



**Occupational Health Clinics
for Ontario Workers Inc.**

2nd Annual Mining Vehicle Powertrain Workshop
(MVPC) 2024

Introduction to Diesel Emissions Exposure in the Mining Environment

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



What this presentation will cover:

- Recap on previous MDEC / MVPC presentations.
- Occupational exposure limits are not fine dividing lines.
- Need to consider all exposures not only diesel particulate matter.
- Statistical analysis is important for similar exposure groups and trending.
- Health effects, epidemiology and recent research.
- Reduce diesel emissions “as low as reasonably practicable” (ALARP), and as part of an overall Airborne Hazard Management Program, required in Regulation 854
- The diesel risk calculator can be used to advocate for change.
- When measuring and evaluating airborne hazards, it is also important, that the risk assessment be carried out for a mixture.

Previous presentations / webinars



Year	Title
2013	<u>Diesel emission in underground mining—A program for control, shared learning from Queensland, Australia</u> Kevin Hedges, former Senior Principal Occupational Hygienist, Queensland Mines Inspectorate
2017	<u>Is setting a suitably protective occupational exposure limit (OEL) for diesel particulate matter (DPM) a “key driver” to reduce exposure</u> Kevin Hedges, Occupational Health Clinics for Ontario Workers Inc.
2017	<u>Diesel Exhaust - Need to monitor exposure and further reduce occupational exposure limit</u> . WSN Mining Conference.
2018	<u>Occupational disease action plan (ODAP)and collaboration between system partners</u>
2019	<u>Diesel Emission Reduction</u>
2022	<u>The Past, Present & Future: Diesel Exhaust Exposures in Mining – A Tool to Assess Lung Cancer Risk</u>
2022	<u>Diesel Exhaust Exposure – Influencing Change</u> . Collaboration between CROSH, OHCOW & USW presented via OHCOW
2023	<u>Reduction of Diesel Emissions as part of an overall Airborne Hazard Management Program.</u>

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](#)





2022 Series: Worker-Focused Science & Prevention

Diesel Exhaust Exposure – Influencing Change

Recorded November 3, 2022

0:11 / 1:58:59 • Introduction >



OCC-TOBER 2022: Diesel Exhaust Exposure – Influencing Change



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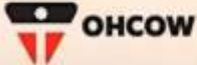




Occupational Health Management Programs, Training, Courses & More

Occ|tober & Beyond: Occupational Illness and Disease Prevention Webinar Series

Occ|tober 2023: Collaborating to Reduce and Control Workplace Exposures

Occupational Health Clinics for Ontario Workers Inc. Centres de santé des travailleurs (ses) de l'Ontario Inc.

Friday, November 24

Occ/tober 2023: Airborne Hazard Management - Airborne Hazard Management Program- Reducing Exposures in Mining

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<https://www.ohcow.on.ca/posts/airborne-hazard-management-programs-reducing-exposures-in-mining/>

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Blog OHCO / Events / Webinars (Live) / Occ|tober / Airborne Hazard Management Programs- Reducing Exposures in Mining

Airborne Hazard Management Programs- Reducing Exposures in Mining

OCC-TOBER, WEBINARS (LIVE) DERMAL EXPOSURE ASSESSMENT METHOD, DERMATITIS

Occ|tober & Beyond: Occupational Illness and Disease Prevention Webinar Series

Occ|tober 2023: Collaborating to Reduce and Control Workplace Exposures




Recorded: November 24, 2023

Reducing Exposures in Mining

This webinar helps employers, workers, and other workplace parties to develop and implement an airborne hazard management program (AHMP) as required by Section 192 of Regulation 854 – Mines and Mining Plants made under the Occupational Health and Safety Act (OHSA). Practical information in reducing exposures as part of the AHMP is provided.

Speakers:

- Kevin Hedges (OHCO) Host
- Scott Secord / Kyle Watson (MLTSD)
- Brent Rubell (CANMET)
- Ralph Deayton (Mammoth)
- Daniel Rose (PINGSAR)
- Judis Nelson (WISN)
- Kimberly O'Connell (OHCO)
- Janice Martel



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New requirements under the revised mining legislation require mines to have an **airborne hazard management program** (AHMP), developed in consultation through the Mining Legislative Review Subcommittee (MLRC), - “ventilation and hygiene”

airborne hazard management program (AHMP) as required by Section 182 of Regulation 854 – Mines and Mining Plants made under the Occupational Health and Safety Act (OHSA).

183.2 Where diesel-powered equipment is operated in an underground mine, the time-weighted average exposure of a worker elemental carbon shall not be more than 0.12 milligrams per cubic metre of air. O. Reg. 69/23, s. 26.

183.4 (1) At an underground mine, an employer shall test the undiluted exhaust discharging from diesel-powered equipment into the atmosphere to ensure that it contains,

- (a) less than 600 parts per million by volume of carbon monoxide; and
- (b) less than 60 parts per million by volume of nitrogen dioxide. O. Reg. 69/23, s. 26.

