Ministry of Labour, Immigration, Training and Skills Development

2023 Amendments to Regulation 854 (Mines and Mining Plants)

Workshop: Ontario Regulation 854 Review and Guidance October 2023

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Disclaimer

- The purpose of today's presentation is to assist the workplace parties in understanding their obligations under the Occupational Health and Safety Act (OHSA) and its regulations. It is not intended to replace the OHSA or the regulations, and reference should always be made to the official versions of the legislation.

- It is the responsibility of the workplace parties to ensure compliance with the legislation and this presentation does not constitute legal advice. If you require assistance with respect to the interpretation of the legislation and its potential application in specific circumstances, please contact your legal counsel.

- Ministry of Labour, Immigration, Training and Skills Development (MLITSD) inspectors will apply and enforce the OHSA and its regulations based on the facts as they may find them in the workplace. This presentation does not affect their enforcement discretion in any way.

FAIR, SAFE AND HEALTHY WORKPLACES DIVISION

Our Vision

We envision an Ontario that is the most attractive place to work in the world because every employee is treated fairly and comes home safely.

Our Mission

We set, communicate and enforce legislation to help make Ontario workplaces fair, safe and healthy. Through our professionalism, innovation and collaboration, we earn and maintain the public trust.

Key amendments regarding the use of diesel-powered equipment include:

- **Section 183:** general requirements for diesel-powered equipment used in underground mines
- **Section 183.1:** airflow rates where diesel-powered equipment is operated in underground mines
- **Section 183.2:** occupational exposure limit for elemental carbon from diesel emissions in underground mines
- **Section 183.3:** worker exposure testing in underground mines
- **Section 183.4:** tailpipe testing of diesel-powered equipment in underground mines

General Requirements for Diesel-Powered Equipment (Section 183)

Record Keeping

- Diesel-powered equipment first used in an underground mine after June 1, 1995, must meet the requirements established in *CSA M424.2-22 Non-Rail-Bound Diesel- Powered Machines for use in Non-Gassy Underground Mines*.
- Mines are required to maintain records for each piece of diesel-powered equipment used underground. At minimum, the records must contain the following information:
  - make, model and serial number
  - rated power, rated engine revolutions per minute (RPM), and maximum fuel injection rate
  - ventilation rate as certified in accordance with CSA M424.2-22
  - make, model and serial number of any emission control devices used with the equipment
  - capacity of both the fuel and hydraulic fluid tanks

General Requirements for Diesel-Powered Equipment (Section 183)

Ventilation Requirements

- Employers at underground mines must keep and maintain information about
  - the volume of air flowing in haulage ways and workings where the equipment is operating; and
  - the total ventilation requirements for the equipment when it is operating in a single continuous course of air.
- This information must be provided directly to the operators or available in a readily accessible format.

Operator Information

- Section 183.1 (4) further requires that each piece of diesel-powered equipment must have the airflow posted in a location on the equipment that is visible to and readable by the operator.
- Although not defined in the regulation, a single continuous course of air is generally considered to be:
  - a continuous path where the same air remains between entrance and exit; or,
  - a continuous path where the same air remains until a new air source enters; or,
  - a path with a continuous source of air that has no addition from other sources.

General Requirements for Diesel-Powered Equipment (Section 183)

Fuel Requirements

- Diesel fuel used in underground mines must meet one of the three following Canadian General Standards for diesel fuel:
  - Canadian General Standards Board CAN/CGSB-3.517-2020 Diesel Fuel
  - Canadian General Standards Board CAN/CGSB-3.520-2020 Diesel fuel containing low levels of biodiesel (B1-B5)
  - Canadian General Standards Board CAN/CGSB-3.522-2020 Diesel fuel containing biodiesel (B6-B20)
- All diesel fuel used underground, regardless of what fuel standard applies, must have a **minimum flash point of 52°C.**

General Requirements for Diesel-Powered Equipment (Section 183)

Compliance Considerations

- Although no longer required, the ministry's "Notice of Diesel-Powered Equipment" form can still be used as a record keeping template.
  - The volume of air flowing in haulage ways and workings where the equipment is operating; and the airflow rate for each piece of equipment may be provided to operators in many ways such as:
    - at pre-shift line up meetings or safety huddles
    - through instruction from a supervisor
    - on pre-operational equipment inspection cards
    - by digital means, such as a phone or tablet
- Airflow rates posted on the equipment could include a placard mounted in the operator's cab or in a location visible from the operator's controls

