Occupational Health Clinics for Ontario Workers Inc.

1st Annual Mining Vehicle Powertrain Conference (MVPC) 2023

Reduction of Diesel Emissions as part of an overall Airborne Hazard Management Program

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http://www.ohcow.on.ca/

What this presentation will cover:

- Recap on previous MDEC presentations.
- Occupational exposure limits are not fine dividing lines.
- Health effects, epidemiology and recent research.
- Diesel emissions contain "**Non-threshold**" Genotoxic Carcinogens – what does this mean?
- Reduce diesel emissions "as low as reasonably practicable" (ALARP), and as part of an overall Airborne Hazard Management Program, required in Regulation 854
- When measuring and evaluating airborne hazards, it is also important, that the risk assessment be carried out for a mixture.

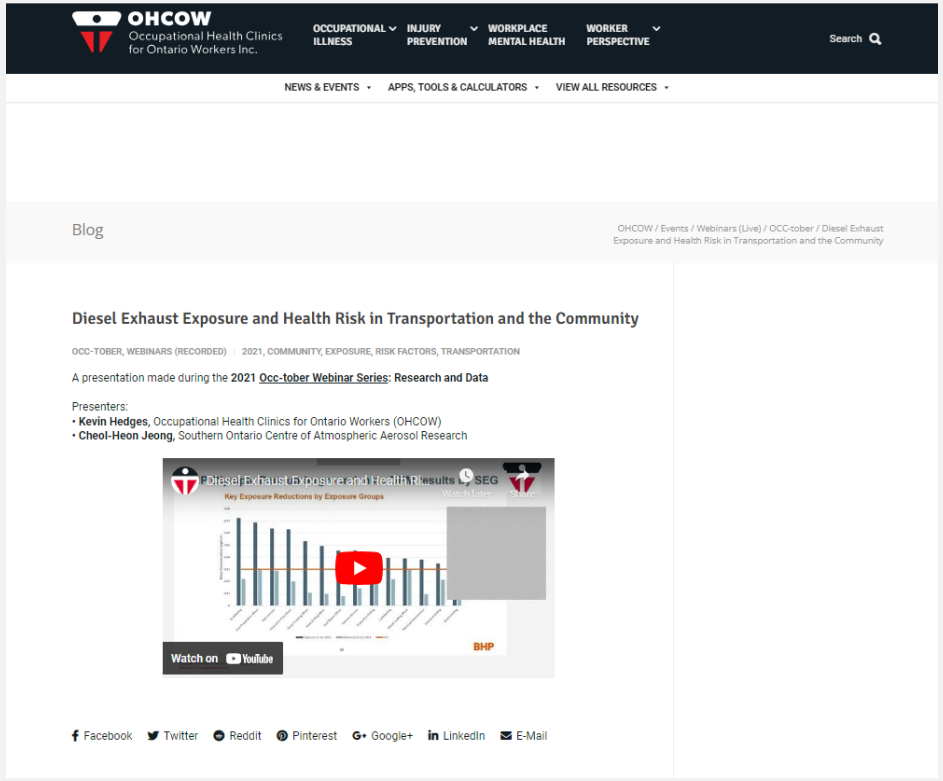
MDEC year	Title
MDEC 2013	Diesel emission in underground mining – A program for control, shared learning from Queensland Australia.
MDEC 2017	Is setting a suitably protective occupational exposure limit (OEL) for diesel particulate matter (DPM) a "key driver" to reduce exposure.
MDEC 2018	Occupational disease action plan (ODAP) and collaboration between system partners.
MDEC 2019	Diesel emission reduction.
MDEC 2022	The Past, Present and Future: Diesel Exhaust Exposures in Mining – A Tool to Assess Lung Cancer Risk

Via OHCOW webinars

https://www.ohcow.on.ca/posts/emissions-based-diesel-engine-maintenance/

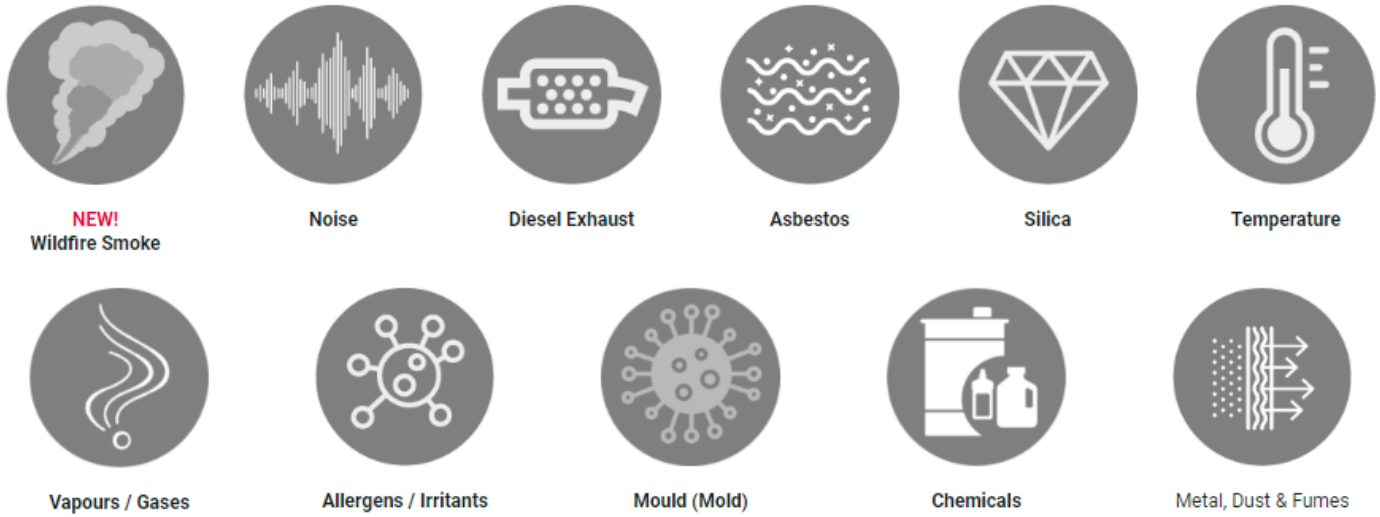
Diesel Exhaust Exposure and Health Risk in Transportation and the Community

- OCC-TOBER, WEBINARS (RECORDED)
- 2021, COMMUNITY, EXPOSURE, RISK FACTORS, TRANSPORTATION



EXPOSURES

Exposure to hazards in the workplace can result from many sources including:



These hazards are outlined in greater detail below and resources are provided where available.

