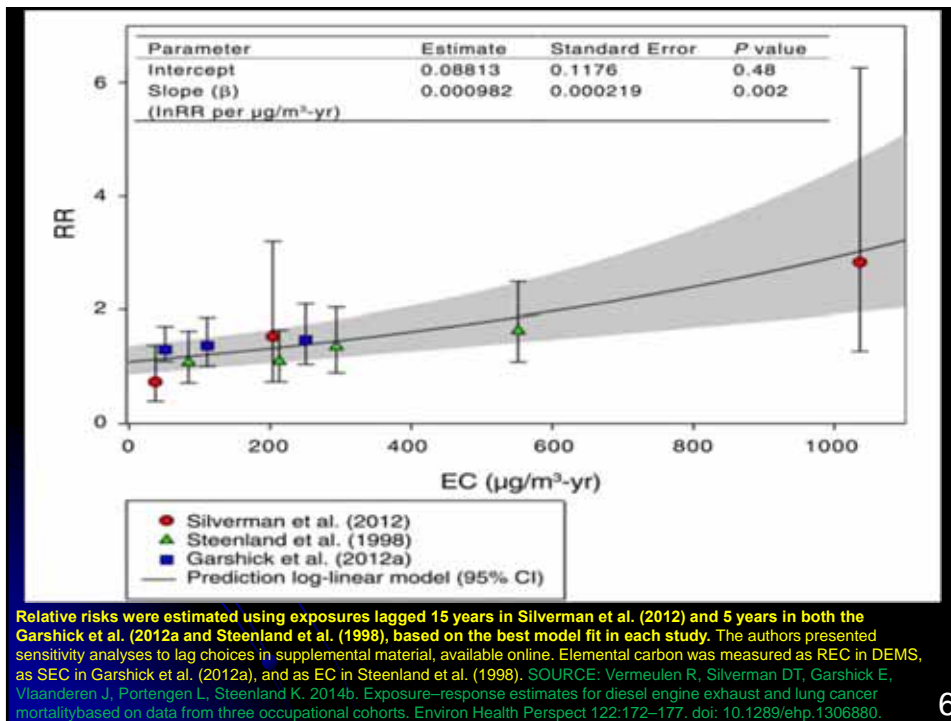
According to a recent article from the Australian Broadcasting Commission (ABC), Underground miners face high risk of lung cancer death from diesel exhaust exposure: study (17 November 2016):

“Diesel exhaust could be causing fatal lung cancer in underground miners at a rate of up to 38 times the accepted occupational risk, according to a new study”.

In light of the recent classification by the International Agency for Research on Cancer IARC (2013) Monograph 105 “Diesel engine exhaust is carcinogenic to humans (Group 1)”, and the subsequent review of the epidemiology by the Health Effects Institute (HEI) the question should be asked:

Are regulators setting occupational exposure limits at levels low enough to drive continuous improvement and provide the impetus for newer technology such as tier 4 engines and battery powered vehicles in underground mining?


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Health Canada (2016) – Human Health Risk Assessment for Diesel Exhaust

Health effects	Evidence
Lung cancer	Sufficient
Acute adverse respiratory effects	Sufficient
Chronic adverse respiratory effects	Sufficient
Acute adverse cardiovascular effects	Sufficient
Immunological effects	Sufficient
Bladder cancer	Suggestive
Chronic adverse reproductive and developmental effects	Suggestive
Central nervous system effects based on acute neurophysiological symptoms in overexposed workers	Suggestive



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Occupational health and safety legislation and regulations are a method for the **primary prevention** of injury and disease at the societal level. They are intended to establish a **minimum level** of protection either for all workers or for those in specific industries.

Regulatory approaches to preventing occupational disease include: **limits on levels of exposure**

A **performance-based** regulation establishes the endpoint and allows the employer to identify the most suitable means of achieving it. A **prescriptive regulation specifies the endpoint** and the means by which it is to be achieved.

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R.R.O. 1990, Reg. 854: MINES AND MINING PLANTS 183.1 (4)

The flow of air must reduce the concentration of toxic substances in diesel exhaust emissions to prevent exposure of a worker to a level in excess of the limits prescribed under section 4 of Regulation 833 of the Revised Regulations of Ontario, 1990 (Control of Exposure to Biological or Chemical Agents) made under the Act. O. Reg. 265/15, s. 11.

