IHSA.ca
Work Safe for Life

Carbon Monoxide from Fuel-Powered Equipment

Recognizing, Evaluating, and Controlling Exposure

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WHO WE ARE

IHSA is part of Ontario's Health and Safety System, which includes the Ministry of Labour, Training and Skills Development (MLTSD), the Workplace Safety and Insurance Board (WSIB), four safe workplace associations, a training centre, and a medical clinic.

WHAT WE DO

IHSA is Ontario's trusted occupational health and safety resource for effective sector-specific engagement, education, products, and services. Our goal is to prevent injuries, illnesses, and fatalities at the workplace by helping employers and workers identify health and safety hazards and develop strategies to control or eliminate them. As a leader in health and safety education, we ensure that our training adheres to the latest regulatory requirements and compliance standards.

IHSA members get our health and safety training and products at no charge or at a reduced price.

ONTARIO'S HEALTH & SAFETY SYSTEM

Ontario

Ministry of Labour, Training and Skills Development

Develops legislation and regulations, and is responsible for enforcement and prevention.

Workplace Safety and Insurance Board

Provides compensation and supports return-to-work programs for injured workers. Funds the health & safety system through employer premiums.

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Serves the public service sector including health and community care, education and culture, municipal and provincial government, and public safety.

Workplace Safety North™

Serves the forestry, mining, pulp and paper, and printing sectors.

Public Services Health & Safety Association™

Serves the agricultural, industrial, manufacturing, and service sectors.

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Workers Health & Safety Centre

Provides training for workers, JHSC members, supervisors, and employers in every sector.

MEDICAL CLINIC

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Occupational Health Clinics for Ontario Workers Inc.

Provides medical diagnostics, information, and services to prevent work-related health conditions.

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IHSA has additional information on this and other topics.
Visit **ihsa.ca** or call Customer Service at **1-800-263-5024.**

This guide is intended to be used as a reference for employers and workers to help recognize, evaluate, and control carbon monoxide (chemical abbreviation: CO) in their workplace. It does not provide specific recommendations for any given workplace, as controlling carbon monoxide depends on a number of factors specific to the workplace, type of work, and the equipment being used.

Specific solutions for any given workplace will need to be assessed in consultation with the employer's Joint Health and Safety Committee and other safe workplace parties.

This manual was developed, reviewed, and endorsed by the **Concrete Floor Labour-Management Health and Safety Committee** in association with the Infrastructure Health and Safety Association. IHSA would like to thank the members of the committee for contributing their knowledge, experience, and time to produce this manual.

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Labour Management NETWORK

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1 Introduction

In many construction operations, everyday equipment such as gas-powered trowels, concrete-cutting saws (pictured below), generators, and other internal combustion engine machinery have the potential to generate dangerous levels of carbon monoxide (CO). If appropriate measures are not taken, such as providing adequate ventilation of a workspace, CO exposure can be a serious health and safety concern for both workers and employers.

Gas-Powered Equipment Can Generate Dangerous Levels of CO

Ontario's *Occupational Health and Safety Act* (OHSA), also known as the green book, places the overall authority for health and safety matters at a project on the constructor of the project. This is the person with the most control over health and safety at the entire project and is ultimately responsible for the health and safety of all workers.

The constructor must ensure that all the employers and workers on the project comply with the OHSA and regulations. On multi-employer projects, the constructor is in the best position to coordinate the activities of trade contractors so that hazards, including CO exposure, are planned for and controlled.

The Constructor is Responsible for the Health and Safety of Workers at a Project

Controlling CO exposure in construction operations should begin before the job starts. To reduce CO to acceptable levels, a combination of controls may be necessary. This guide will outline some of the possible controls, such as:

- Minimizing the use of fuel-fired equipment indoors whenever possible
- Keeping compressors and generators outside
- Using air movers or large fans to ventilate the area
- Keeping windows and doors open to bring fresh air in and let contaminated air out
- Requesting information from contractors and subcontractors about fuel-powered equipment that will be used on site, such as:
  - Type and number of fuel-powered vehicles, equipment, and tools
  - Type of temporary heaters
  - Where and when tools and equipment will be used
  - How tools and equipment will be used (e.g., Will they be used in a poorly ventilated area?).

Other considerations and controls are listed in Chapter 7.

Because CO is a clear, colourless gas with no odour or taste, it is not easily detectable. Air quality testing equipment such as direct-reading instruments, monitors, or detectors are needed to evaluate CO levels in the workplace.

Direct-reading instruments are capable of detecting and measuring chemicals in the air in real-time. They can detect the presence of CO, record the levels, and activate alarms to warn workers when airborne levels reach a dangerous point.

Monitoring CO levels is not considered a control measure. Air testing equipment only measures the level of CO exposure faced by workers to determine whether the control measures are being effective.