WILDFIRE SMOKE

Smoke from wildfires is a definite concern for both indoor and outdoors workers.
The biggest health concern from smoke is from fine particles (PM2.5) that can irritate or harm eyes and your respiratory system.
There are several things you can do to minimize your risk while at work.
Your employer also has responsibility to do everything "reasonable" to protect you.

https://www.ohcow.on.ca/occupational-illness/exposures/

DIESEL EXHAUST LUNG CANCER RELATIVE RISK CALCULATOR

[15 Year Lag]

A calculator designed to assist you in determining your risk of developing lung cancer from exposure to diesel fumes.

The International Agency for Research on Cancer (IARC) has concluded that Diesel Engine Exhaust (DEE) is a cause of lung cancer (Group 1: carcinogenic to humans). CAREX Canada estimates that approximately 897,000 Canadians are currently exposed to diesel engine exhaust at work. Approximately 2.4% (OCRC) to 6% (Vermeulen et al 2014) of annual lung cancer deaths may be due to DEE exposure.

Combined data from three U.S. occupational cohort studies including more than 40,000 workers in the trucking and mining industries (Vermeulen et al 2014) have provided a powerful estimate of the risk of lung cancer based on the level and duration of exposure to DEE. The truckers' study Garshick et al. (2012) and miners' studies Silverman et al. (2012), (Attfield et al. 2012), (Stewart et al. 2010) combined, allows for a determination of the risk of lung cancer based on the level of exposure to diesel particulate matter (DPM). DPM measured as elemental carbon (EC) is the best surrogate of exposure.

The following calculator, created by OHCOW, can be used as a guide to communicate the risk from DEE exposure and lead to prevention.

The tool requires either an ***estimate*** of exposure, as **EC** (NIOSH 5040) and duration of exposure.
Where the only measures available are total carbon (NIOSH 5040) or Respirable Combustible Dust (RCD) conversion factors have been provided.

The Calculator

You can use this calculator in **two** ways:

1. Let the calculator automatically enter data by selecting an occupation and entering your exposure period.
2. If you have actual readings, you can leave the occupation blank and enter the data manually.

Occupation

Exposure Period

20 Years

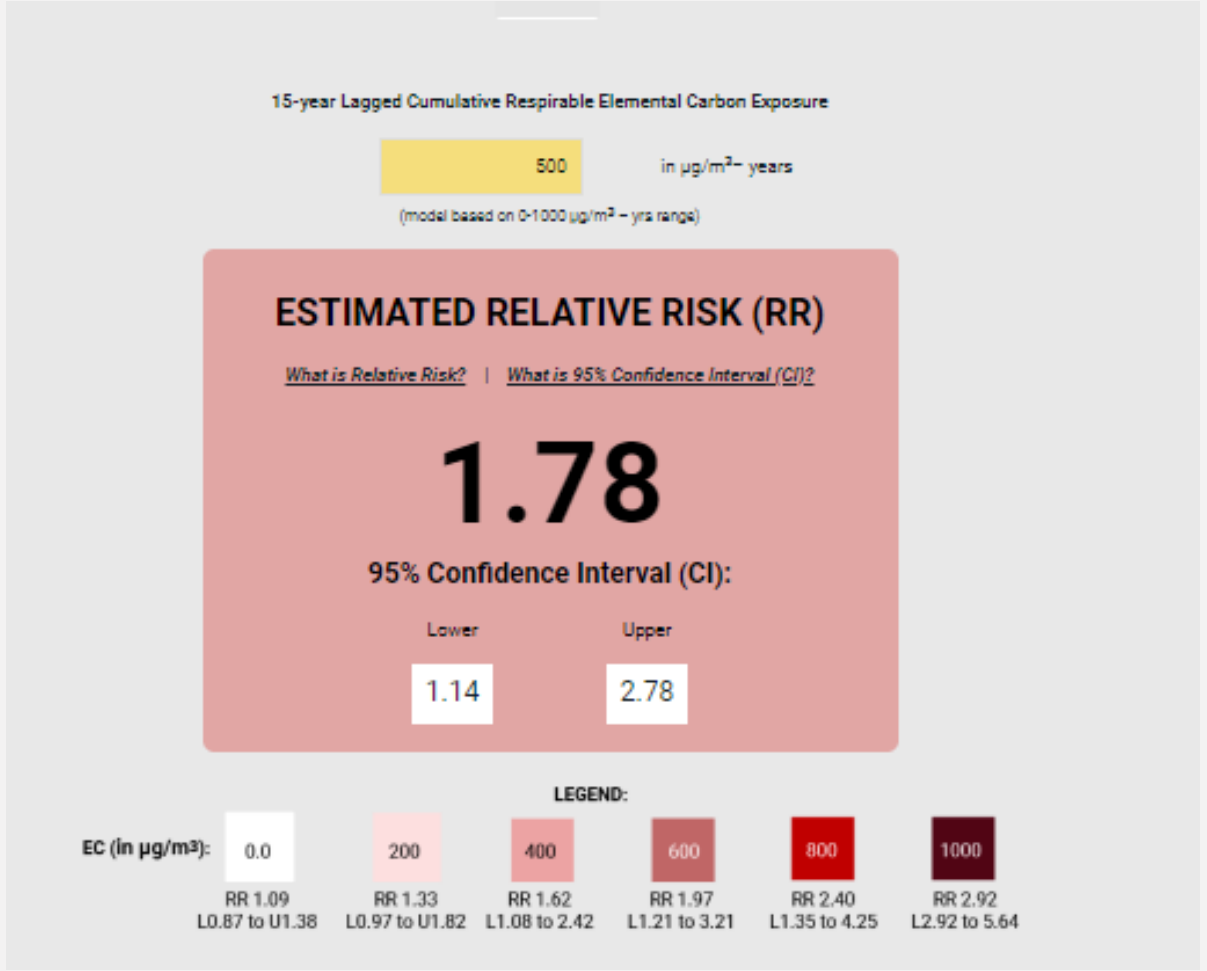
Average Respirable Elemental Carbon (REC) Exposure