(5) The flow of air must,

- (a) reduce the time-weighted average exposure of a worker to total carbon to **not more than 0.4 milligrams per cubic metre of air**; or
- (b) reduce the time-weighted average exposure of a worker to **elemental carbon, multiplied by 1.3, to not more than 0.4 milligrams per cubic metre of air.**

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<https://www.legislation.qld.gov.au/view/pdf/inforce/current/sl-2017-0166>

135 Limiting workers' exposure

- (1) The site senior executive must ensure a worker's exposure to a hazard at the mine—
 - (a) does not exceed the exposure limit applying to the worker for the hazard; and
 - (b) is as low as reasonably achievable.

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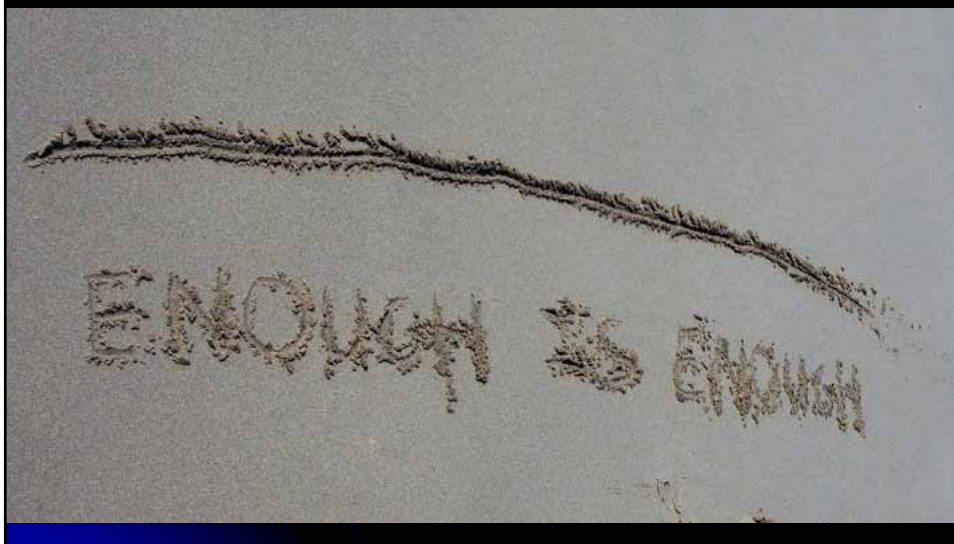
While safe levels of exposure “promulgated” as occupational exposure limits (OELs), are being discussed and debated,

it appears that previously acceptable OELs are no longer safe.

Therefore it is important that the internal responsibility system be implemented and the precautionary principle approach be followed, especially as it may be some time before a suitably protective OEL specifically for diesel particulate matter (DPM) is in place.

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There must be a line in the sand!



Mining (differences between jurisdictions)

Canada	Early 1990's	1.5mg/m ³
Ontario	2012	0.4 mg/m ³ TC equivalent to 0.31 EC (Quebec is now the same)
MSHA American mines	2008	0.16 mg/m ³ TC equivalent to ~ 0.12 EC (dividing TC by 1.3)
Australia		0.1mg/m³ EC (measured as submicron elemental carbon)

Note: Occupational Exposure Limit for Provinces in Canada are **3 X US & Australia.**

Notes:

Newfoundland / Labrador is the same as ON
Quebec has changed from RCD to TC using NIOSH 5040 in early 2016 and reduced from 0.6 RCD to 0.4 TC in 2016.