Airflow Rates (Section 183.1)

- Where diesel-powered equipment is operating in an underground mine, a mechanical ventilation system must produce a flow of air in accordance with the following rules:

Rule 1: Certified Airflow Rate (CSA M424.2-22)

- A piece of diesel-powered equipment that is certified in accordance with CSA Standard M424.2-22 must have an airflow rate equal to the rate posted on its certificate of homologation.
- The certified rate is determined by CanmetMINING through comprehensive laboratory testing of engine emissions, including CO_2, CO, NO, NO_2, and DPM.
- CanmetMINING List of certified engines

Airflow Rates (Section 183.1)

Rule 2: Engine Power x 0.06 m^3/s per Kilowatt

- Diesel-powered equipment that has not been certified in accordance with CSA Standard M424.2-22 follows this rule:
    - The airflow must be at least equal to the engine power multiplied by the unit airflow requirement of 0.06 m^3/s per kilowatt.
- Known informally as the "100 CFM per brake horsepower rule."

Airflow Rates (Section 183.1)

Example: Certified Ventilation Rates

Engine Manufacturer: **Caterpillar**
Engine Model: **Caterpillar C13 (R1700K), PN 549-6935, Tier 4 Final**
Governing Standard: **CSA M424.2-16 (Non-Gassy Mines)**

Certificate Number	Engine Rating and Fuel Rate at Sea Level	Fuel Sulphur Fuel - ppm	Ventilation Prescription	
			CFM	m^3/s
1304	345 HP (257 kW) @ 2050 RPM, 128.3 lb/h	15	12, 500	5.90

Rule 1 M424.2 Certificate Rate:
12,500 CFM

Rule 2 100 CFM Rule:
34,500 CFM

Airflow Rates (Section 183.1)

Rule 3: After-Treatment Device without Certified Airflow Rate

- Applies when equipment is fitted with an after-treatment device without a certified or recertified airflow rate.
- Employer determines suitable airflow rate in consultation with the Joint Health and Safety Committee (JHSC) or Health and Safety Representative (HSR).
- Considerations include pre-modification rates, good engineering practices, and testing results.
- This rule accounts for changes caused by after-treatment devices, maintaining effective ventilation even with modifications.

Airflow Rates (Section 183.1)

Compliance Considerations for Determining Suitable Airflow Rate using Rule 3

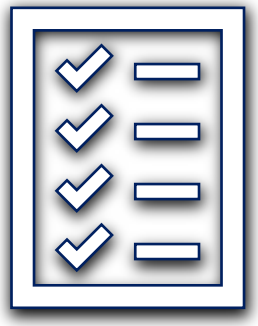
In consultation with the JHSC or HSR, if any:

Step 1: Determine the Original Airflow Rate

Identify the original airflow rate for the equipment before it was fitted with the after-treatment device. This rate might be certified in accordance with CSA M424.2 or another relevant standard, or based off the airflow rates determined under Rule 2 (100 CFM per brake horsepower rule).

Step 2: Evaluate the After-Treatment Device

Examine the specifications and performance data of the after-treatment device. You need to understand how the device affects emissions and airflow requirements.



Airflow Rates (Section 183.1)

Compliance Considerations for Determining Suitable Airflow Rate using Rule 3

Step 2: Evaluate the After-Treatment Device Continued

Diesel Particulate Filter (DPF):

- DPFs are designed to capture and remove particulate matter (PM) or soot from the exhaust gases produced by diesel engines but in some cases, DPFs can lead to an increase in nitrogen dioxide (NO_2) emissions due to the oxidation of nitrogen monoxide (NO) to NO_2 as part of the regeneration process (cleaning of the DPF).

Selective Catalytic Reduction (SCR) System:

- SCR systems use a catalyst to convert harmful nitrogen oxides (NOx), including into nitrogen (N_2) and water vapor (H_2O) but are less effective in the reduction of PM.

Diesel Oxidation Catalyst (DOC):

- DOCs are highly effective in reducing emissions of unburned hydrocarbons (HC) and carbon monoxide (CO), both of which are harmful pollutants however, can lead to an increase in NO_2 emissions due to the conversion of NO to NO_2.

Airflow Rates (Section 183.1)

Compliance Considerations for Determining Suitable Airflow Rate using Rule 3

In consultation with the JHSC or HSR, if any:

Step 3: Use Good Engineering Practices

Employ recognized engineering practices to determine the suitable airflow rate. Consider industry standards and guidelines for after-treatment device integration. Ensure modifications do not compromise overall safety or emission controls.