100 in µg/m³

CONVERSION FACTORS for MINERS

CALCULATE

CLEAR



https://www.ohcow.on.ca/resources/apps-tools-calculators/diesel-exhaust-relative-risk-calculator/

Recent research

Diesel Exhaust in Miners Study updated literature

The Diesel Exhaust in Miners Study (DEMS) II: Temporal Factors Related to Diesel Exhaust Exposure and Lung Cancer Mortality in the Nested Case–Control Study (August, 2023)
https://ehp.niehs.nih.gov/doi/10.1289/EHP11980

Diesel Exhaust Exposure and Cause-Specific Mortality in the Diesel Exhaust in Miners Study II (DEMS II) Cohort (August 2023)
https://ehp.niehs.nih.gov/doi/full/10.1289/EHP12840

Invited Perspective: Diesel Exhaust and Lung Cancer—Delayed Findings Confirmed, but Consequences Continue (August 2023)
https://ehp.niehs.nih.gov/doi/full/10.1289/EHP13258

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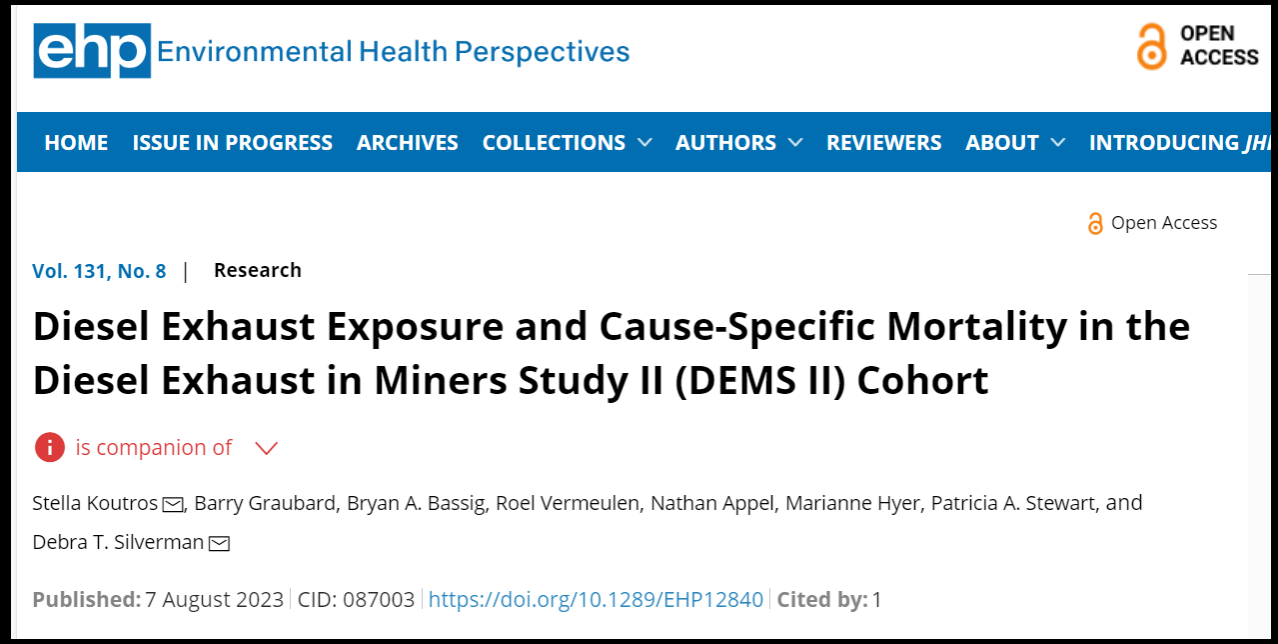
Vol. 131, No. 8 | Research

The Diesel Exhaust in Miners Study (DEMS) II: Temporal Factors Related to Diesel Exhaust Exposure and Lung Cancer Mortality in the Nested Case–Control Study

is companion of

Debra T. Silverman, Bryan A. Bassig, Jay Lubin, Barry Graubard, Aaron Blair, Roel Vermeulen, Michael Attfield, Nathan Appel, Nathaniel Rothman, Patricia Stewart, and Stella Koutros

Published: 7 August 2023 | CID: 087002 | https://doi.org/10.1289/EHP11980 | **Cited by:** 2



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Diesel Exhaust Exposure and Cause-Specific Mortality in the Diesel Exhaust in Miners Study II (DEMS II) Cohort

is companion of

Stella Koutros, Barry Graubard, Bryan A. Bassig, Roel Vermeulen, Nathan Appel, Marianne Hyer, Patricia A. Stewart, and Debra T. Silverman

Published: 7 August 2023 | CID: 087003 | https://doi.org/10.1289/EHP12840 | **Cited by:** 1

Cumulative REC

Tripling of risk for exposures of about 950 to less than 1700 micrograms per meter cubed per year~950 to<1,700 µg/m3-y (equivalent to an exposure of 0.05mg/m^3 to < 0.08 mg/m^3. for a period of 20 years).

[odds ratio equals 3.23 OR=3.23; 95% confidence interval (CI): 1.47, 7.10]

Also observed a significant trend in non-Hodgkin lymphoma (NHL) risk with increasing 20-y lagged cumulative REC.