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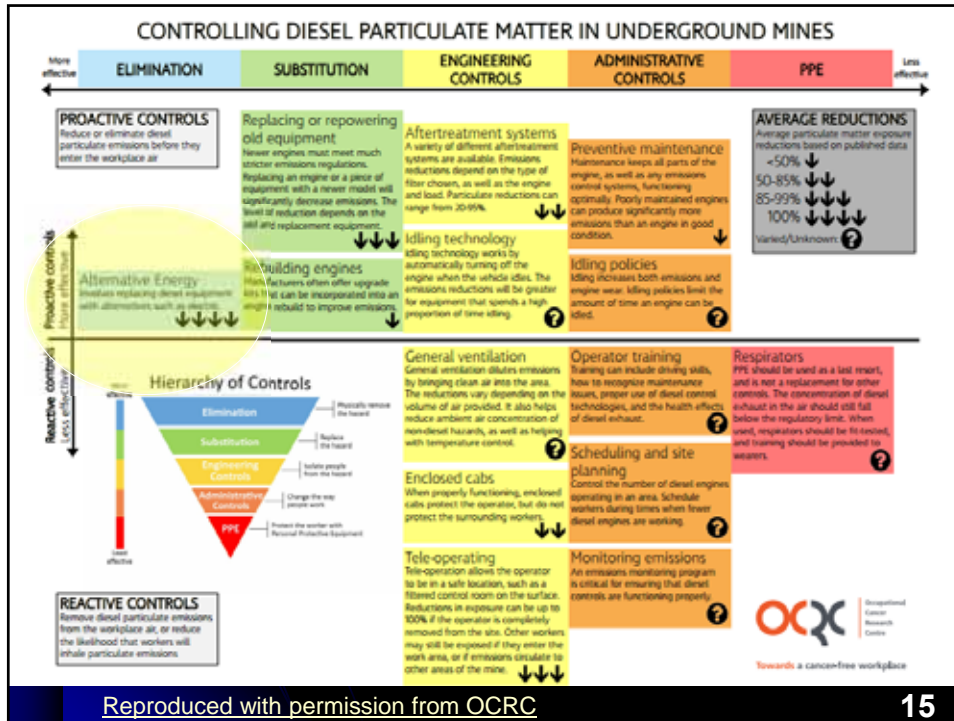
Dr. Rob McDonald VP Health and Hygiene, BHP Billiton.

Australian Institute of Occupational Hygienists (AIOH), plenary December 2016.

- “Significant **lag** that exists between regulatory action and the level of science that informs health risk”.
- “Should be managing exposure to diesel exhaust to **as low as technically feasible**”.
- Interim target to be managing diesel exhaust to **0.03mg/m³** TWA 8-hrs measured as elemental carbon.

https://www.youtube.com/watch?v=n_iFh-BsECo&feature=youtu.be&a

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GE and BHP Billiton announce global partnership to improve efficiency and reduce emissions in the mining sector

<http://www.genewsroom.com/press-releases/ge-and-bhp-billiton-announce-global-partnership-improve-efficiency-and-reduce>

Using battery powered vehicles ie. battery powered scoop used underground.
<https://gereports.ca/breathing-easier-underground/>

We have the technology!

Must be action when line is crossed!

4.1 GASEOUS EXHAUST EMISSIONS

When tested in accordance with SECTION 5 *Monitoring of Diesel Engine Pollutants* the raw exhaust gas of the diesel engine shall:

- a) not exceed the limits specified in Table 3 below, and
- b) be compared against the baseline limits as specified in Table 4 below.

Description	CO (ppm)	NO (ppm)	NO ₂ (ppm)	NO _x (ppm)
Type testing of new engines for underground coal mines without methane injection ¹	900	100	100	-
Type testing of new engines for underground coal mines with methane injection ²	900	100	100	1,000
In-service engines in underground coal mines	1,100	900	100	1,000
Engines in other underground environment	1,100	900	100	1,000

Table 3 – Raw exhaust gas limits for diesel engines operating in underground environments

Notes:

- 1. Based on the coal legislation

“In NSW Australia Where “failed” - must be withdrawn from use underground”

Any engine which fails to meet the specified limits above must have the licensed laboratory report stamped with a ‘FAIL’ and must be withdrawn from use in the underground environment.

Source MDG 29 (2009) *Guideline for the management of diesel pollutants underground.*

ON Limit CO 600 ppm

In ON there is no requirement to measure NO, NO₂, or NO_x

Nitrogen dioxide:

Caution there may be an **increase in nitrogen dioxide after installing a diesel oxidation catalyst (DOC).**

NIOSH note

“ The concentration of nitrogen dioxide should also be monitored before and after the DOC. A history of this data should be stored to assess the activity of the DOC in increasing the concentration of this compound”.