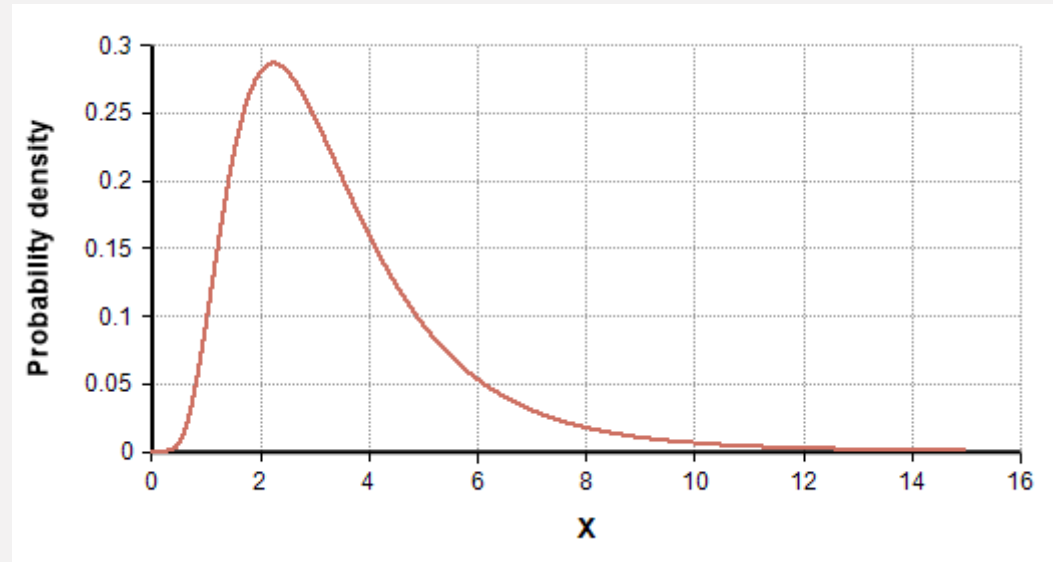
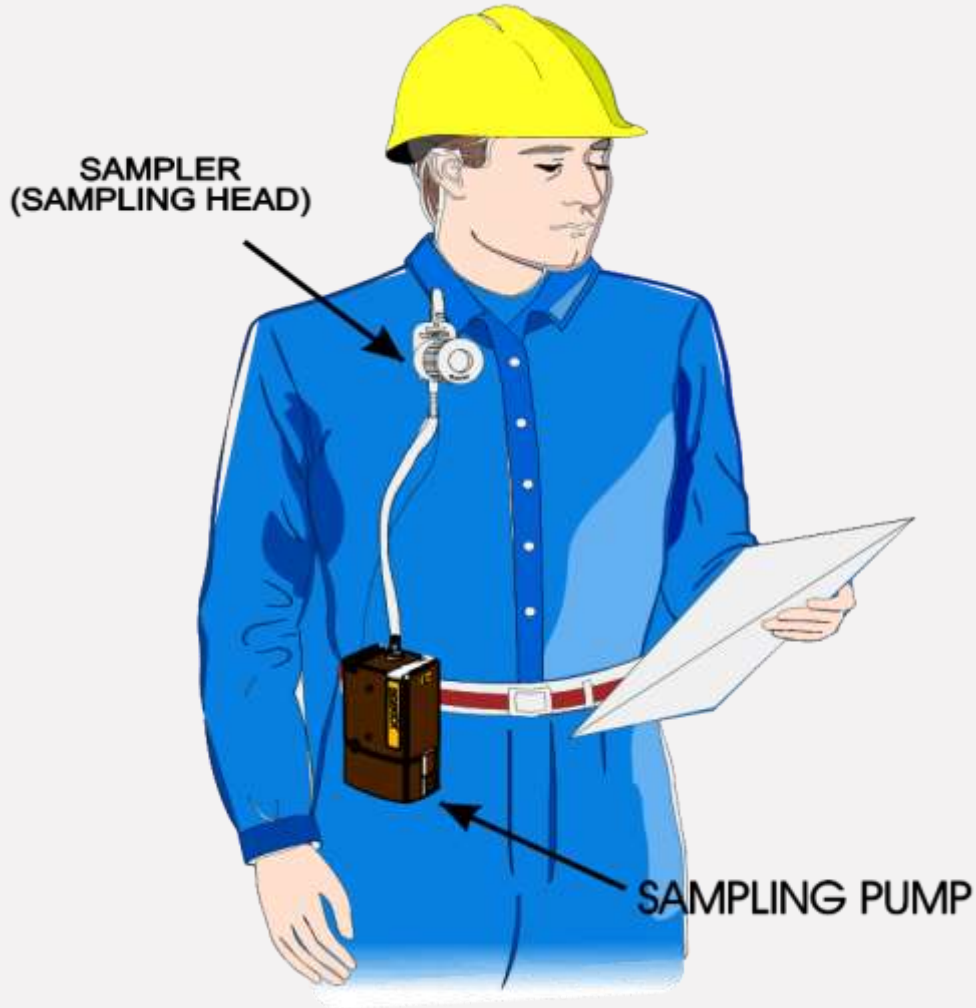
(2) The testing in subsection (1) must be done,

- (a) immediately after repairs are made to the engine or the exhaust system or both; and
- (b) at routine intervals for maintenance as the manufacturer recommends or, if there is no such recommendation, at least once a month. O. Reg. 69/23, s. 26.

(3) The employer shall ensure that,

- (a) testing measures and procedures are developed in consultation with, and take into consideration any recommendations made by, the joint health and safety committee or health and safety representative, if any;
- (b) each individual piece of equipment is tested under consistent conditions so that results from different tests can be compared;

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>



Operating Instructions

863 Valley View Road, Eighty Four, PA 15330 USA
Tel: 724-941-9701 • www.skcinco.com

DPM Cassette with Impactor Cat. No. 225-317

SKC Diesel Particulate Matter Cassettes are designed for sampling in atmospheres where it is necessary to separate DPM, carbon nanotubes (CNTs), and carbon nanofibers (CNFs) from other respirable dust (such as coal dust). Single-use disposable SKC DPM Cassettes are tamper-evident sealed to ensure sample integrity. Each streamlined plastic cassette comprises an impactor with precision sapphire orifice, impaction substrate, and two heat-treated, binder-free quartz filters. The impactor screens out respirable particles $\geq 1.0 \mu\text{m}$. Particles less than $1.0 \mu\text{m}$ are collected on the first filter, and the second filter serves as a dynamic blank for correction of adsorbed organic carbon. Samples are analyzed for organic and elemental carbon content of DPM per NIOSH Method 5040 or for CNTs and CNFs; see NIOSH CIB 65.

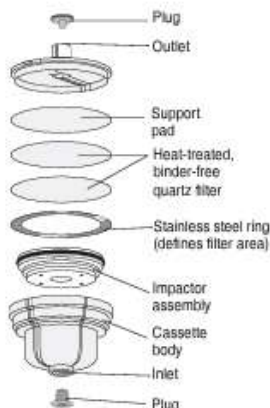


Figure 1. Exploded view of DPM Cassette (Cat. No. 225-317)

Performance Profile

Cassette Size: 37 mm
Filter: Two heat-treated, binder-free quartz fiber with cellulose support pad
Filter Collection Area: 8.04 cm²
Impactor: Four-nozzle, precision sapphire orifices
Flow Rate: Calibrated at 1.7 and 2 L/min for sampling of submicron particles
Analysis: For organic and elemental carbon using evolved gas analysis (EGA) with thermal-optical analyzer (NIOSH 5040) and electron microscopy (NIOSH CIB 65)

Sampling Equipment

The SKC DPM Cassette is designed for use with an appropriate sample pump and cyclone that pre-selects non-respirable particles.* An SKC Universal XR or AirChek® Series sample pump can provide the specified flow rate. Use SKC Cassette/Cyclone Holder Cat. No. 225-1 to secure the cassette when used with the GS-1 Cyclone.

* A cyclone is not necessary in all sampling situations. It should be used in settings where larger particulate is likely to clog the impactor.