Excesses in deaths for diseases of the respiratory and cardiovascular system, including ischemic heart disease and cerebrovascular disease, warrant further study and provide evidence of the potential widespread public health impact of diesel exposure.

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Vol. 131, No. 8 | Invited Perspective

Invited Perspective: Diesel Exhaust and Lung Cancer—Delayed Findings Confirmed, but Consequences Continue

is accompanied by

Gregory R. Wagner and David Michaels

Published: 7 August 2023 | CID: 081301 | https://doi.org/10.1289/EHP13258

The original DEMS publications were instrumental in moving the World Health Organization's International Agency for Research on Cancer (IARC) to revise its 1988 categorization of diesel exhaust exposure from group 2A, probably carcinogenic to humans, to group 1, a human carcinogen.

DEMS II, extend follow-up of the original cohort by 18 y, adding 2,700 additional deaths to the cohort and 178 new lung cancer deaths to the case–control analysis.

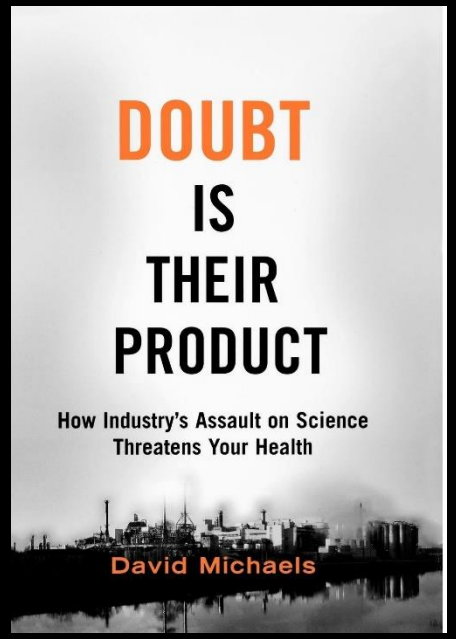
Industries whose operations would be adversely affected by stronger regulation protecting diesel-exposed workers also mounted a well-funded initiative to magnify and manufacture uncertainties in the original DEMS findings and the IARC reclassification.

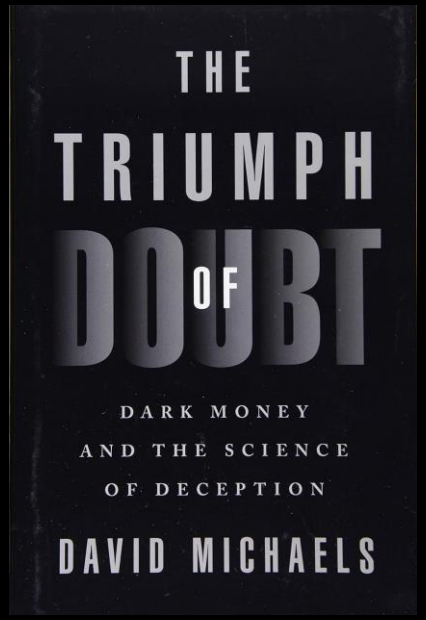
Although these commissioned efforts were appropriately considered, the DEMS publications were further put under the microscope by a special scientific committee of the Health Effects Institute (HEI), an independent organization funded by the U.S. Environmental Protection Agency and the motor vehicle industry. In 2015, the HEI review found no significant flaws in the DEMS work.

(Dr. David Michaels 2023)

(Dr. David Michaels)

David Michaels PhD, MPH, is an epidemiologist and professor at the George Washington University School of Public Health. He has held high-level, Senate-confirmed public health positions in the administrations of President Barack Obama (in which he was Assistant Secretary of Labor for Occupational Safety and Health) and President Bill Clinton (Assistant Secretary of Energy for Environment, Safety and Health).



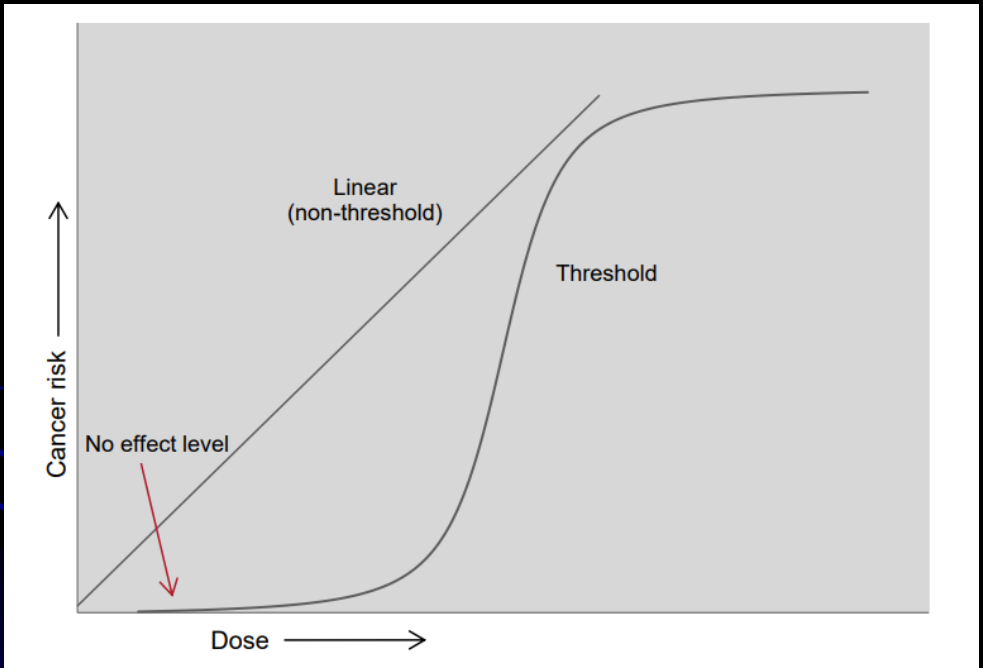


"*Industries whose operations would be adversely affected by stronger regulation protecting diesel-exposed workers also mounted a well-funded initiative to magnify and manufacture uncertainties in the original DEMS findings and the IARC reclassification*". (Michaels D, 2023).