This guide will help you establish a strategy for recognizing, evaluating, and controlling CO in your workplace by:

- Introducing the properties of CO
- Outlining the factors that affect worker exposure to CO
- Demonstrating the importance of monitoring CO levels in the workplace
- Reviewing the controls to put in place to reduce CO exposure before work begins.

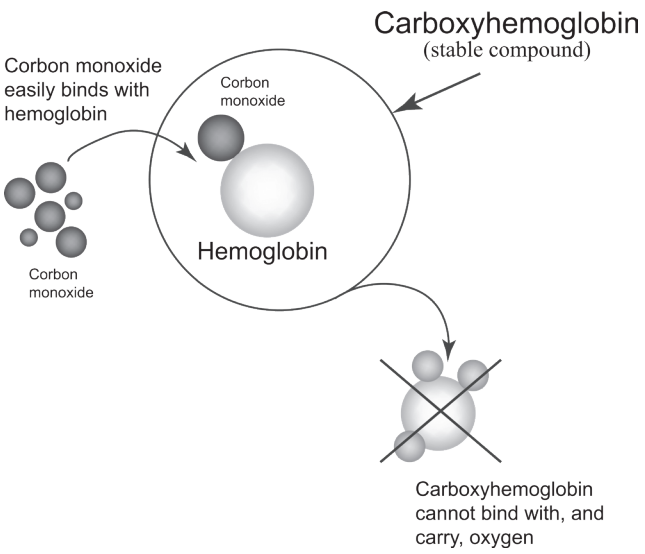
Gas Monitors Can Evaluate CO Levels in the Workplace

2 CO Hazards in the Workplace

Properties of CO

Carbon monoxide (chemical abbreviation: CO) is a clear, colourless gas with no odour or taste. Exposure to CO is dangerous because it interferes with the body's ability to use oxygen. Even in small doses, CO can kill.

CO combines with hemoglobin in the blood to produce carboxyhemoglobin, which is unable to carry oxygen to body tissues. Body parts that are deprived of oxygen will start to die.



CO Prevents Blood from Carrying Oxygen to Cells

The first signs and symptoms of CO exposure can appear flu-like and include headache, nausea, and/or vomiting. Prolonged or greater levels of exposure can rapidly lead to loss of consciousness, arrested breathing, heart failure, and death.

KNOW THE FACTS ABOUT CO

- CO is produced by equipment that is powered by gasoline, diesel, propane, or other fuels.
- CO is a gas at room temperature.
- CO mixes with air and breaks up easily. But without proper ventilation, it can build up and form pockets with dangerous levels of CO.
- CO has poor warning properties—it has no smell, no taste, and no colour and does not irritate the skin or lungs.

Common Sources of CO

CO is present in indoor and outdoor air in varying amounts from things like vehicle exhaust, gas and wood-burning stoves, furnaces, and cigarette smoke. On a construction site, a major source of CO is engine exhaust. Gasoline, propane, and diesel engines all release CO. The risk is greater when these engines are used indoors where gas can accumulate in poorly ventilated spaces.

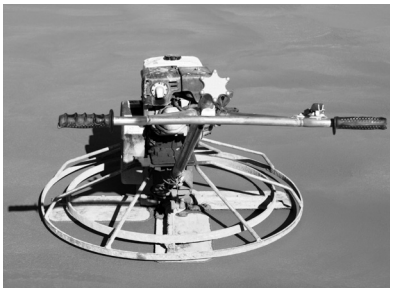
All equipment and vehicles powered by fuel (gasoline, diesel, or propane) emit CO. When using any fuel-powered equipment, it is important to take measures and adopt procedures to prevent overexposure.

Vehicle Exhaust is a Major Source of CO

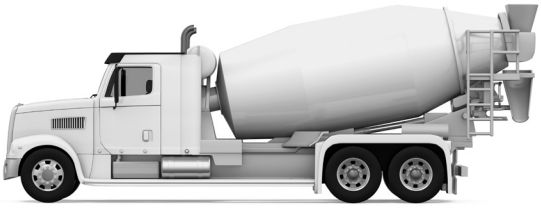
Common Sources of CO

Generators

Propane Heaters



Power Trowels



Concrete Trucks

Fuel-powered Lift Trucks

Concrete Cutting Saws

Heavy Machinery

3 Health Effects of CO

Exposure to CO can cause a variety of symptoms and negative health effects. It is important to recognize the signs and symptoms early to prevent serious harm to your health and avoid putting others in the area in danger.

The symptoms of overexposure to CO can be divided into mild, moderate, and severe.

Mild Symptoms (often confused with the flu, so not always recognized early on)

- Headache
- Dizziness (common)
- Nausea
- Vomiting
- Blurred vision
- Occasionally cherry red lips and skin.

Mild Symptoms of CO Exposure Include Headaches

Moderate Symptoms

- Confusion
- Fainting
- Chest pain
- Shortness of breath
- Weakness
- Faster-than-normal heart beat
- Rapid breathing
- Breakdown of muscle tissue, which can damage the kidneys.