Step 4: Determine a Suitable Flow of Air

Based on the consultation and considering the factors mentioned above, determine a suitable flow of air for the equipment. This should be done in a way that ensures safe air quality within prescribed exposure limits, accounting for any changes introduced by the after-treatment device.

Airflow Rates (Section 183.1)

Compliance Considerations for Determining Suitable Airflow Rate using Rule 3

Step 4: Determine a Suitable Flow of Air Continued

- Conduct tailpipe testing before and after installing the after-treatment device in accordance with original equipment manufacture's (OEM) requirements.
- Establish periodic benchmark tailpipe testing after the system is installed and operating, ensure that exhaust emissions are within range.
- Establish workplace air quality baselines prior to the application of the after-treatment device.
- Compare tailpipe testing results to the normal operating emission levels of the engine before the aftertreatment device was installed.
- Perform air quality test in the workplace under varying airflow rates:
- Isolate the equipment in an air stream with a known air volume and quality.
- While simulating normal operation of the equipment, test both the intake and exhaust air quality of the engine.

Airflow Rates (Section 183.1)

Compliance Considerations for Determining Suitable Airflow Rate using Rule 3

In consultation with the JHSC or HSR, if any:

Step 5: Document the Determination

Record the suitable flow of air determined in consultation with the JHSC or HSR. Ensure that this documentation includes all relevant information, such as test results, calculations, and any other data used to establish the new airflow rate.

Step 6: Keep Records Readily Available

Maintain the records of the suitable flow of air readily available at the mine site. This documentation should be accessible for reference and inspection by relevant parties, including MLITSD inspectors.

Airflow Rates (Section 183.1)

Rule 4: Cumulative Airflow Rate for Multiple Equipment

- Used when multiple pieces of diesel-powered equipment operate in a single continuous course of air.
- Total airflow rate should be equal to the cumulative ventilation rates calculated under either Rules 1, 2, or 3 (as applicable).
- Ensures that overall ventilation meets requirements when multiple pieces of equipment contribute to emissions.
- Prevents concentration of contaminants in the shared airflow path.

Airflow Rates (Section 183.1)

Rule 4: Cumulative Airflow Rate for Multiple Equipment

Example:

- **In an active heading at a remuck you have an LHD loading 2 Trucks**
- **The LHD requires 35k CFM and each Truck requires 40k CFM**
- **Total Vent Required: 115k CFM**

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Exposure Limits to Diesel Particulate Matter (DPM) (Section 183.2)

- Diesel emissions in underground mines contain various contaminants, including carbon monoxide, oxides of nitrogen, and diesel particulate matter. Prolonged exposure can lead to health issues, including cancer.
- Currently, the best way to assess worker exposure to DPM is to measure airborne elemental carbon concentrations in the ambient atmosphere.
    - Elemental carbon is used as a surrogate for measuring DPM levels because it can be accurately measured at low concentrations and diesel engines are likely the only source of submicron elemental carbon in underground mines.
- The time-weighted average (TWA) exposure of a worker to elemental carbon shall not be more than 0.12 milligrams per cubic meter (mg/m3) of air.

Worker Exposure Testing (Section 183.3)

- Employers at underground mines must conduct testing of the volume of air flowing in underground haulageways and workings where diesel-powered equipment is operating at least weekly.
- A worker may request that the employer test the personal exposure to carbon monoxide (CO), nitrogen dioxide (NO_2), or elemental carbon.
- The results of the tests must be:
  - recorded and maintained
  - readily available
  - shared with the JHSC or HSR, if any, on request

Worker Exposure Testing (Section 183.3)

Compliance Considerations

- MLITSD Hygienists may check to see that the methods used for sampling and monitoring airborne concentrations comply with the requirements of Reg. 833.

A workplace must:

- Follow sound industrial hygiene practice, for example, with respect to sampling and analysis strategy, procedures, equipment, quality assurance measures, documentation, accreditation, data assessment, interpretation and management as required by subsection 6(1) of Reg. 833.
- Use standard methods, defined as methods published by one of the agencies listed in section 1 of Reg. 833. For elemental carbon, the standard method is USA National Institute for Occupational Health (NIOSH) "Method #5040 DIESEL PARTICULATE MATTER (as Elemental Carbon)". **Direct reading instruments for elemental carbon are not available.**
- When direct reading instruments are used, for example for CO and NO_2: operate, calibrate and maintain the instruments according to the manufacturer's instructions, as required by subsection 6(2) of Reg. 833.