What level of exposure is safe?

The evidence strongly suggests that diesel engine emissions, and many of its components, can induce lung cancer in humans through genotoxic mechanisms that include DNA damage (DFG, 2014; HCOTN, 2019; IARC, 2014; SCOEL, 2016). Consequently, diesel engines emissions are characterised as a non-threshold genotoxic carcinogen. At present, no appropriate inhalation unit risk exists with which to derive a suitable TWA to protect for carcinogenic effects.

(Safe Work Australia 2019)



For non-threshold based genotoxic carcinogens, a no effect level would be a dose or exposure of zero.

Johan Högberg & Jill Järnberg (2023) "Approaches for the setting of occupational exposure limits (OELs) for carcinogens".

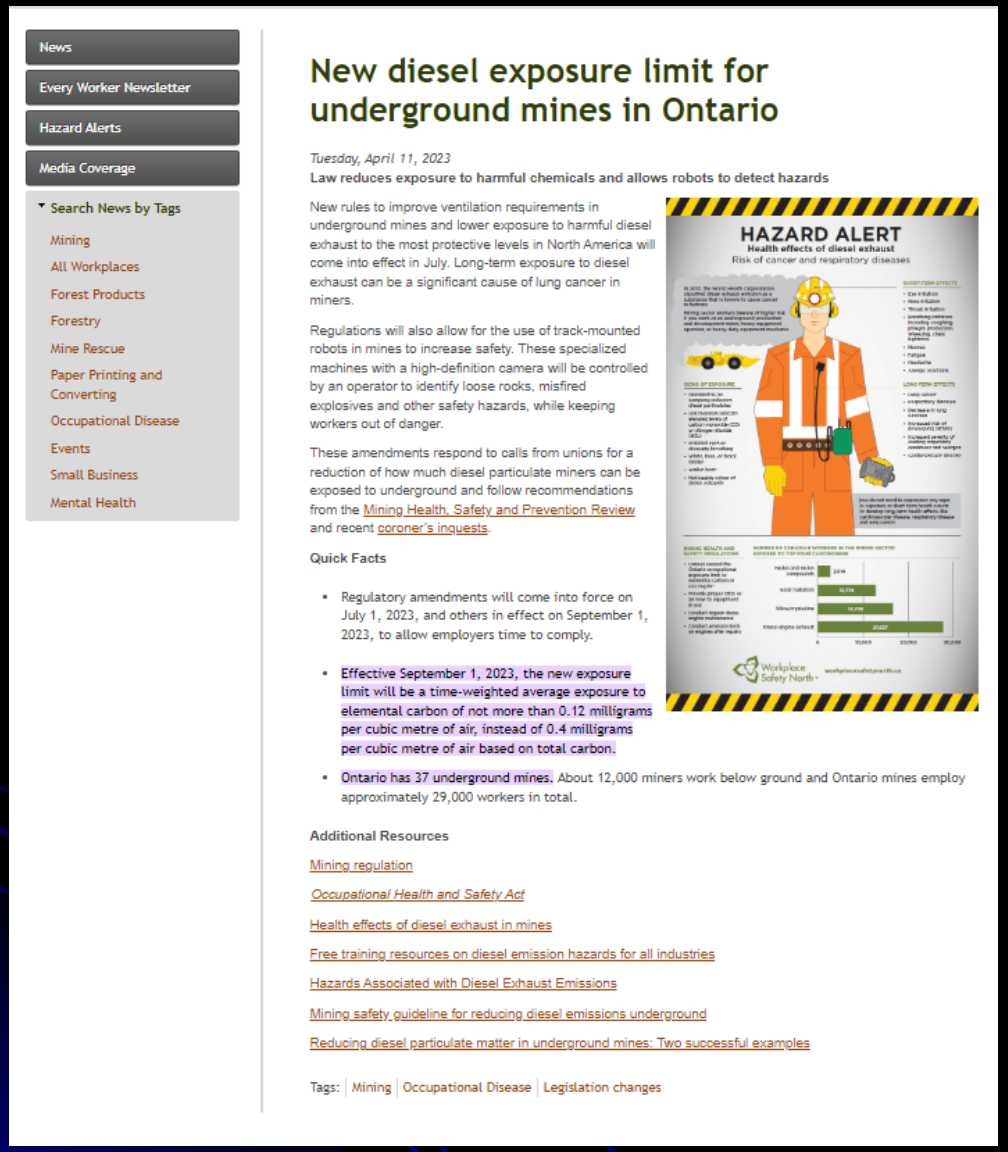
Based on the most up to date literature, even though: the new exposure limit will be a time-weighted average exposure to elemental carbon of not more than 0.12 milligrams per cubic metre of air (measured as elemental carbon), instead of 0.4 milligrams per cubic metre of air based on total carbon, “Effective September 1, 2023” (WSN, 2023); following international leading practices - emissions should also be controlled as “low as reasonably practicable”.

Just meeting the new OEL, may not be suitably protective. Many workers may still be at risk of adverse health effects including lung and bladder cancer (Health Canada 2016).

In addition, the “quality” of air in a worker breathing zone rather than the “quantity” of air is more important. This means controlling the emission at source should be the primary way to reduce exposures including exposure to nitrogen dioxide. The new mining regulation, for the first time, will include a limit for nitrogen dioxide which should a) further reduce harmful emissions, b) be another catalyst for an emissions-based maintenance (EBM) program, c) “weed out” those engines that are the main polluters, and d) improve overall productivity of underground diesel fleets (Deon et al. 2023, Hines 2019).