Setting Up the Sampling Train with Cyclone and Holder

1. Insert stem of GS-1 Cyclone into large hole in cassette holder.
2. Orient cyclone in holder until the small round nodule on the bowl adapter rim fits into the notch in the cassette holder.
3. Remove inlet and outlet plugs from a DPM Cassette, pull back spring-loaded hold-down plate on cassette holder, and gently push inlet of cassette onto top of cyclone.
4. Position small hole in hold-down plate over cassette outlet.
5. Insert Luer adapter on the holder's rubber tubing into cassette outlet.



Figure 2. DPM Sampling Train with GS-1 Cyclone, Cassette Holder, and Universal PCXR4 Pump

Setting Up the Sampling Train Without a Cyclone

1. Remove the plug from the outlet of the cassette (Figure 1).
2. Attach one end of a length of Tygon® tubing to the cassette outlet and the other end to the inlet of an air sample pump capable of maintaining the desired flow rate.
3. Secure the cassette on a worker by using a cable tie and collar clip.
4. Remove plug from the cassette inlet immediately before sampling.

NIOSH		DIESEL PARTICULATE MATTER (as Elemental Carbon)		5040
C	MW: 12.01	CAS: none	RETECS: none	
METHOD: 5040, Issue 4	EVALUATION: FULL		Issue 1: 13 May 1996	Issue 2: 10 March 2016
OSHA: None	PROPERTIES: nonvolatile solid			
NIOSH: None				
SYNONYMS: diesel particulate matter, diesel exhaust, diesel soot, diesel emissions				
SAMPLING		MEASUREMENT		
SAMPLER:	Filter (quartz fiber, 37-mm or 25-mm size selective sampler may be required) (1)	TECHNIQUE:	Thermal optical analysis flame oxidation detector (TO)	
FLOW RATE:	2 to 4 L/min (typical)	ANALYTE:	Elemental carbon (EC). Total carbon is determined, but an EC exposure marker was proposed. See (1) for details.	
VOL. MIN.:	142 L at 40 µg/m ³	FILTER PUNCH SIZE:	1.3 cm ² (or other) (2)	
MAX.:	18 m ³ (for filter load of ~ 90 µg/cm ²)	CALIBRATION:	Methane injection	
SHIPMENT:	Room temp.	RANGE:	1 to 100 µg per filter portion (See also (1))	
SAMPLE STABILITY:	Stable	ESTIMATED LOD:	0.7 µg per filter portion	
BLANKS:	2 to 10 field blanks per set	PRECISION (3,4):	0.15 at 1 µg-C, 0.01 at 10 to 72 µg-C	
ACCURACY				
RANGE STUDIED:	23 to 240 µg/m ³ (See also ref. (1))			
BIAS:	None (See also ref. (1))			
OVERALL PRECISION (5,6):	0.07			
ACCURACY:	+ 16.7% at 23 µg/m ³ (See also ref. (1))			
APPLICABILITY: The working range is approximately 0 to 620 µg/m ³ , with an LOD of ~ 2 µg/m ³ for a 900-L air sample collected on a 37-mm filter with a 1.5 cm ² punch from the sample filter. If a lower LOD is desired, a larger sample volume and/or 25-mm filter may be used (e.g., a 1800-L sample on 25-mm filter gives an LOD of 0.4 µg/m ³). The split between organic carbon (OC) and EC may be inaccurate if the sample transmittance is too low. The EC loading at which this occurs depends on laser intensity. In general, the OC/EC split may be inaccurate when EC loadings are above 20 µg/cm ² . High loadings can give low (and variable) EC results because the transmittance remains low and relatively constant until some of the EC is oxidized. The split should be reassigned (prior to EC split) in such cases (2). An upper EC limit of 800 µg/m ³ (90 µg/cm ²) can be determined. Low EC loadings (e.g., near the LOD) also may require a manual split to improve accuracy (1).				
INTERFERENCES: Total carbon (as OC and EC) is determined by the method, but EC was recommended as a measure of workplace exposure because OC interferences may be present (1,2). Cigarette smoke and carbonates ordinarily do not interfere in the EC determination. Less than 1% of the carbon in cigarette smoke is elemental. If heavy loadings of carbonate or organic dusts are anticipated, a size-selective sampler (impactor and/or cyclone) should be used (1); for measurement of diesel-source EC in coal mines, a cyclone and impactor with a submicrometer cutoff are required to minimize collection of coal dust. A cyclone and/or impactor may be necessary in other workplaces (e.g., containing dusts) as present.				
OTHER METHODS: Other methods for determination of EC and OC have been employed, but these are not equivalent to the method described herein. Information on other methods is summarized elsewhere (1). The method procedures are unchanged from the 4th edition supplement to NIOSH, but the corresponding diesel guidance chapter was updated for the 5th edition.				
NIOSH Manual of Analytical Methods (NMAM), 10th Edition				

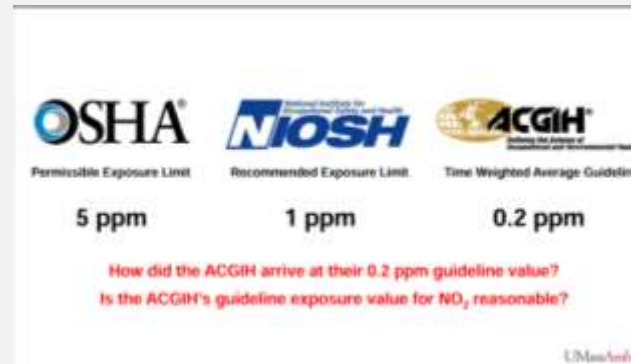
<https://www.skcinco.com/products/diesel-particulate-matter-dpm-cassettes-1>

<https://www.cdc.gov/niosh/nmam/default.html>

Don't forget about other exposures such as nitrogen dioxide.



https://mdec.ca/2015/S1P1_pollitt.pdf



<https://www.ontario.ca/page/current-occupational-exposure-limits-ontario-workplaces-under-regulation-833>

What is the Ontario Occupational Exposure Limit

		TWA 8-hr	Short Term Exposure Limit
Ontario Table	Nitrogen dioxide [10102-44-0]	3 ppm	5 ppm

- The ACGIH's TWA value for NO₂ of 0.2 ppm was set to ensure **sensitive individuals** were protected from adverse effects
- The exposure limit was set based on short-term controlled NO₂ exposures conducted with **asthmatics**
- Concern raised for adults surviving cardiac events.

An example of why occupational exposure limits are not fine dividing lines between safe and unsafe.