NIOSH (2011): Diesel Aerosols and Gases in Underground Mines: Guide to Exposure Assessment and Control

See also MSHA: HEALTH HAZARD ALERT Underground Coal Mines Increased Nitrogen Dioxide (NO₂) Emissions

Occupational Cancer Research Centre (OCRC) (2017)

The Occupational Cancer Research Centre recommends reducing personal exposure to **0.02 mg/m³** measured as elemental carbon.

More than a **10-fold reduction** from the current ON mining limit

Reg. 854: MINES AND MINING PLANTS 183.1 (4)

<http://www.occupationalcancer.ca/2017/controlling-dpm-in-mining/>

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Think about the future!

Switzerland

Diesel engines used in new construction machines must comply with a **Swiss particle number (PN) emission limit**. The PN emission requirements ensures that all construction machines sold in Switzerland be fitted with **diesel particulate filters**.

<https://www.dieselnet.com/standards/ch/>

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Need to understand what the exposures are by carrying out a baseline exposure assessment for diesel particulate matter (DPM) measured as total and elemental carbon.

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NIOSH 5040



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Measure nitrogen dioxide as well!

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SKC markets a passive sampler called the UMEx. <http://www.skcltd.com/passive-samplers/9-uncategorised/270-umex-passive-samplers-3> and CASSEN offers analysis of these devices. <http://www.cassen.ca/>

The reported detection limit is 6 ppb for 8 hours.

Maxxam Laboratories has a passive environmental monitor <http://maxxam.ca/services/air-services/passive-air-sampling-2> which is intended for 30 days exposure. The reported detection limit is 0.1 ppb for 30 days, which suggests a very similar detection limit for 8 hours.

(Courtesy John Petherick)



See Dräger white paper

https://www.draeger.com/en-us_ca/Mining/Mine-Safety-No2-Limits

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doi: 10.1093/annweh/wwx024
Advance Access publication 29 March 2017
Original Article

BOHS
The Occupational Hygiene Society
Member of the British Society for Occupational Hygiene

OXFORD

Original Article

Diesel Exhaust Exposure Assessment Among Tunnel Construction Workers – Correlations Between Nitrogen Dioxide, Respirable Elemental Carbon, and Particle Number

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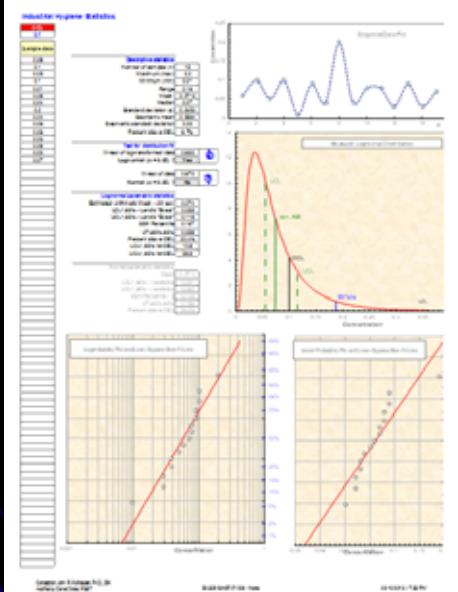
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Carry out statistical analysis to understand exposure profiles, identify outliers and risk rank exposure groups to prioritize controls.

“Drill down” - clearly define similar exposure groups (SEGs).

Avoid pooling the data into a **blancmange!** YOU WILL GET FALSE READINGS

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The screenshot displays the IHStat software interface. It features a central data table with columns for substance name, concentration, and other parameters. To the right, there are several graphs: a line graph showing fluctuating exposure levels over time, a bell-shaped curve representing a distribution, and two scatter plots with regression lines. The interface includes various input fields and dropdown menus for configuring the assessment parameters.