Evaluating Test Results (Section 183.3)

- If worker exposure tests indicate a worker has been exposed to CO or NO_2 in excess of the limit as set out in section 4 of Regulation 833 (Control of Exposure to Biological or Chemical Agents), or elemental carbon in excess of limit set out in section 183.2, subsection 183.3 (4) requires the employer to:
  - investigate the cause and take remedial action, if possible, to prevent recurrence.
  - notify the affected worker(s) and the JHSC or the HSR, if any, of the exceedance.
  - re- test and confirm that the concentrations do not exceed the applicable limits.

Evaluating Test Results (Section 183.3)

MLITSD Hygienists may review air sampling data and calculations.

Example: TWA exposure for a 12-hour shift

If a worker has a measured elemental carbon exposure of 0.09 mg/m^3 over ten hours underground and an exposure of 0 mg/m3 is assumed over the remaining two hours of the shift working on the surface, then the worker's TWA exposure is calculated using the method from Reg. 833 Schedule 1, as follows:

$$\boldsymbol{Daily\ TWA\ Exposure} = \frac{\boldsymbol{C1T1 + C2T2 + \ \ldots CnTn}}{\boldsymbol{8}}$$

Where: C is the measured concentration, and T is the time the worker is taken to be exposure to that concentration

$$Daily\ TWA\ Exposure = \frac{10\ hrs\ x\ 0.09 mg/m^3 + 2\ hrs\ x\ 0\ mg/m^3}{8}$$

$$Daily\ TWA\ Exposure = 0.11\ \text{mg/m}^3$$

The calculated Daily TWA exposure of 0.11 mg/m3 is below the Reg. 854 TWA exposure limit of 0.12 mg/m^3.

Evaluating Test Results (Section 183.3)

Compliance Considerations

The MLITSD Hygienists may verify that correct occupational exposure limits and calculations are used.

- Reg. 833 occupational exposure limits are posted on Ontario.ca
  For example, the TWA limit for CO is 25 ppm and the TWA limit for NO_2 is 3 ppm.
  The TWA limit for elemental carbon in underground mines where diesel equipment is used, of 0.12 mg/m^3, is in Section 183.2 of Reg. 854.
- For some agents, rather than calculate the worker's 8-hour daily or the 40-hour weekly TWA exposure, it is possible to ADJUST the occupational exposure limit based on the shift length.
  - MLITSD accepts use of the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) Quebec Model online tool for this purpose.
  - Take care to use the tool correctly. Be aware of the limitations. Be prepared to do the math if the Quebec OEL for a substance is different from the Ontario OEL. NEVER adjust short term or ceiling exposure limits.
  - There is no Quebec Model adjustment for elemental carbon.
  - OEL adjustments made using the Brief and Scala model are not acceptable.

Evaluating Test Results (Section 183.3)

Example: Use of the Quebec Model

Consider the case of 12-hour workdays and 84-hour work weeks, on a two in- two out rotation (average 42 working hours per week), with carbon monoxide exposure.

If, on one day, a worker is exposed to 25 ppm CO (i.e., at the value of our OEL) for a duration of 12 hours, the worker's daily TWA exposure, calculated according to Reg. 833, would be 37.5 ppm.

$$Daily\ TWA\ Exposure = \frac{12\ hrs\ x\ 25\ ppm}{8} = 37.5\ ppm$$

This would be considered an overexposure, since the calculated daily TWA exposure of 37.5 ppm is greater than the Ontario OEL of 25 ppm.

The Quebec Model gives an adjustment factor for this situation of 0.67, and an adjusted OEL of 17 ppm.

This would be considered an overexposure, since the measured 12-hour exposure of 25 ppm is greater than the adjusted OEL of 17 ppm.

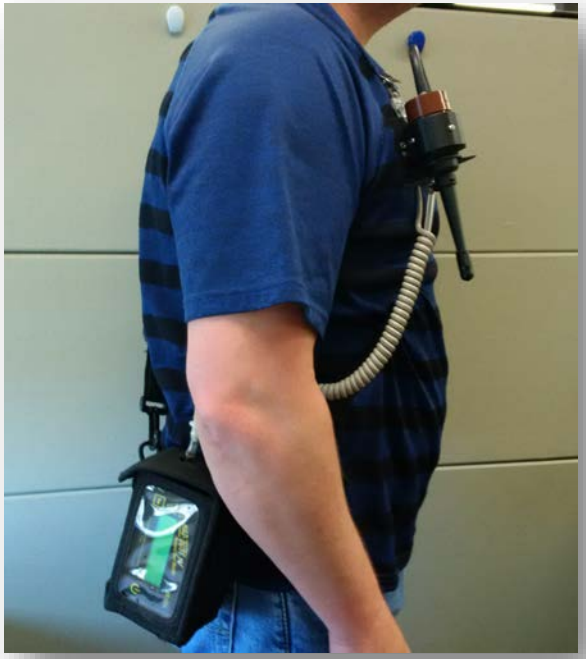
So, either method gives the same result- identifying that the worker is overexposed!