Dust particles

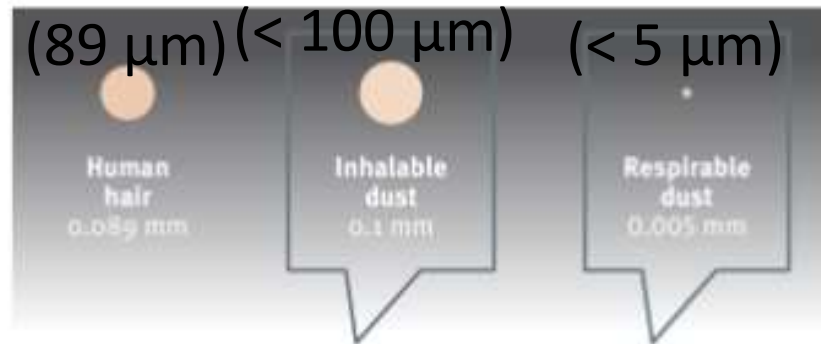
Dust is a word often used to describe fine, dry particles on the ground and in the air.

Dust particles fall into two categories, according to their size:

- *inhalable dust* (less than 0.1 mm or 100 μm diameter)
- *respirable dust* (less than 0.005 mm or 5 μm diameter).

To give you an idea of these sizes, the following diagram compares both types of dust with the diameter of a single human hair.

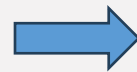
Dust particle size comparison



	Inhalable dust	Respirable dust
Size	Dust particles of all sizes (typically less than 0.1 mm diameter)	Smallest dust particles (typically less than 0.005 mm diameter)
Visibility	Can be seen with the naked eye	Cannot be seen with the naked eye

<https://www.rshq.qld.gov.au/miners-health-matters/media/documents/airborne-dust-exposure.pdf>

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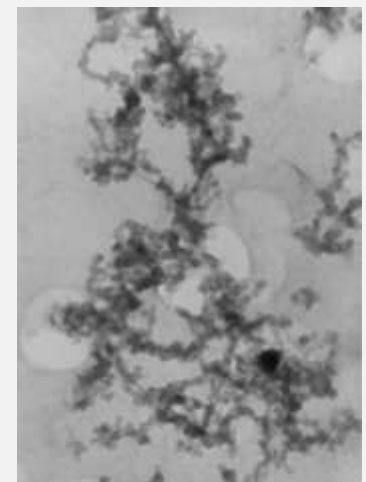


PM 2.5 (< 2.5 μm) typically associated with air pollution – an environmental measure

<https://www.igair.com/newsroom/pm2-5>



PM 0.1 (< 0.1 μm or 100 nm) are also called nanoparticles / ultra fines



A useful resource

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Nederlandse norm

NEN-EN 689 (en)

Blootstelling op de werkplek - Meting van de
inhalatieblootstelling aan chemische stoffen -
Strategie om te voldoen aan de
arbeidshygiënische blootstellingsgrenswaarden

Workplace exposure - Measurement of exposure
by inhalation to chemical agents - Strategy for
testing compliance with occupational exposure
limit values

Vervangt NEN-EN 689:1995;
NEN-EN 689:2016 Ontw.;
NEN-EN 689:1995/C1:2012

ICS 13.040.30
mei 2018

A useful resource

EN 689:2018

Workplace exposure. Measurement of exposure by inhalation to chemical agents. Strategy for testing compliance with occupational exposure limit values

The strategy described gives a procedure to overcome the problem of variability and to use a relatively small number of measurements to demonstrate with a high degree of confidence that workers are unlikely to be exposed to concentrations exceeding the OELVs.

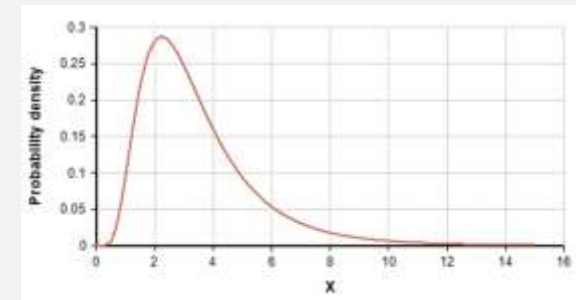
To reduce the number of exposure measurements, and therefore the cost of assessment, personal air samples are collected among workers within similar exposure groups (SEGs). A single measurement or even several measurements below the limit value can be insufficient to reliably demonstrate compliance without using a statistical test like the one proposed in this European Standard.

“The new EN-689 also takes into consideration simultaneous exposure to several chemicals, and workshift durations higher than 8 hours. The informative annexes give recommendations to determine for example: sampling duration, statistical distribution of exposure measurements results and treatment of representative results lower than the limit of quantification (LoQ)” (Raymond Y Vincent BMJ [the new European standard on testing compliance with occupational exposure limit values](#)).

Errico et al. 2022.

[Is the New EN689 a Better Standard to Test Compliance With Occupational Exposure Limits in the Workplace?](#)