<http://www.aiha.org/get-involved/VolunteerGroups/Pages/Exposure-Assessment-Strategies-Committee.aspx>

Examples of guidance / tools

Assessing acceptability of occupational exposures against occupational exposure limits

Agency	Tool
American Industrial Hygiene Association (Exposure Assessment Strategies Committee)	IHStat https://www.aiha.org/get-involved/VolunteerGroups/Pages/Exposure-Assessment-Strategies-Committee.aspx
British / Dutch Occupational Hygiene Society Sampling strategy guidance published in 2011 'Testing Compliance with OELs for Airborne Substances', BOHS/NVvA (Dutch occupational hygiene society) working group	BOHS / Dutch BWSatv2 http://www.bohs.org/library/technical-publications/
Australian Institute of Occupational Hygienists WES Adjustment tool for extended shifts	AIOH https://www.aioh.org.au/
University of Montreal NDExpo – Treatment of non-detects in industrial hygiene samples	University of Montreal http://www.dsest.umontreal.ca/recherche_rayonnement/NDExpo/nd7.htm

Establish a diesel emission management program and nominate a champion.

Visibility to the highest level of management in a clear and concise way!

What gets measured gets noticed.....what gets noticed gets action!

*Engage all (at risk) workers & managers, across all Departments in raising awareness and management this important issue. Must be **multi disciplinary** and there is **no silver bullet!***

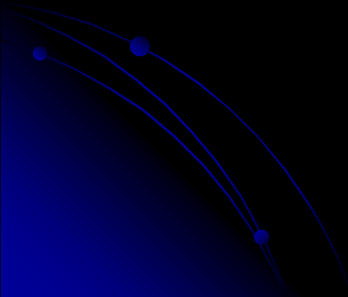
Develop performance measures!

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Can an exposure reduction (EC) be achieved in underground mining?

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What gets measured gets noticed,
what gets noticed gets action:



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Operations | Occupational Health & Safety | Employment Standards | 

Ontario Mining Regulation Amendment 2012

RCD Changed Total Carbon

- The flow of air must reduce the time-weighted average exposure of a worker to total carbon to not more than 0.4 milligrams per cubic metre of air; or reduce the time-weighted average exposure of a worker to elemental carbon, multiplied by 1.3, to not more than 0.4 mg/m³. (subsection 183.1(5))