Severe Symptoms (life-threatening)

- Irregular heartbeat
- Blocked arteries leading to decreased blood flow to the heart
- Cardiac arrest (heart stops)
- Low blood pressure
- Respiratory arrest (breathing stops)
- Seizures
- Coma.

Moderate and Severe Symptoms of CO Exposure Include Chest Pains and Cardiac Arrest

NOTE: Workers who smoke may experience symptoms from CO exposure sooner than workers who do not smoke. Because cigarettes also produce CO, smokers will already have elevated levels in their blood.

CO exposure is measured in parts per million (ppm). Normal, fresh air has 0 ppm of CO. However, when working with fuel-powered equipment, there will be some level of CO in the air from the exhaust. It is important to recognize that CO is present and levels need to be monitored in order to keep workers safe.

WHAT IS PARTS PER MILLION (PPM)?

PPM is a ratio of one to a million for a given unit of measurement. For example, an Olympic-sized swimming pool contains 2.5 million litres of water. If 2.5 litres of chlorine was added to the pool, the concentration of chlorine in the pool water would equal 1 ppm.

Table 1: Health Effects of CO at Different Exposure Levels

Health Effects	Exposure Level (ppm)
Natural levels in the body	0
Irregular heartbeat in people with coronary artery disease	0.5 to 10
Decreased blood flow to the heart and irregular heartbeat in people with coronary artery disease	14 to 40
Decreased energy	30 to 50
Effects on the central nervous system (e.g., visual, hearing, learning, attention level, driving performance)	30 to 160
Headache, dizziness, drowsiness, weakness, nausea, vomiting, confusion, disorientation, irritability, convulsions, and coma	160 to 1,000
High risk of death	> 600

Source: Adapted from Toxicological Profile for Carbon Monoxide. Agency for Toxic Substances and Disease Registry (www.atsdr.cdc.gov) June 2012. p.22.

4 Occupational Exposure Limits

Regulation 833: Control of Exposure to Biological and Chemical Agents under the *Occupational Health and Safety Act* is the primary regulation for controlling workers' exposure to hazardous and chemical agents in Ontario workplaces.

Regulation 833 establishes occupational exposure limits (OELs) for chemicals in the air, including carbon monoxide, ammonia, silica fume, and many other substances. The limits are intended to prevent adverse health effects in workers.

The regulation sets out time-weighted averages (TWAs) for a variety of chemicals. The TWA limit is the amount of a chemical substance in the air that a worker may be exposed to, which is averaged over an 8-hour work day (40-hour work week). It is believed that adverse health effects should not occur for chemical concentrations below the TWA limits.

TIME-WEIGHTED AVERAGE (TWA) LIMIT

Based on a calculation used to estimate a workers exposure to chemicals averaged over an 8-hour workday taking into account the airborne level of that chemical and duration to which the worker was exposed.

Gas Detector

OELs for CO Exposure

The exposure limits for CO are listed in the table below and apply to most Ontario workplaces.

Table 2: Occupational Exposure Limits for CO

Time Limit	Airborne Concentration
Time-Weighted Average (for 8-hour work shift)	25 ppm
Time-Weighted Average (for 10-hour work shift)	17.5 ppm
30-Minute Excursion Limit	75 ppm
15-Minute Short-Term Exposure Limit	100 ppm (with at least one hour between exposures)
Ceiling Excursion Maximum Limit	125 ppm

The OEL for CO is 25 ppm for an 8-hour TWA. In addition to the TWA limit, workplaces must also ensure that exposure to CO does not exceed excursion limits. The purpose of an excursion limit is to limit short-term high exposures to prevent very sudden adverse health effects in workers.

The excursion limits are:

- Three times the TWA for any period of 30 minutes (called a 30-minute excursion limit), and
- Five times the TWA at any time (called a ceiling excursion maximum limit).

SHORT-TERM EXPOSURE LIMIT (STEL)

This means the maximum airborne concentration of a biological or chemical agent to which a worker may be exposed in any 15-minute period and no more than four times during an eight-hour work shift with at least one hour between exposures.

Exposure to CO shall not exceed 75 ppm for any 30-minute period (3 x 25 ppm) and 125 ppm at any time (5 x 25 ppm).

For longer work shift durations, the TWA limit must be reduced because the body has less time to recover between workdays (e.g., the TWA limit for CO during a 10-hour work shift is reduced from 25 ppm to 17.5 ppm).

> **REMEMBER**
>
> OELs should never be viewed as a line between "safe" and "unsafe". The best approach is to always keep exposures or the risk of a hazard as low as possible.

Using OELs to Reduce Exposure

Knowing the OEL can help reduce worker exposure. See some examples below.

Example 1

Joe works 8 hours a day finishing concrete in several basements at a residential subdivision. As part of his job, he wears a personal CO monitor. The monitor records the 20-highest readings and has two alarm settings:

1. at 25 ppm
2. at 75 ppm.