Deon SW, Hines J, Gopaldasani V, Davies B (2023), “Hitting two birds with one emissions-based maintenance stone – a literature review on improving overall productivity of underground diesel fleets”.

Hines J (2019), The Role of Emissions Based Maintenance to Reduce Diesel Exhaust Emissions, Worker Exposure and Fuel Consumption. University of Wollongong Thesis Collection 2017+.

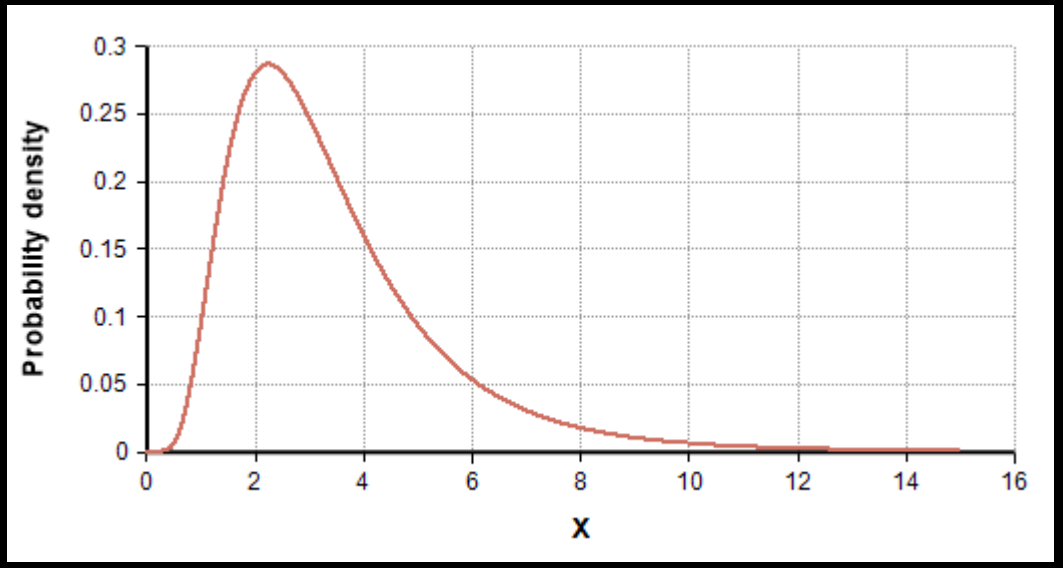


Effective September 1, 2023, the new exposure limit will be a time-weighted average exposure to elemental carbon of not more than 0.12 milligrams per cubic metre of air, instead of 0.4 milligrams per cubic metre of air based on total carbon.

Ontario has 37 underground mines. About 12,000 miners work below ground and Ontario mines employ approximately 29,000 workers in total.

https://www.workplacesafetynorth.ca/news/news-post/new-diesel-exposure-limit-underground-mines-ontario

Personal exposure monitoring



https://wiki.analytica.com/index.php?title=Log-normal_distribution

- Exposures (typically) are **log-normally** distributed.
- Enough samples have to be collected to enable statistical analysis and ensure exposures are representative.
- There may be situations where “worst case” monitoring is required.

http://www.ohlearning.com/training/training-materials/w501-measurement-of-hazardous-substances.aspx

Table 1 Allocation of H-statements to hazard groups and the associated airborne concentration ranges deemed to represent adequate control.

Hazard group	Type	Acceptable concentration range	Units	H-statements
A	Dust	>1 to 10	mg/m³	H304, H315, H319, H336, EU66
	Vapour	>50 to 500	ppm	
B	Dust	>0.1 to 1	mg/m³	H302, H312, H332, H371
	Vapour	>5 to 50	ppm	
C	Dust	>0.01 to 0.1	mg/m³	H301, H311, H314, H317, H318, H331, H335, H370, H373, EU71
	Vapour	>0.5 to 5	ppm	
D	Dust	<0.01	mg/m³	H300, H310, H330, H351, H360, H361, H362, H372
	Vapour	<0.5	ppm	
E	Dust	-	mg/m³	H334, H340, H341, H350, EU70
	Vapour	-	ppm	