Exhaust Limit

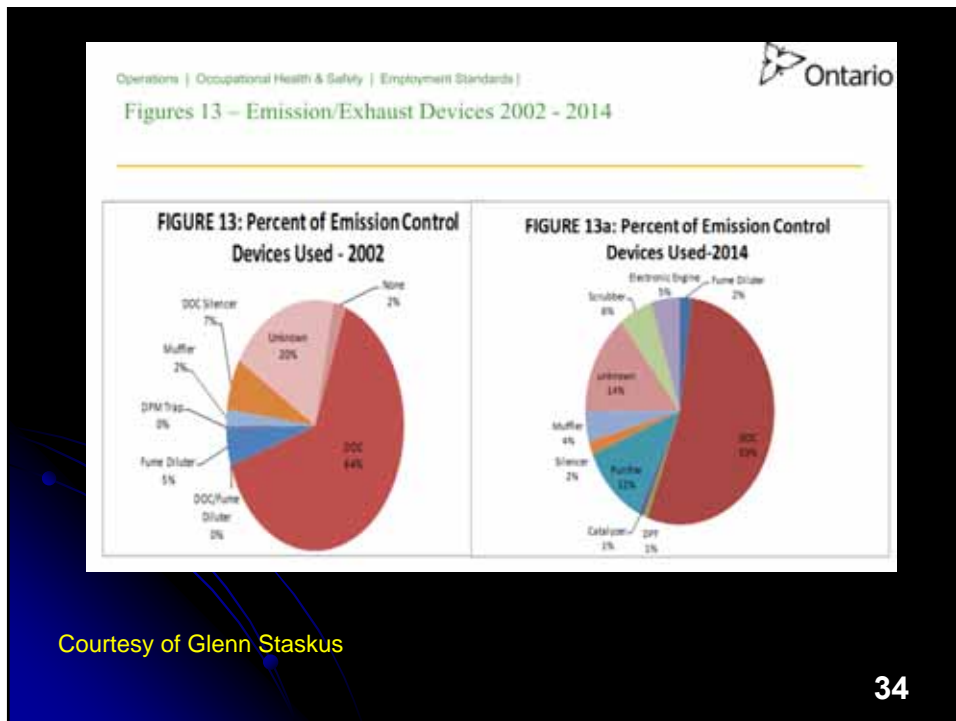
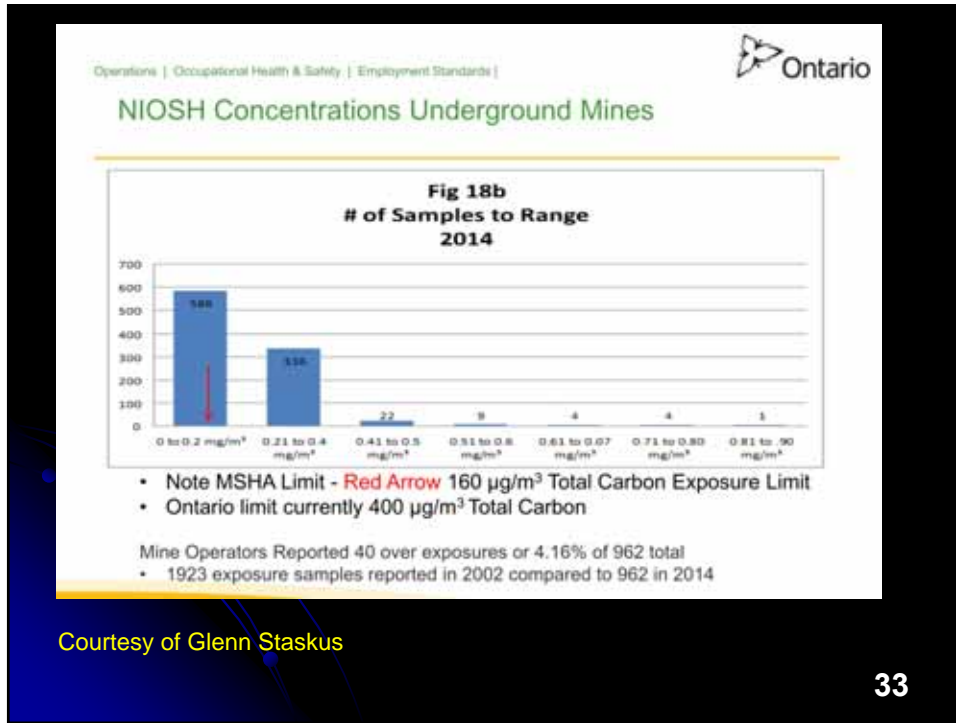
- In addition, employers are required to ensure that the undiluted exhaust emissions from diesel-powered equipment contain less than 600 parts per million (PPM) by volume of carbon monoxide (down from the previous limit of 1500 PPM). (subsection 182(5))

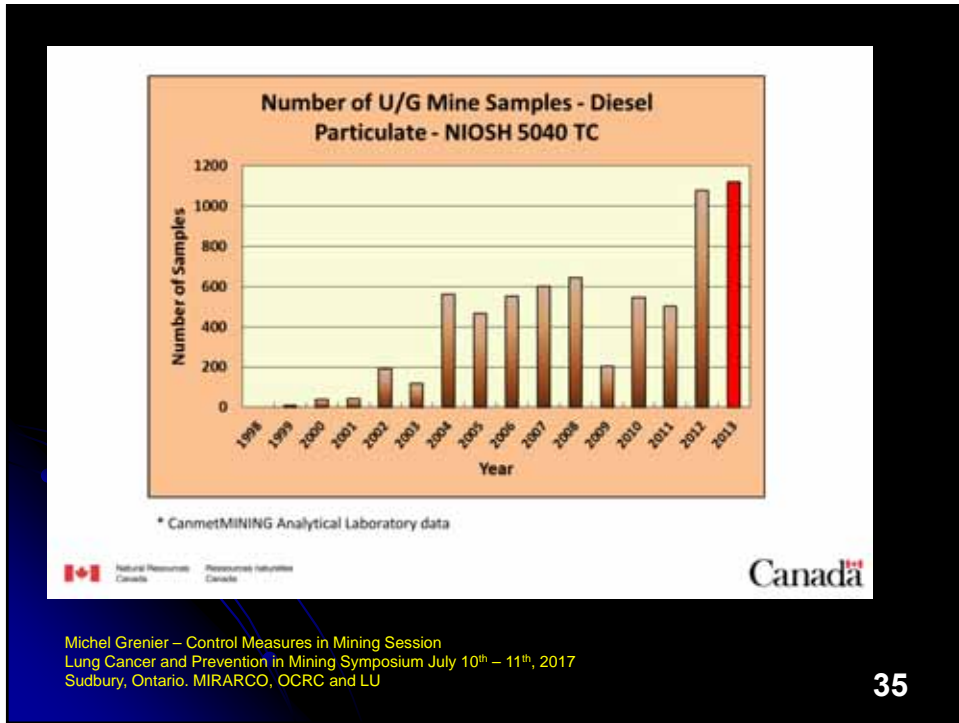
Testing Procedures Developed in Consultation with JHSC