The following data collected by Joe's monitor is reviewed by the company's Health and Safety Representative:

- 8-hour TWA = 10 ppm
- Alarm 1 (25 ppm) = 3 activations
- Alarm 2 (75 ppm) = 0 activations

Although the TWA limit was not exceeded, the alarm went off three times during the day. It was decided that more ventilation would be provided for the next day to reduce the number of alarms.

Example 2

Frank is placing concrete in a basement using a gas-powered screed. He wears a CO monitor on the lapel of his jacket. Twenty minutes after the power screed is turned on, the 25 ppm alarm on his monitor beeps.

Frank turns off his screed machine, uncovers windows and turns on an extraction fan to remove the exhaust emissions from one window, while allowing fresh air to enter the other window.

Frank calls his supervisor to notify him about the alarm and the steps he took to ventilate the space. He returns to the work area after the CO levels falls below 25 ppm. As his monitor did not alarm again, he knows this strategy worked to reduce CO to safer levels.

Gas-Powered Vibrating Screed

5 Assessing CO Exposure Risks

Whenever fuel-powered equipment is used in the workplace, it is necessary to assess the risk to workers of CO exposure. Identifying how workers can be exposed to CO will help determine the controls to put in place so that this exposure can be prevented.

When assessing the risk, consider the exposure **at the source**, look at how CO travels **along the path** from the source to the worker, and how to limit exposure **at the worker**.

Exposure at the Source

Gather as much information as possible about the source of CO. The following are some factors to consider:

- **Location of sources**
  Before fuel-powered equipment or tools are used on a jobsite, the constructor and employer should determine where they will be used.
- **Age of equipment**
  Older equipment may not operate as efficiently as new, more modern equipment and may generate more CO.
- **Maintenance condition**
  Determine whether equipment and tools have been maintained according to the manufacturer's instructions. Poorly maintained equipment may generate greater amounts of CO.
- **Tightness of building**
  When fuel-powered equipment is used indoors, consider the amount of outdoor air introduced into the space. In winter, buildings are generally kept well sealed to conserve heat and minimize the amount of outdoor air that enters the space. When fuel-powered equipment is used in such conditions, levels of CO may rise.

CO Exposure Can Increase in Winter Months when Outdoor Openings are Kept Closed

- **Information from the manufacturer**
  Read the manufacturer's information about tools or equipment. Note any hazard warnings and instructions about using the equipment or tools, and determine if they are being followed.
- **Other sources of CO**
  In many workplaces, other trades that are working in the same space may be using equipment or tools which could produce CO.

Exposure along the Path

- **Ventilation**
  Windows, doors, and other openings can allow outdoor air into the work area and dilute contaminated air. In some cases, that form of natural ventilation can be effective. In other cases, fans may be used in the work area to pull fresh air into the building or exhaust contaminated air to the outside.
- **Duration of equipment use**
  In general, the longer fuel-powered equipment or tools are used, the greater the likelihood that CO can build up. However, some tools and equipment can release substantial amounts of CO within a short time.

Exposure at the Worker

- **Number of workers in the area**
  The more workers there are in the workspace where fuel-powered equipment or tools are used, the more workers may be exposed to CO.
- **Existing controls**
  Consider whether engineering controls (e.g., ventilation or exhaust control technology), administrative controls (e.g., limiting the time a worker is exposed to carbon monoxide), or personal protective equipment is being used in the workplace to help protect workers from exposure.

Factors Affecting CO Exposure

Exposure to CO is influenced by several factors including its **airborne concentration**, the **length of exposure**, and the **work intensity** of the exposed worker. It is important to consider these factors when putting control measures in place.

- **Airborne concentration of CO**
  The more CO in the air, the more likely it is to enter the body and cause harm.
- **Length of exposure**
  The longer you are exposed to CO, the higher amount will likely enter your body. However, even a short exposure to CO at very high levels can cause negative health effects and even death.
- **Work intensity**
  The more heavily you breathe, the more air (and CO) will be taken into your body. Therefore, when you are performing heavy work (e.g., shoveling), more CO will be absorbed into the body than when you are doing lighter work (e.g., sitting at a desk).
- **Other factors**
  Those with underlying heart problems or lung disease may be extra sensitive to CO. Chemicals that are released in the body from cigarette smoking can also make smokers more susceptible to the effects of CO.

Heavy Work Can Increase Exposure to CO

6 Monitoring Air Quality

CO has poor warning properties. To detect it in the workplace, air quality testing equipment is needed.

Direct-reading instruments, monitors, and detectors are all interchangeable terms to describe the devices used to monitor and detect CO in the air. These instruments are capable of detecting and measuring airborne chemicals in real-time, recording the levels, and activating alarms to warn workers when dangerous levels are reached.