Least harmful

More harmful

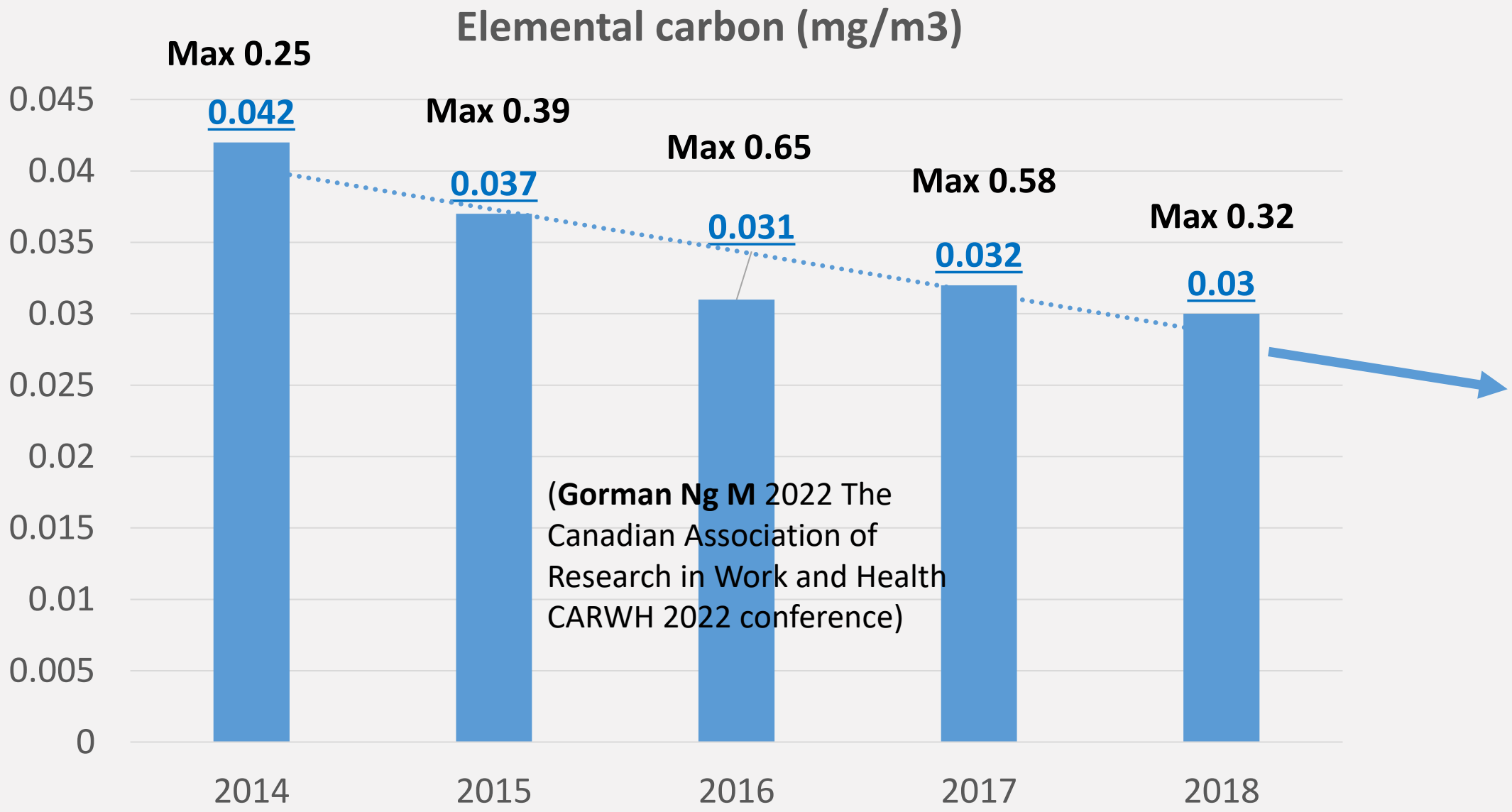
Suspected of damaging fertility or the unborn child

May cause occupational asthma

May cause cancer

http://www.hse.gov.uk/pubns/guidance/coshh-technical-basis.pdf

Reduce diesel emissions “as low as reasonably practicable” (ALARP), as part of an overall Airborne Hazard Management Program.



Canada, Ontario

Need to understand the risk from “all exposures” including, but not limited to, respirable crystalline silica (RCS)

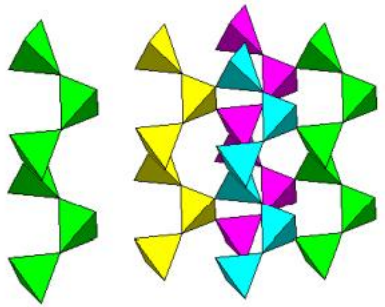
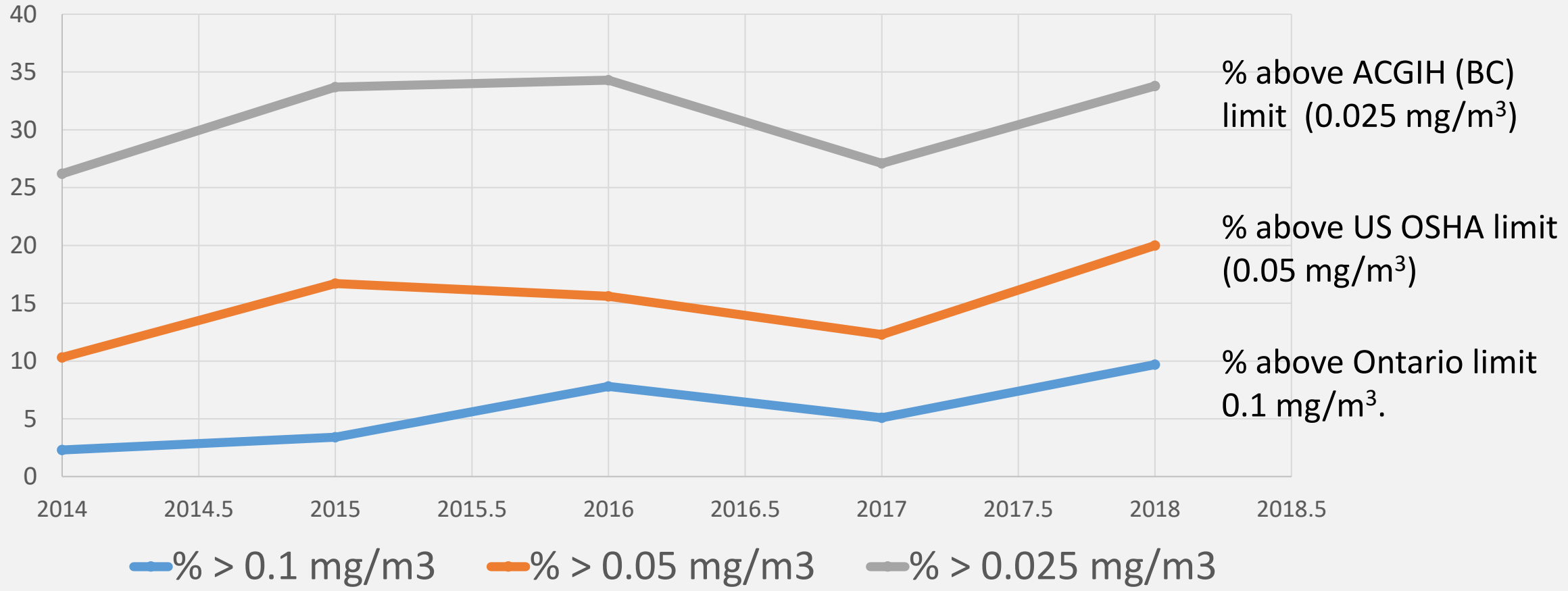


Figure 2.13: Model showing three dimensional structure of quartz
(Source: Dutch 2002).