- Each individual piece of equipment must be tested under consistent conditions so that results from different tests can be compared. (subsection 183.2(1.1))

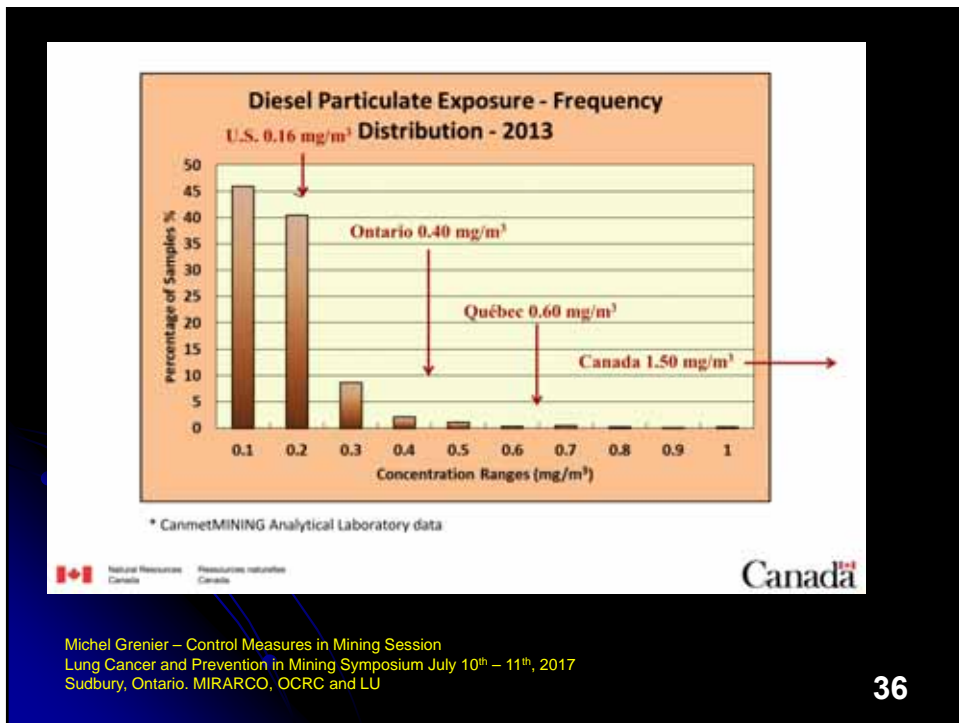
Courtesy of Glenn Staskus

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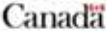


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Percentage of Samples in Excess of Various Exposure Limits – 2013 Canadian Underground Mine Data (1000+ samples)

