

Testing Undiluted Exhaust in Underground Mines

Purpose

To assist employers, workers and other workplace parties with understanding the requirements in Regulation 854 (Mines and Mining Plants) under the Occupational Health and Safety Act (OHSA), for the purpose of testing undiluted exhaust discharge from diesel powered equipment (diesel engine tailpipe testing).

Objectives

- To provide information on performing undiluted emissions tests on diesel equipment in underground mines.
- To control and minimize the exposure of workers to diesel emissions.
- To conduct carbon monoxide (CO) tests under consistent conditions.

Legal requirements

Sections 181.1, 182, 183, 183.1 and 183.2 of [Regulation 854 \(Mines and Mining Plants\)](#) under the [OHSA](#) cover the important requirements.

History

A survey conducted by the Ministry of Labour in 2002 determined that consistent testing for tailpipe CO was not being carried out. In many cases, the results of tailpipe tests could not be used to assess the condition of engines. Changes to sections 182, 183.1 and 183.2 of Regulation 854 (Mines and Mining Plants) came into force on January 1, 2012. Among other things, the amended provisions require testing measures and procedures to be developed and implemented in consultation with the Joint Health & Safety Committee (JHSC) or health and safety representative (H&S Rep) and that each piece of diesel-powered equipment be tested under consistent conditions with the intent to help industry to achieve reproducible tailpipe testing for CO emissions.

Background

Underground workers can potentially be exposed to diesel particulate, carbon monoxide, aldehydes and oxides of nitrogen as well as other emissions at levels higher than those encountered in other occupational environments. Diesel engines can be a

significant source of contaminants in the underground environment. Properly maintained engines emit less diesel emissions. Engines can be adjusted to give both low carbon monoxide and diesel particulate matter, but this can potentially increase the amount of oxides of nitrogen emitted. This is especially true of mechanically controlled engines. Engine manufacturers have designed modern engines for optimum performance and changes to fuel mixtures and engine timing may no longer be possible.

Understanding CO levels is important. The requirements that relate to undiluted exhaust emissions in Regulation 854 for Mines and Mining Plants focus on testing to reduce emissions and ensure the CO limit set out in subsection 182(5) is not exceeded.

Improved engine maintenance can reduce emissions by up to 65 per cent for gases (CO) and up to 55 per cent for diesel particulate matter.

Studies on engine maintenance and emissions have shown that:

- CO can be used to determine if an engine may be in need of maintenance.
- Testing CO may indicate repairs are needed for systems including engine intake, exhaust, fuel and cooling systems.
- Untreated exhaust should be measured before any after-treatment devices are used, in order to form a base line for engine CO emissions that can be referred to for comparison of the CO levels being emitted. Maintenance programs developed to include testing CO before after-treatment devices and at the tailpipe were useful when determining engine health.
- Levels of CO can be checked against historical readings — the data collected may indicate engine maintenance is needed.
- Maintenance programs developed to evaluate engines and related systems against previous results have been successful in reducing emissions.

Acceptable practices for sampling CO

Application

The information in this guideline is applicable to all diesel engines in underground mines, whether stationary or mobile.

Any testing described in this guideline should be conducted by a person with experience and/or knowledge of the testing equipment and procedures.

Preparation and sampling equipment

Employers must develop and implement safe measures and procedures for testing undiluted exhaust from diesel-powered equipment in underground mines. These measures and procedures must be developed in consultation with the JHSC or H&S

Rep and must take into consideration any recommendations made by the JHSC or H&S Rep. In addition, each piece of equipment must be tested under consistent conditions and testing should be carried out, as far as is practical, under a full load. (See subsection 183.2(1.1) of Reg. 854.)

If a test is carried out on equipment that is not under full load, the employer should be able to provide clear evidence demonstrating why it was not practical to do so.

Sampling equipment

- The sampling equipment should be in good working order and designed for undiluted diesel emission testing, following manufacturer's recommendations.
- For consistent results, the same make/model of equipment should be used for sampling.
- During the first 30 seconds of engine loading, CO levels are likely to spike before reaching a stable level. Samples should be taken after that.

Electronic testing equipment

The initial spike in CO levels will be evident with a real-time gas monitor. The gas monitor should be calibrated by manufacturer's recommendations. The monitor should also perform an initial self-check procedure before use.