Limitations of CO Monitors

Before using a CO monitor or detector, you must understand what that specific direct-reading instrument can do. Consult the manufacturer for detailed information and instructions about the make and model used in your workplace.

In general,

- Detectors can be used to monitor only the gases they were designed to detect.
- Other chemicals in the workplace can interfere with the instrument's ability to detect CO and cause false readings.
- The monitor's sensor can break down over time with exposure to CO.

Use a Monitor to Measure CO Levels in the Air

Choosing a CO Monitor

Consider the following factors before choosing a CO monitor for your workplace:

- **Cost**
  Technology has come a long way and modern monitors cost a fraction of what they used to. The price of a monitor can depend on the number of features. For example, some monitors include features such as data logging, which stores the gas readings that were recorded.

  Another factor to consider is the need for replacement parts such as sensors or batteries. Some units are intended to be discarded at the end of their useful life, while others may simply require replacement parts, such as a new sensor.

  Decide which features are important to your workplace and get prices from a variety of manufacturers and suppliers.
- **Weight and Portability**
  Some workers may have to wear the monitor on their shirt or clip it onto a piece of equipment such as a hard hat. Larger or heavier monitors would make that more difficult.

  Some types of monitors can weigh as little as 85 to 100 grams (3 to 3.5 ounces).
- **Ruggedness**
  A monitor must be able to withstand the conditions in which it will be used every day. That may include being bumped, dropped, and exposed to concrete and water.
- **Weather, temperature, and humidity**
  Temperature extremes, humidity, elevation above sea level, barometric pressure, the presence of particulates, and oxygen concentration can all affect the performance of a monitor.

  The manufacturer can provide more details about the factors that affect the instrument.

- **Simplicity of operation**
  There are many different makes and models of detectors available. Choose one where the operator can understand all of its functions and how to use it properly. Some modern instruments are quite simple to use.

REMEMBER

A CO monitor designed for in home use is ***not*** suitable for detecting CO on a construction site.

Operating a CO Monitor

Monitoring the CO levels of the workplace should be done on a regular basis and after any significant change that may increase worker exposure.

Before someone operates a CO monitor for the first time, here are some things they should know.

- **Battery Check**
  Most portable CO monitors operate on battery power. The battery must be checked before each use to determine whether it will hold a charge throughout the monitoring period. If it will not, the batteries must be replaced.
- **Cross Sensitivities**
  Before using the detector, determine if other chemicals in the workplace can interfere with the monitor's ability to measure CO. Some gases can cause a monitor to read more or less CO than is actually present. Consult the monitor's manufacturer for more information.
- **Sensors**
  A monitor is equipped with a sensor for detecting and measuring specific gases. It is important to calibrate this because sensors degrade over time. Consult the manufacturer's instructions to determine when the sensor should be replaced.
- **Bump Test**
  A bump test is performed by exposing the monitor to a known concentration of gas, usually available from the manufacturer. The bump test shows whether the monitor's alarms go off when a certain airborne level of CO is reached.

  CO monitors must be bump-tested daily when working in an "Immediately Dangerous to Life and Health" (IDLH) environment. In a non-IDLH environment, bump testing must be performed in accordance with the manufacturer's instructions.

  Consult the manufacturer's instructions about how often this test should be done and what to do if the monitor fails a bump test.

IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH)

IDLH is a term used by the National Institute for Occupational Safety & Health (NIOSH). Airborne concentration values are assigned to IDLH and include exposures to airborne contaminants that would:

- cause death or permanent health effects, or
- prevent a person from escaping a hazardous environment.

- **Calibration**
  Over time, the accuracy of a monitor is affected by temperature, humidity, exposure to gas, and age. Calibration of the instrument is necessary to correct for these effects and verify its accuracy.

  Follow the manufacturer instructions for how often a calibration should be done. Like a bump test, calibration involves exposing the monitor to a known concentration of gas. Use only a calibration gas that is recommended by the manufacturer and has not expired.

Calibrate a CO Monitor by Exposing it to a Known Concentration of Gas

- **Alarm Limits**
  Most detectors are equipped with various alarm settings, which warn the user whenever the airborne concentration of CO exceeds specific levels. The monitor may have a visible alarm (flashing light), an audible alarm (beep), and a vibration alarm.

  The manufacturer may set a predetermined alarm level that can usually be changed by the user. For Ontario workplaces the following limits should be used, based on the OELs outlined on page 7.

Alarm Setting	Concentration
Low	25 ppm
High	75 ppm

  Refer to Appendix B for procedures to follow if your detector alarms at the low or high concentration levels.
- **Ambient Area Monitoring**
  Careful consideration of the placement of a detector will ensure that all workers are protected from overexposure. Whenever possible, a detector should be worn by a worker. If that is not possible, the monitor may be attached to a structure or piece of equipment in close proximity to workers.