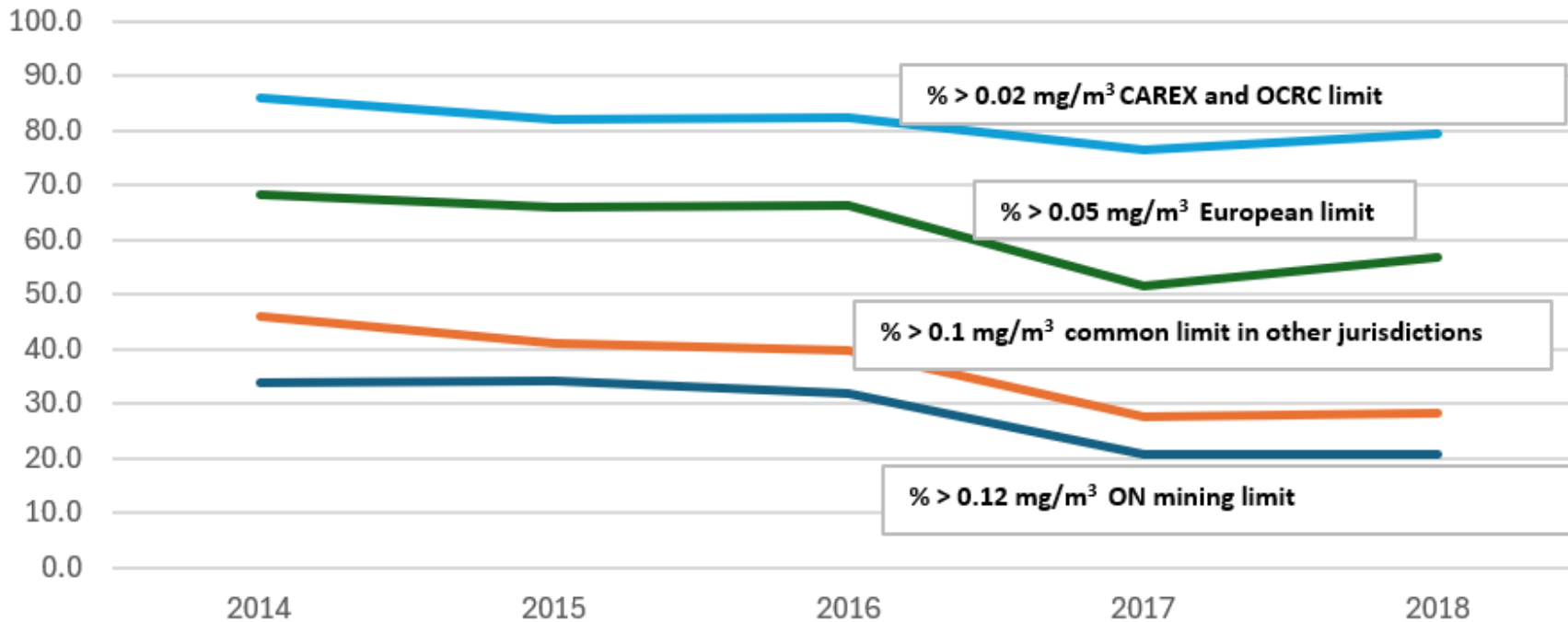
Ann Work Expo Health
. 2022 Mar 15;66(3):412-415. doi:
10.1093/annweh/wxab111



Diesel Engine Exhaust (DEE) as respirable elemental carbon (REC)



% of samples exceeding occupational exposure limits for respirable elemental carbon (REC)



The Ontario Mining occupational exposure limit of 0.12 mg/m³ is

6 X

the Occupational Cancer Research Centre (OCRC) [policy recommended limit](#) of 0.02 mg/m³.

Exposure to - [vapours, dusts, gases and fumes](#) (VDGF) is also getting much more attention.

Refer to Arrandale et al. 2024 "[Exposure to Vapours, Gases, Dusts, and Fumes at Work in Relation to Chronic Bronchitis, Emphysema, and Chronic Obstructive Pulmonary Disease: A Systematic Review With Meta-analyses](#)".



The annual decrease in EC concentration was significant, suggesting approximately a 10% decrease per year. This is encouraging and may reflect the focus on reducing exposure to diesel engine exhaust in mining specifically.

However, many measurements were still above the current exposure limit for mining in Ontario which is set at 0.12mg/m³ EC, and well above the health-based limit suggested by the Health Council of the Netherlands (0.00001mg/m³) (Vermeulen & Portengen, 2016).

The Ontario mining occupational exposure limit is

12,000 X

higher than the Netherlands health based suggested limit.



[OCC-TOBER 2022: Diesel Exhaust Exposure – Influencing Change](#)

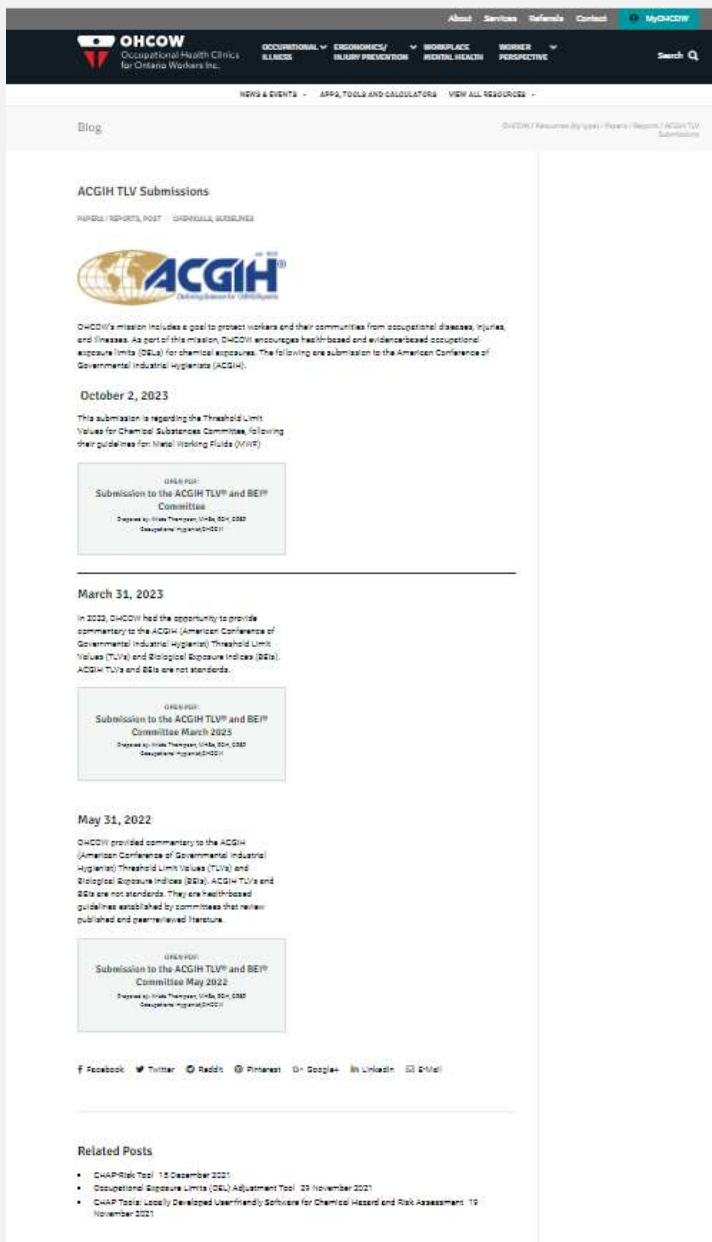
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<https://www.ohcow.on.ca/posts/occ-tober-worker-focused-science-prevention-webinars-kickoff-event-2/>



See also the OHCOW submission to the ACGIH submitted 2023



Date Submitted March 31, 2023

Chemical Substance Diesel Exhaust
(8 pages + citable materials)

Name of Group/Individual Submitting Comments Occupational Health Clinics for Ontario Workers Inc. (OHCOW)

Authored by: Kevin Hedges, PhD, MAppSc, BSc, DipEd, COH, CIH

Reviewed by: Krista Thompson, MHSc, ROH, CRSP Occupational Hygienist; Kimberly O'Connell, M.Sc.(A), CIH, ROH, CRSP Executive Director

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Executive Summary (limit 250 words)

Elemental carbon (EC) is used as an indicator for diesel exhaust by most jurisdictions. The European Union has decided on an occupational exposure limit of 0.05 mg/m³ EC, in effect from 2023, which is the same limit in Germany and Sweden. The Australian Institute of Occupational Hygiene recommends a limit of 0.1 mg/m³ EC, though Cherrie 2019 noted that a limit of 0.1 mg/m³ "would do little to reduce the predicted death toll from occupational exposure to diesel exhaust particulate."