Stain tube testing equipment

If a stain tube system is used, sampling should begin 30 seconds after starting the load test, to avoid sampling the initial CO spike. The equipment should be tested using the manufacturer's recommendations. Tubes should not be used past the expiry date.

Stopping the test

If for any reason there is a concern of risk to the operator or the person sampling, the test should be stopped. If the operator notices that temperature levels (engine or torque converter) are getting too high, the test should be interrupted to allow the engine systems to return to normal operating temperatures.

Test preparation

- The area where equipment is being tested should be assessed for safety during the load test.
- The equipment being tested should be evaluated to prevent unintended movement.
- Vehicle testing must be performed in a properly ventilated area. (See subsection 183.1(3) of Reg. 854.)

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- Proper personal protection equipment, clothing and devices (i.e. gloves for heat protection) must be worn. (See subsection 12(3) of Reg. 854.)
 - Workers conducting the sampling should have safe and comfortable access to the exhaust sampling point.

Tailpipe testing

To ensure tailpipe tests are done under consistent conditions, tailpipe tests must be done with normal engine operating temperature and stabilized CO levels and must be conducted while the engine is under full load as far as is practical. Here are some recommended steps:

- The engine should be at operating temperature during testing.
- All mobile equipment brakes should be tested and functioning properly.
- The equipment being tested should be assessed for safety during the load test.
- The results of all testing must be recorded. (See subsection 183.2(3) of Reg. 854.)

Selection of test procedures based on equipment

- An auto transmission with hydraulic systems should be tested using a torque converter stall or hydraulic stall (e.g. load haul dump and haulage trucks). Here are the recommended steps:
 - Place the drive unit in forward at the highest gear.
 - Place the hydraulic system under a consistent stall condition (the testing measures and procedures should specify what hydraulic function is to be used to perform the test)
 - Operate the engine at full throttle.
- A standard transmission with a hydraulic system (e.g. many articulated units such as scissor lifts and forklifts, etc.) should be tested by:
 - Operating the engine at high idle (maximum revolutions per minute or RPM)
 - Placing the hydraulic system under a consistent stall condition (the testing measures and procedures should specify what hydraulic function is to be used to perform the test)

Note: Ensure the hydraulic system is capable of safely withstanding a stall condition.
- An automatic/power shift or standard transmission with no hydraulic system (e.g. pickup trucks, mine mules, gators and tractors, etc.) should be tested by:

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- Operating the engine at the maximum RPM recommended by the manufacturer
 - Having a method to verify the RPM.
 - Stationary units (e.g. welders, compressors and pumps, etc.) should be tested by operating the unit under full load as far as is practical (full load would be determined by the procedure).
Note: the full load may have to be estimated or the use of a tachometer is recommended for reproducible results.
 - Other test protocols may need to be established for special vehicles or circumstances (example hydro-static drive).

Terms

Untreated versus undiluted

Untreated exhaust refers to the emissions that are emitted prior to any after treatment devices. Undiluted exhaust is measured at the end of the tail pipe and refers to the emissions that are released into the air of the mine.

Resources

The Canadian Mining Industry Research Organization (CAMIRO) oversees multi-sponsored research efforts, including the Diesel Emission Evaluation Program (DEEP) material. This material is available on the CAMIRO website (see Maintenance Impact on Diesel Emissions).

- [Canadian Mining Industry Research Organization](http://www.camiro.org)
www.camiro.org

More information

- [Mining Safety](http://Ontario.ca/miningsafety)
Ontario Ministry of Labour
Ontario.ca/miningsafety
- [Health and Safety Ontario](http://www.healthandsafetyontario.ca) (health and safety association)
www.healthandsafetyontario.ca

Toll-free number

Call 1-877-202-0008 any time to report critical injuries, fatalities or work refusals. Call 8:30 a.m. to 5 p.m. Monday to Friday for general questions about workplace health and safety. **Always call 911** in an emergency.

Disclaimer: This guideline has been prepared to assist workplace parties in understanding some of their obligations under the OHSA and its regulations. It is not intended to replace the OHSA or its regulations — reference should always be made to the official version of the legislation.

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

While this guideline will also be available to Ministry of Labour inspectors, they will apply and enforce OHSA and its regulations based on the facts as they find them in the workplace. This guideline does not affect their enforcement discretion in any way.

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