  Many construction activities require workers to move throughout the workplace, so a stationary monitor may not give a true indication of the workers' exposure. Also, if the monitor is put on or near a fuel-powered machine or tool, it may overestimate the exposure because the workers may not be as close to the machine.
- **Personal Monitoring**
  An ideal place in which to monitor for CO is the personal breathing zone of a worker. That zone is around the worker's nose and mouth. The monitor can be clipped to a shirt or to the brim of a hard hat. If only one monitor is available for a crew of workers, it should be worn by the worker who will likely receive the highest exposure.

Duration of CO Monitoring

Detectors should monitor the atmosphere for the whole time that fuel-powered equipment or tools are used indoors. This will ensure that any periods of high concentration are captured and alarms are triggered to warn workers about the danger.

Because levels of CO can rise and fall throughout the day, short monitoring periods should be avoided. If monitoring is not done for the whole time that fuel-powered equipment is used, high levels of exposure may be missed and workers may be overexposed.

Monitor for CO Whenever Gas-Powered Equipment is Used Indoors

Record Keeping

Appendix A contains an example of a form for recording critical information about CO monitoring.

At a minimum, the following information should be collected and retained:

- Model and serial number of detector
- Calibration date
- Date of monitoring
- Jobsite and work area
- Bump test confirmation (if applicable)
- Location of monitor
- Period of monitoring
- Time of alarm activations
- Any controls implemented

Some detectors may be capable of data logging. That allows the detector to store important information such as airborne levels of CO over the test duration. It can also calculate the average airborne concentration, highest recorded levels, and other important information.

The data can be downloaded periodically to a computer for storage and further analysis.

CO Detectors with Data Logging Capabilities Can Store Testing Results for Further Analysis

Training for CO Monitoring

Anyone using a monitor to detect CO in the workplace must be competent to do so. A "competent person" as defined by the *Occupational Health and Safety Act* is a person who:

a) is qualified because of knowledge, training, and experience to organize the work and its performance

b) is familiar with this Act and the regulations that apply to the work, and

c) has knowledge of any potential or actual danger to health or safety in the workplace.

A person who operates the detector must receive specialized training, which should cover as a minimum the following topics:

- Hazards of CO
- Legal requirements related to CO exposure
- Operating instructions
- Limitations of the instrument
- Calibration and bump testing requirements
- Alarm limits
- Care and use of the instrument
- Any other information that the manufacturer considers important.

7 Controlling CO Exposure

Consider controlling CO exposure in construction operations before the job starts. This will ensure that the job is completed in the safest way possible, keep your workplace free of incidents, and also minimize disruptions so it can be completed on time.

Although monitoring CO is not considered a control measure, it helps to show the level of exposure faced by workers and whether the controls are being effective.

Below are some measures and procedures for constructors, employers, and workers to consider. To reduce CO to acceptable levels, a combination of controls may be necessary.

- **Minimize use**
  Avoid using fuel-fired equipment indoors whenever possible. Try using electric-powered equipment instead or schedule certain work for times that minimize CO exposure to workers.
- **Maintain heaters**
  Ensure fuel-fired heaters are in good condition and maintained according to the manufacturer's instructions.
- **Move outside**
  Work outside or keep equipment such as compressors, generators, and heaters outside and vent or run the leads inside.

Ventilate Fuel-Fired Equipment Outdoors or Keep it Outside of Building

- **Use only indirect-fired heaters indoors**
  Open-flame heaters are not permitted for use inside buildings unless they are ventilated outside. Use indirect-fired temporary heaters instead. They circulate clean heat into the workplace while filtering exhaust to the outdoors.

  A fuel-fired heating device that generates noxious products of combustion shall discharge the products of combustion outside the building or structure in which it is located.
  – O.Reg.213/91 s. 49(5)
- **Don't idle**
  Avoid excessive idling and unnecessary operation of fuel-powered vehicles, equipment, and tools.
- **Develop and follow procedures**
  Develop procedures for using fuel-powered equipment and tools indoors. Procedures should include:
  - Responsibilities
  - Training workers
  - Training personnel to use detectors
  - Control measures
  - Evacuation procedures
  - First aid measures
- **Use CO monitors**
  If fuel-powered equipment must be operated indoors, use CO monitors. If the TWA limit is reached and the alarm goes off, reduce emissions by introducing additional fresh air into the space until levels fall below 25 ppm. If the "high" alarm is activated, evacuate the work area immediately and ventilate it fully.
- **Inspection and maintenance**
  Fuel-powered equipment and tools should receive regular inspection, maintenance, and tuning in keeping with the manufacturer's instructions. Over time, equipment and tools may be damaged or altered, or may wear out, leading to greater CO emissions.

Inspect vehicles to ensure that the air intake and fuel systems are working correctly. Check for such things as leaking exhaust connections or manifolds, as well as loose or broken floorboards, exhaust pipes, and mufflers.