Long et al (2022) studied controlled human exposure to diesel exhaust from traffic air pollution and reported findings including a controlled human experiment which included 40 volunteers, who had an acute exposure of PM2.5 at 25 µg/m³ (0.025 mg/m³). At this level, adverse effects on endothelial function, vascular walls, and heart rate variability even at 24 h post-exposure were reported. In addition, the study by Chen et al (2017), between 2001 and 2012, in Ontario, Canada, found an adjusted incident dementia hazard ratio (HR) of 1.07 for people living less than 50 m from a major traffic road (95% CI 1.06–1.08).

Based on shorter term acute exposures, we recommend a TLV®-TWA for EC of 10 µg/m³ EC with (L) notation as an evidence-based limit for all workplaces.

As diesel exhaust is in the "under study" list, we provide the following recommendation: a TLV®-TWA of 60 µg/m³ for 1-nitropyrene (1-NP) especially where EC is at relatively low levels of exposure / approaching the limit of quantitation using NIOSH 5040.

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<https://www.ohcow.on.ca/posts/submission-to-the-acgih-tlv-and-bei-committee/>

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New guideline for reducing diesel particulate matter in underground mines

Monday, February 14, 2022
Two successful examples of control strategies for airborne hazards

 [Reducing diesel particulate matter in underground mines: Two successful examples](#)

A new guideline document for controlling diesel emissions in underground mines was introduced by the Ontario mining industry technical advisory committee.

"Diesel engine exhaust, including the diesel particulate matter, has been classified as carcinogenic to humans by the World Health Organization," says Keith Birnie, Industrial Hygienist and Ventilation Specialist at Workplace Safety North (WSN) and committee chair and coordinator. "For many years, diesel engines have been the workhorse in a large number of industries including mining, and diesel exhaust exposure presents an inhalation health hazard to workers."



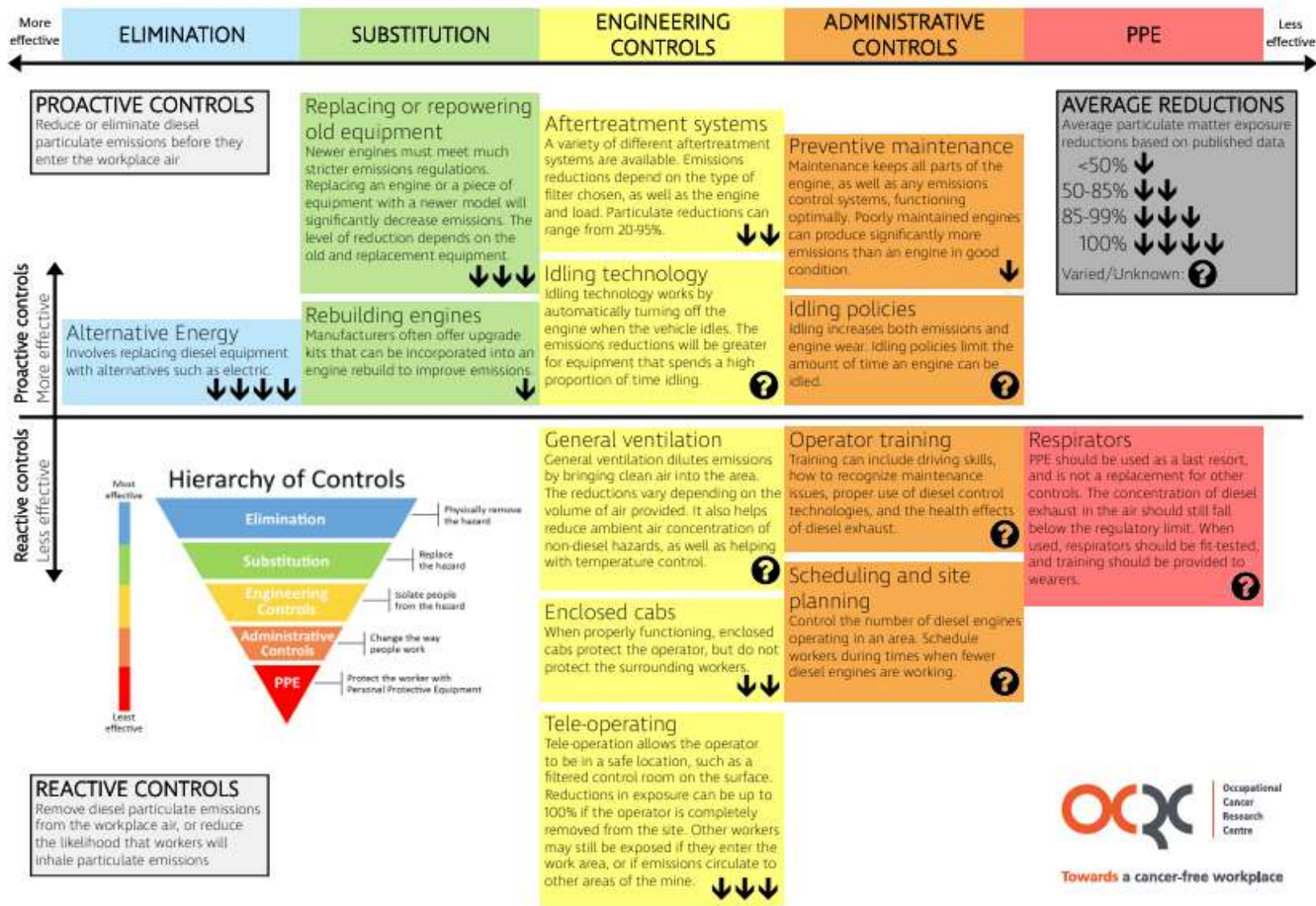
In 2021, mining industry volunteers who make up the WSN Workplace Environment Technical Advisory Committee developed a practical reference document, "[Reducing diesel particulate matter in underground mines: Two successful examples](#)," for Ontario mining operations. The guide has information about the hazards of diesel engine exhaust along with examples on controlling diesel emissions, with a focus on diesel particulate matter.