Evaluating Test Results (Section 183.3)

Compliance Considerations

MLITSD Hygienists may look at other aspects of occupational hygiene sampling and exposure controls, for example:

- **Sampling instruments** - equipment, sampling media, calibration records, and ask for demonstrations of use
- **Records** – results, laboratory certificates, data trends
- **Overexposures** - how are these communicated, investigated and addressed
- **Physical agents** – how are heat stress and noise assessed and controlled
- **Respirators** - if used, there must be a Respiratory Protection Program that meets the requirements of Reg. 833 or Reg. 490 as applicable



Additional considerations for determining underground airflow rates

- Regulation 833 (Control of Exposure to Biological or Chemical Agents) requires that employers take all measures reasonably necessary in the circumstances to protect workers from exposure to a hazardous biological or chemical agent because of the storage, handling, processing or use of such agent in the workplace.
- **There will be situations where airflow rates based solely on diesel-powered equipment may not be sufficient for managing other airborne hazards in the workplace, such as silica, blasting contaminants, or heat.**
- All mines and mining plants are required to have a comprehensive airborne hazard management program under section 182 of Reg. 854 to manage airborne hazards, including diesel exhaust.

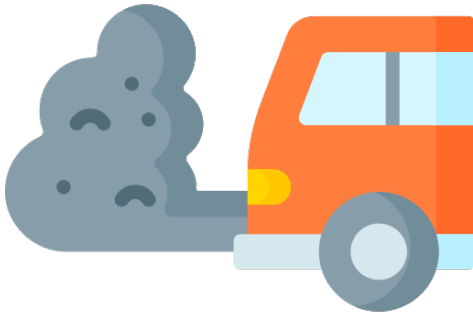
Tail Pipe Testing Undiluted Exhaust (Section 183.4)

- Tailpipe emission testing is critical to ensure engines and after-treatment devices are operating as designed.
- Employers must develop and implement safe measures and procedures for testing undiluted exhaust from diesel-powered equipment.
    - These measures and procedures must be developed in consultation with the JHSC or HSR, if any.
- Each piece of diesel-powered equipment must be tested under consistent conditions and testing must be carried out under a full load, as far as is practical.
- Exhaust testing must be performed both routinely, such as once per month, or more frequently if required by the OEM and after any repairs are made to the engine or exhaust system.
- Employers must ensure that **undiluted exhaust from diesel-powered equipment contains less than 600 parts per million by volume of CO and less than 60 parts per million by volume of NO_2.**

Tail Pipe Testing Undiluted Exhaust (Section 183.4)

- All testing equipment should be used following manufacturer's recommendations.
- Use equipment which prevents condensation in the sampling line when testing for NO_2 as water can affect the sensor readings.

- To ensure tailpipe test consistency, tests must be conducted:
  - at normal engine operating temperature
  - at stabilized CO/CO_2 levels
  - while the engine is under full load as far as is practical



- Engines which fail to meet prescribed limits should be:
  - removed from service
  - inspected to determine the cause of the failure
  - repaired where required
  - re-tested to ensure compliance

- The results of all testing must be recorded and kept readily available at the mine site.

Tail Pipe Testing Undiluted Exhaust (Section 183.4)

Compliance Considerations

- Tailpipe test devices are also direct reading instruments.
- MLITSD Hygienists may verify that the devices are used, calibrated and maintained according to the manufacturer's instructions, as required under subsection 6(2) of Reg. 833.
- MLITSD Hygienists may also request test records for specified diesel-powered equipment.

Ontario

Consultation

Joint Health and Safety Committee or Health and Safety Representative, if any

Genuine consultation with the Joint Health and Safety Committee (JHSC) or Health and Safety Representative (HSR) is essential.

Collaborative input from the JHSC or HSR enhances decision-making and ensures worker safety.

Meaningful consultation goes beyond information sharing and involves incorporating recommendations into actions.