- **Ventilate**
  Use air movers (or large fans) and keep windows and doors open to bring fresh air in and let contaminated air out. When purchasing a large fan, make sure the side of the fan is completely covered or sealed with polyethylene, metal, or other material to prevent the air from returning back to the fan. The air flow of the fan should be one direction—air flowing from the back of the fan to the front. **NOTE**: This alone may not reduce CO to safe levels. Use respiratory protection (a supplied-air respirator) if controls are inadequate.

Use Large Fans to Ventilate Work Areas

- **Report symptoms immediately**
  Encourage all workers to notify their supervisor immediately if they develop symptoms of CO exposure. Call 911 for medical attention. If exposed, DO NOT drive or operate a motor vehicle.

- **Train workers**
  All workers who might be exposed to CO must be instructed on how to recognize the symptoms of overexposure in themselves and their co-workers.

  The following topics should be covered:

  - Recognizing signs and symptoms of exposure to CO
  - Company policies and procedures related to CO
  - Common sources of CO in the workplace
  - Control measures
  - First aid and emergency response.

  IHSA has a developed a Safety Talk for CO (see Appendix C) that can help train workers.

8 Emergency Procedures

The health effects of CO exposure can be serious if control measures are insufficient or fail and symptoms are not recognized. Companies must always have first aid and emergency response procedures in place.

First Aid

If a worker is overexposed to CO and develops medical symptoms, first aid must be administered as soon as possible to prevent serious and permanent illness. All workplaces covered by the *Workplace Safety and Insurance Act* are required to have a first aid station and trained first aid personnel on site.

The specific requirements in Regulation 1101: First Aid Requirements covers such things as the following:

- Requirements of a first aid station
- Minimum contents of a first aid box and first aid room
- Items to be displayed on the notice board (WSIB's *In Case of Injury at Work* poster, valid first aid certificates of trained workers on duty, and inspection card for the first aid box)
- Requirements for records of first aid treatments given
- Inspection requirements for first aid boxes, stations, equipment and records.

First aid stations must be easily accessible and must be in the charge of a worker who is certified to give first aid and who works near the first aid box. That person must have received training from a recognized provider, such as the St. John's Ambulance or the Canadian Red Cross.

For a full list of approved first aid training providers, consult the WSIB's website.

First Aid Procedures for CO Exposure Must Be in Place

Learning first aid, CPR, and how to use an AED can help you save a life. Knowing how recognize the signs of someone who is in distress from a heart attack, stroke, or choking, for example, can help you get them the treatment they need quickly.

In cases where every second counts, prompt treatment can mean the difference between loss of life, life-long impairment, or a full recovery. If a worker has not lost consciousness, a full recovery is possible. However, it is a good idea to seek medical attention before starting to work again as weakness and lack of coordination can be dangerous.

The following are some general first aid measures for symptoms associated with CO exposure in the workplace:

- **Report symptoms** of possible CO exposure to the supervisor immediately.
- **Call 911** or the facility emergency number for assistance.
- **Ensure the area is safe when rescuing a person.** When rescuing a worker always ensure your own safety first. The only thing that can protect you from exposure to CO is a positive-pressure, self-contained breathing apparatus (SCBA) or a full-facepiece supplied-air (airline) respirator with an "escape" air bottle.

- **Turn off the source.** Before giving first aid, shut down any equipment or tools that may be the source of the CO.
- **Move the worker to a safe location.** Move the affected worker to a place with fresh, clean air that is away from the contaminated area.
- **Keep the worker comfortable.** Keep the worker warm and at rest because physical exertion may increase the effects of CO.
- **Perform CPR.** If the worker is unconscious and has stopped breathing, a trained first aider should administer cardiopulmonary resuscitation (CPR).
- **Always seek medical attention.** In all cases where CO exposure is suspected, seek medical treatment.

Call 911, Move to a Safe Location, and Give First Aid Until Help Arrives

Emergency Response Plan

Every construction project needs an emergency response plan before work begins so that everyone is prepared in case of an emergency. For more detailed information on developing an emergency response plan, refer to Chapter 2: Emergency Procedures in IHSA's *Construction Health and Safety Manual* (M029).

Before beginning work on a jobsite, workers should make sure they are familiar with the emergency response procedures for that site, which includes:

- Emergency warning alarms and codes
- Emergency telephone numbers
- Nearest hospital
- Rescue procedures
- Meeting or muster points
- Names of persons capable of administering first aid
- Location of emergency equipment such as fire extinguishers.

The site supervisor should be able to provide this information to workers.