Occupations with potential exposure to diesel emissions include miners, construction workers, heavy equipment operators, bridge and tunnel workers, railroad workers, oil and gas workers, loading dock workers, truck drivers, material handling operators, farmworkers, long-shoring workers, and auto, truck and bus maintenance garage workers.

WSN (2022)
[Guideline for reducing diesel particulate matter in underground mines](#)



CONTROLLING DIESEL PARTICULATE MATTER IN UNDERGROUND MINES



Respirators



Full protection offered by filtering face piece **respirators** against diesel particulate matter, containing **ultrafine particles** (particle midpoint diameter <100nm) **is questionable.**

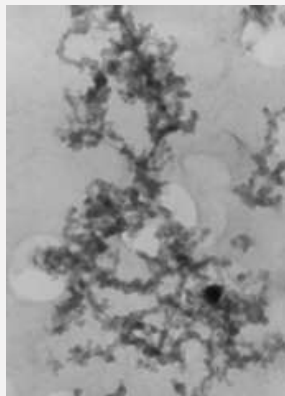
Burton K A (2023), PhD., thesis;

Do AS/NZS Respiratory Protection Standards for Filter Penetration Ensure that Worker Health is Protected Against Nanoparticle Sized Diesel Particulate Matter? <https://ro.uow.edu.au/theses1/1563/>

Even Respirators May Not Be Completely Effective



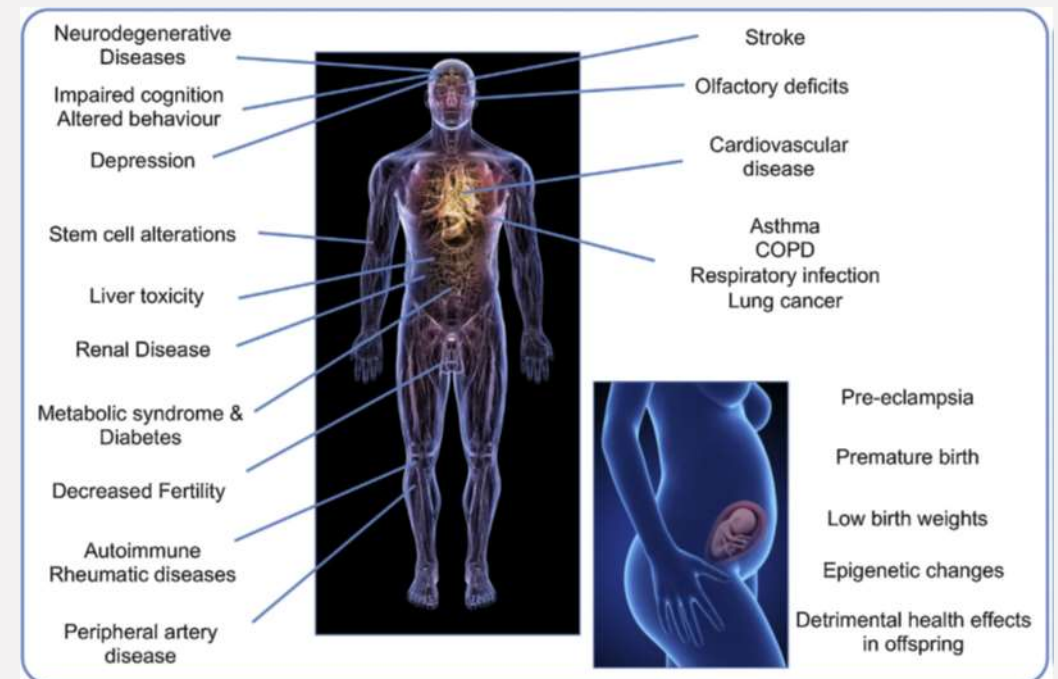
Figure 3.10: NIOSH 5610 filter cassette post-sampling, N428 - pre-filter sample, N429, 430, 432 and 433 - post-filter samples, 95C, 100C



Jennifer B. Raftis, Mark R. Miller (2019)
University/BHF Centre for Cardiovascular Science,
University of Edinburgh, Edinburgh, United Kingdom

Nano Today, Vol. 26, pp.8 – 12

[Nanoparticle translocation and multi-organ toxicity: A particularly small problem](#)



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 $\mu\text{g}/\text{m}^3\text{-y}$ (equivalent to an exposure of $0.05\text{mg}/\text{m}^3$ to $< 0.08 \text{mg}/\text{m}^3$ 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.

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 $\mu\text{g}/\text{m}^3$

[CONVERSION FACTORS for MINERS](#)

CALCULATE

CLEAR

15-year Lagged Cumulative Respirable Elemental Carbon Exposure

500

in $\mu\text{g}/\text{m}^3\text{-years}$

(model based on 0-1000 $\mu\text{g}/\text{m}^3\text{-yrs}$ range)

ESTIMATED RELATIVE RISK (RR)

[What is Relative Risk?](#) | [What is 95% Confidence Interval \(CI\)?](#)

1.78

95% Confidence Interval (CI):

Lower

1.14

Upper

2.78

LEGEND:

EC (in $\mu\text{g}/\text{m}^3$):

0.0

RR 1.09
L0.87 to U1.38

200

RR 1.33
L0.97 to U1.82

400

RR 1.62
L1.08 to U2.42

600

RR 1.97
L1.21 to U3.21

800

RR 2.40
L1.35 to U4.25

1000

RR 2.92
L2.92 to U5.64

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

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)

In addition, for extended shifts either daily and / or weekly the occupational exposure limit may require adjustment.

<https://www.aioh.org.au/media/2021/05/dev-of-tool-for-adjustment-of-wes-for-contaminants-due-to-extended-work-shifts-firt.pdf>

Current occupational exposure limits for Ontario workplaces under Regulation 833

Read this page to learn about current exposure limits to specific biological or chemical substances for workers in Ontario.

On this page

1. Overview
2. Consultations
3. Resources
4. Alphabetical listings
5. Endnotes and abbreviations

Resources

[OEL adjustment tool for irregular work shifts](#) (“Quebec model”)

Use this tool to calculate the adjusted workplace exposure limit for an unusual or extended work shift.

[Code for medical surveillance for designated substances](#)

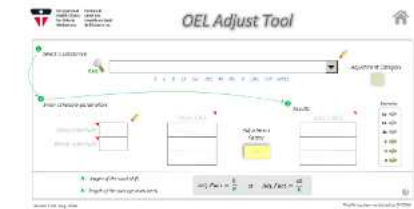
Learn how physicians should conduct surveillance programs of designated substances.