Photo 2.1: Crystal structure of quartz
(Source: Lavinsky 2008)

Exceedances for respirable crystalline silica (RCS)

Adapted from OHCOW Mining Exposure Data Analysis. Prepared for: Occupational Health Clinics for Ontario Workers (OHCOW)
Prepared by: Melanie Gorman Ng, PhD., CIH
June 2, 2022



Known health effects of respirable crystalline silica (RCS) among others.

- Lung cancer.
- Silicosis.
- Chronic obstructive pulmonary disease (COPD).

Spirometer

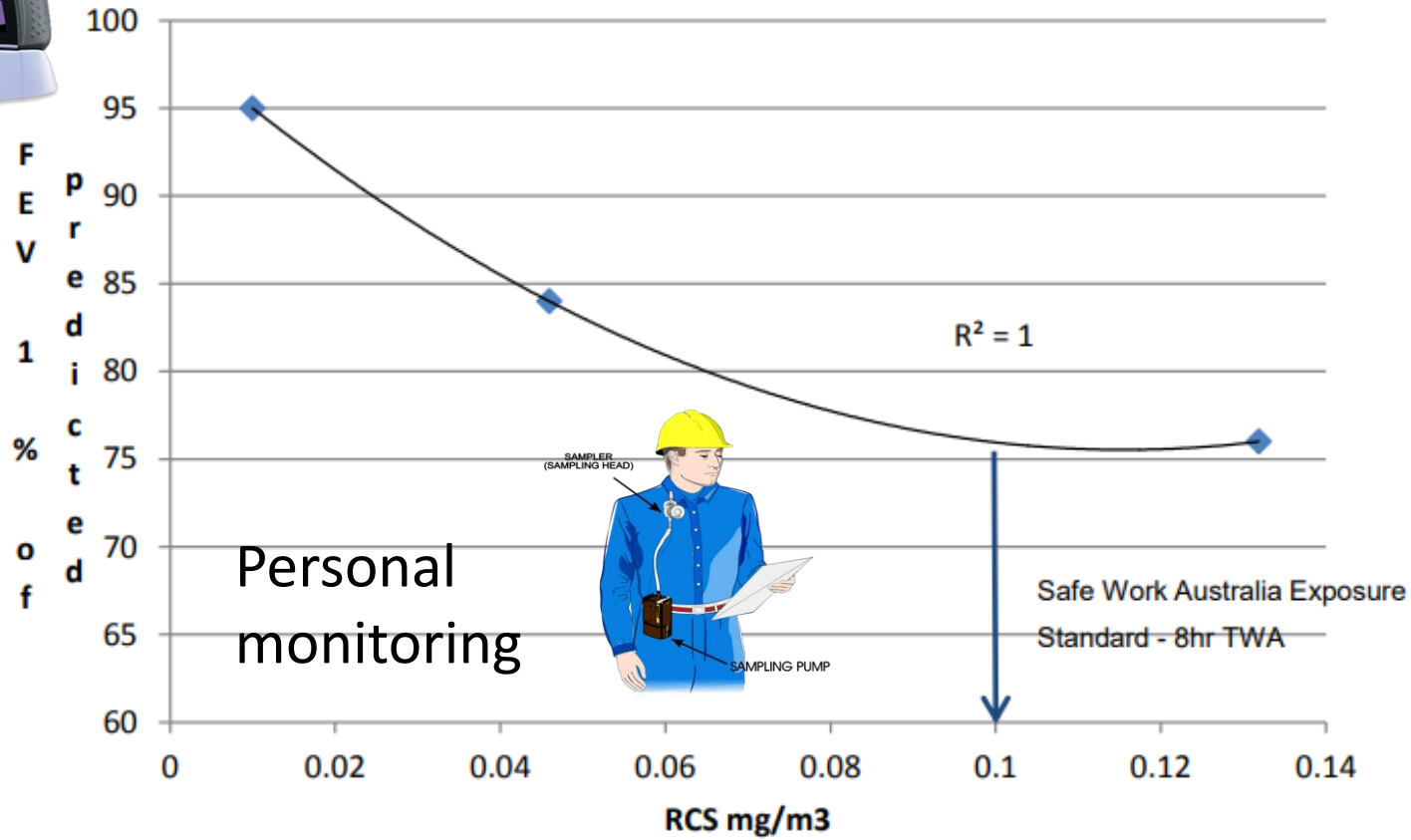


Figure 5.11 Average maximum FEV1 % of predicted for each group correlated with RCS group average exposures.

https://researchdirect.westernsydney.edu.au/islandora/object/uws:36593 Hedges K (2016).

In addition, as respirable crystalline silica (RCS) and diesel particulate matter (DPM) are both confirmed lung carcinogens a mixture formula should apply.

$$\frac{\text{Exposure to DPM}}{\text{(OEL)}} + \frac{\text{Exposure to RCS}}{\text{(OEL)}} \quad \text{Must be} < 1$$

If > 1 *"the occupational exposure limit of the mixture should be considered as exceeded"* (ACGIH Threshold Limit Values)

Conclusions

- Recap provided, along with a brief discussion on **diesel exhaust lung cancer relative risk calculator**.
- In the case of diesel exhaust and the DEMS study there has been an **abysmal history in the manufacture and magnifying of uncertainty**.
- Occupational exposure limits are **not fine dividing lines** between safe and unsafe exposures. Especially as diesel exhaust is a “Non-threshold” Genotoxic Carcinogen.
- Reduce diesel emissions “as low as reasonably practicable” (ALARP), as part of an overall **Airborne Hazard Management Program** (AHMP) that should incorporate all airborne hazards including, but not limited to, respirable crystalline silica (RCS).
- There will be situations where the **mixture formula should apply**. Case in point diesel particulate matter (DPM) and respirable crystalline silica