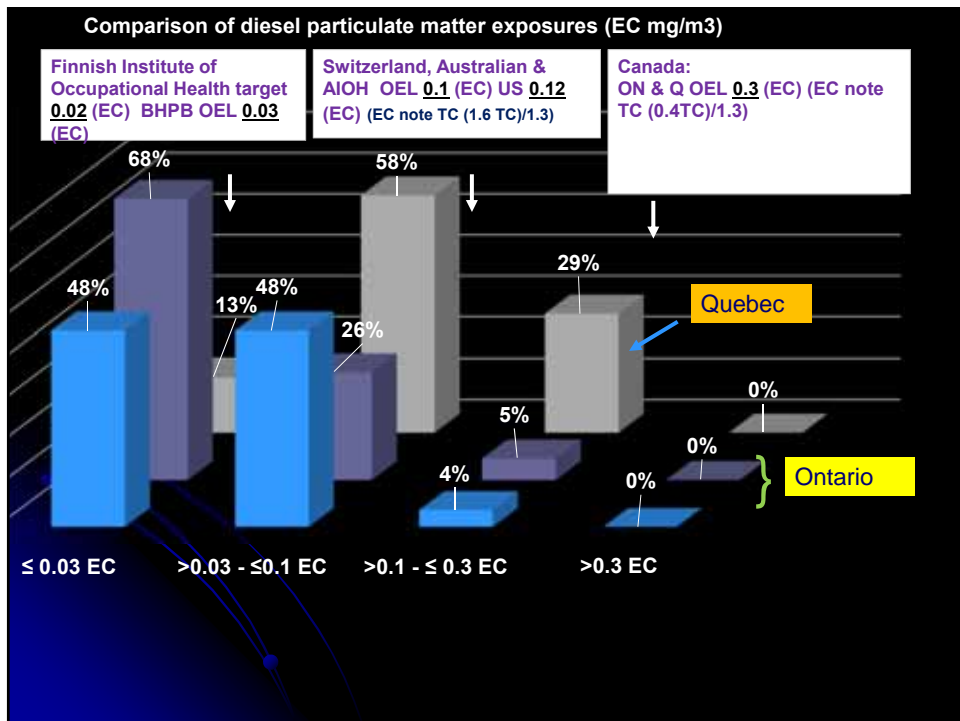
Exposure limit (mg/m ³)	% of samples in excess of limit
1.5 (Canada)	0
0.6 (2003 Québec)	1.5
0.4 (Ontario)	3
0.16 (USA – MSHA)	26

* CanmetMINING Analytical Laboratory data

Michel Grenier – Control Measures in Mining Session
Lung Cancer and Prevention in Mining Symposium July 10th – 11th, 2017
Sudbury, Ontario. MIRARCO, OCRC and LU

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Australia Queensland Mines Inspectorate (QMI)

Brief History – the need for a database

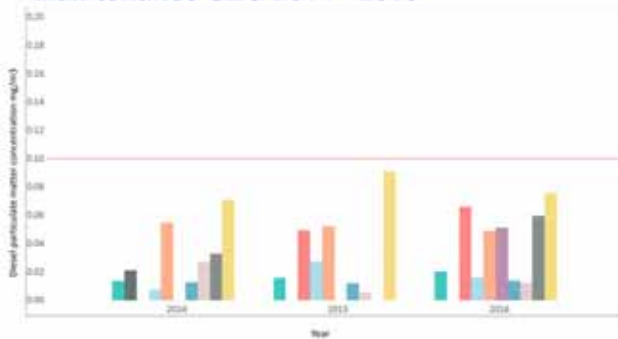
- QMI reviewed 2012 – 2014 data
- QMI reviewed data to 2000
- Regulatory amendments Jan 2017 requiring results to be reported to QMI



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Australia Queensland Mines Inspectorate (QMI)

Mean diesel particulate matter – UG Maintenance SEG 2014 - 2016



Courtesy of Fritz Djukic and Eliza Gill
Principal Occupational Hygienist | Mine Safety & Health Department of
Natural Resources and Mines

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Is setting a suitably protective occupational exposure limit (OEL) for diesel particulate matter (DPM) a “key driver” to reduce exposure?

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Taking care of our future



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Every worker home safe and HEALTHY every day



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Australian Institute of Occupational Hygienists (AIOH) Position paper on diesel particulate matter and occupational health issues
<https://www.aioh.org.au/>

Safe Work Australia
<http://www.safeworkaustralia.gov.au/sites/swa/australian-strategy/vss/pages/dangers-diesel-exhaust-fumes-for-business>
(there is a podcast!)

NSW Mine Design Guideline 29
http://www.resourcesandenergy.nsw.gov.au/_data/assets/pdf_file/0011/419465/M-DG-29.pdf

**Canada Mining Diesel Emissions Council
(MDEC)** <http://www.mdec.ca/>