[Determining occupational exposure limits for certain refined hydrocarbon solvent vapour mixtures](#)

Learn about the recommended method for determining occupational exposure limits for certain refined hydrocarbon solvent vapour mixtures like petroleum ether, rubber solvent and VM&P Naphtha.

Occupational Exposure Limits (OEL) Adjustment Tool

(based on the model and guide developed by the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST))
Brought to you by OHCOW and the Occupational Disease Action Plan Contributors, this tool allows the calculation of the adjusted workplace exposure limit for an unusual or extended work shift which has been adapted using the methodology set out in the [Guide for the Adjustment of Permissible Exposure Values for Unusual Work Schedules](#) (March 2012), published by Québec's Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST).



This method, used in the Province of Québec and referenced by the ACOG and other health and safety organizations, considers toxicological information such as sensitization, irritation, organ toxicity, reproductive system toxicity, and teratogenicity, in addition to exposure and recovery times.

Irregular work shifts are now commonplace in many industries and the standard eight-hour work day/40-hour work week (which has been the basis for the time-weighted average (TWA) occupational exposure limits) is often not the reality. To address this change, exposure standard adjustments have increasingly become an essential component in workplace exposure assessments.

[OHCOW Health-Based OEL Case / Logis](#)

DOWNLOAD TOOL

IMPORTANT NOTE
The file works ONLY if the macro security level of Excel is set to "enable all".
Detailed instructions are provided at the bottom of the Tool's intro page by clicking on the important arrow.

If you need more information, please contact me

Kevin Hedges, PhD., M. App. Sc., BSc., FAIOH, COH, CIH

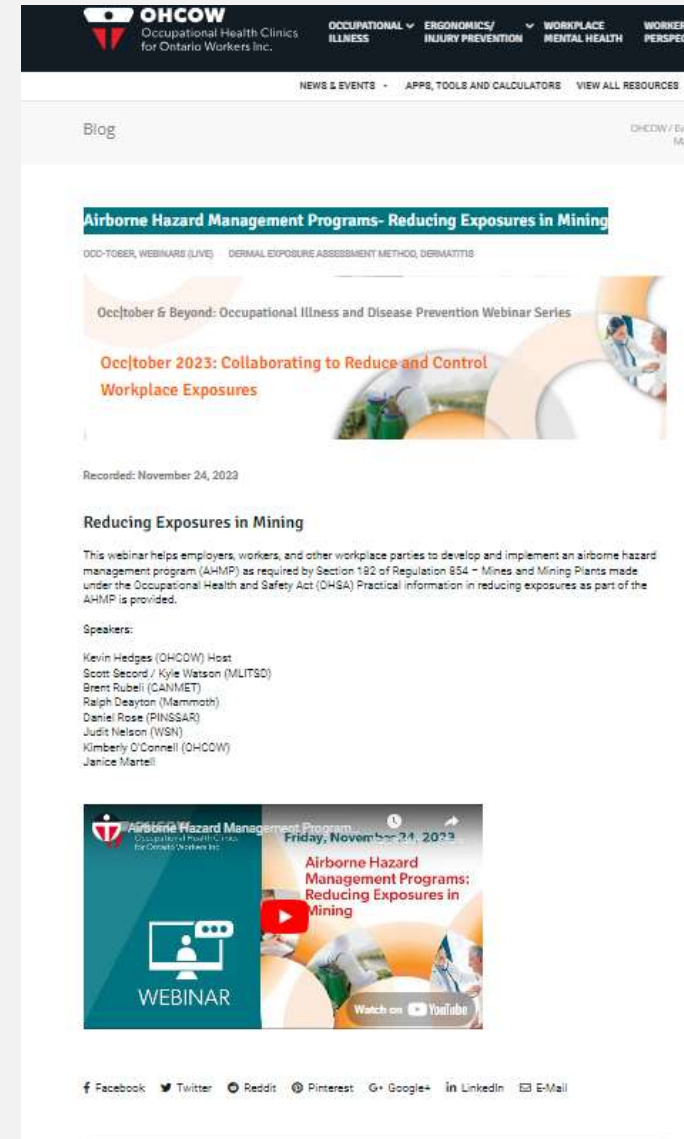
khedges@ohcow.on.ca

Occupational Hygienist

Occupational Health Clinics for Ontario Workers Inc.

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

See also:



The screenshot shows a webpage from OHCOV (Occupational Health Clinics for Ontario Workers Inc.). The page features a dark navigation bar with the OHCOV logo and menu items: OCCUPATIONAL ILLNESS, ERGONOMICS/INJURY PREVENTION, WORKPLACE MENTAL HEALTH, and WORKER PERSPECTIVE. Below the navigation bar, there are links for NEWS & EVENTS, APPS, TOOLS AND CALCULATORS, and VIEW ALL RESOURCES. The main content area is titled 'Blog' and features a post titled 'Airborne Hazard Management Programs- Reducing Exposures in Mining'. The post includes a sub-header 'OCC-TOBER, WEBINARS (LIVE) DERMAL EXPOSURE ASSESSMENT METHOD, DERMATITIS', a date 'October 6 & Beyond: Occupational Illness and Disease Prevention Webinar Series', and a specific event 'October 2023: Collaborating to Reduce and Control Workplace Exposures'. It is recorded on November 24, 2023. The post text describes a webinar that helps employers, workers, and other workplace parties to develop and implement an airborne hazard management program (AHMP) as required by Section 192 of Regulation 854 - Mines and Mining Plants made under the Occupational Health and Safety Act (OHSA). Practical information in reducing exposures as part of the AHMP is provided. The speakers listed are: Kevin Hedges (OHCOV) Host, Scott Secord / Kyle Watson (MLIT&D), Brent Rubell (CANMET), Ralph Dayton (Mammoth), Daniel Rose (PINNSAR), Judith Nelson (WSN), Kimberly O'Connell (OHCOV), and Janice Martell. At the bottom of the post, there is a video player thumbnail with the text 'Airborne Hazard Management Programs: Reducing Exposures in Mining' and 'Friday, November 24, 2023'. The thumbnail also includes the OHCOV logo, a 'WEBINAR' icon, and a 'Watch on YouTube' button. Below the video player, there are social media sharing options for Facebook, Twitter, Reddit, Pinterest, Google+, LinkedIn, and E-Mail.

<https://www.ohcow.on.ca/posts/airborne-hazard-management-programs-reducing-exposures-in-mining/>