Carbon Monoxide Monitoring Record Form

Company Name		**Tester's Name**	
Project Name/ Location		**General Contractor**	
Air Monitor Name/ Unit Number		**Calibration Date**	

Carbon Monoxide Limits	8-hr TWA: 25 ppm	30-min STEL: 75 ppm	Ceiling Limit: 125 ppm
Controls (Legend)	**A** Open windows, doors	**B** Mechanical ventilation	**C** Respiratory protection

Test #	Date	Area	Testing	Results	Controls
1			Bump test performed?*	Time on	The following controls were implemented: A B C
			Who wore monitor or where was it placed?	Time off	
				Time(s) of alarm	Other:
2			Bump test performed?*	Time on	The following controls were implemented: A B C
			Who wore monitor or where was it placed?	Time off	
				Time(s) of alarm	Other:
3			Bump test performed?*	Time on	The following controls were implemented: A B C
			Who wore monitor or where was it placed?	Time off	
				Time(s) of alarm	Other:
4			Bump test performed?*	Time on	The following controls were implemented: A B C
			Who wore monitor or where was it placed?	Time off	
				Time(s) of alarm	Other:
5			Bump test performed?*	Time on	The following controls were implemented: A B C
			Who wore monitor or where was it placed?	Time off	
				Time(s) of alarm	Other:

*A daily bump test must be performed when working in an environment that is "Immediately Dangerous to Life and Health" (IDLH).

Carbon Monoxide Assessment and Control Sheet

At all times while operating equipment or tools capable of emitting carbon monoxide indoors:

- minimize emissions
- extract exhaust
- ensure adequate fresh air ventilation.

Alarm Setting	8-hour Work Shift CO Airborne Concentration (parts per million)	10-hour Work Shift CO Airborne Concentration (parts per million)	Precautions
Low	**25 ppm**	**17.5 ppm**	• Turn off unneeded fuel-powered equipment and tools. • Increase ventilation by opening windows and doors and using a fan. • Record alarm event in log book and discuss with superintendent. If Low alarm continues or activates again after above precautions are taken, increase ventilation by opening more windows and doors and using additional fans where needed. NOTE: The company superintendent should meet with the Constructor to resolve fresh air ventilation before proceeding with any additional work.
High	**75 ppm**	**75 ppm**	• Use the precautions listed for “Low” alarm setting. • Turn off all fuel-powered equipment. • Limit the number of workers in the area while exhaust emissions are ventilated. • Notify company superintendent immediately. • Follow (or formulate) an action plan to deal with CO exposure.

Carbon Monoxide Safety Talk

List sources of CO on site.

_____

_____

_____

_____

Explain dangers

- Carbon monoxide (chemical abbreviation: CO) is a clear, colourless gas you can't smell or taste.
- It's dangerous because it interferes with your body's ability to use oxygen. Even in small doses, CO can kill you.
- The first signs are headache and fatigue. More exposure can rapidly lead to loss of consciousness, arrested breathing, heart failure, and death.
- A major source of CO is engine exhaust. Gasoline, propane, and diesel engines all release CO. Some types of welding may also produce it.

Identify controls

Because CO has no taste or smell, you need a gas detector to see if it's present.

Some detectors are tubes that change colour when CO is in the air. These can be used only once. Others are continuous monitors with a cell designed to sense CO.

Whenever possible, operate engines outdoors. Welding machines and generators, for example, can be left outside—only the leads have to run into the building.

Never work alone in an area where CO can accumulate.

When engines must be operated indoors, take these precautions.

- Make sure the area is well ventilated. Keep doors and windows open. Use fans to bring in fresh air if necessary.
- Limit running time and don't let engines idle.
- Monitor CO levels regularly to make sure that ventilation is adequate.
- When necessary, use exhaust hoses or fans to draw engine exhaust out of the work area.
- Keep engines well-tuned. They will run cleaner and produce less CO.
- When possible, use equipment that is powered by electricity, battery, or an alternative source such as hydrogen rather than powered by gasoline, diesel, or propane.
- When other controls are inadequate, workers must wear respiratory protection. This means a supplied-air respirator. You need a respirator attached to an independent supply of clean air.

Demonstrate

- Point out sources of CO on site.
- Demonstrate how to use a CO detector.
- Show how to ventilate indoor areas.

IHSA.ca
Work Safe for Life

Get Approved Working at Heights Training

Workers on construction projects who may use a method of fall protection must complete a working at heights training program that has been approved by Ontario's Chief Prevention Officer. In addition, a refresher course must be taken every three years.

IHSA is proud to offer our CPO-approved ***Working at Heights—Fundamentals of Fall Prevention*** course at many locations throughout Ontario. Train with IHSA and be confident that you are compliant with legislated requirements.

Together we can stop falls from killing Ontario workers.

Yes! I'd like my free subscription to *IHSA.ca Magazine!*

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For more information, contact Ariel White at **awhite@ihsa.ca**

Also available for download at **ihsa.ca** PDF

Document what happens on site

Supervisor Log Book (RF008)

A competent supervisor keeps a record of daily events on the job. Designed with safety in mind, IHSA's ***Supervisor Log Book*** contains safety talks, inspection checklists, a job safety analysis (JSA) form, a due diligence checklist, and other helpful resources.

A COR™ version is also available (CORRF008).

To order your copy, visit **ihsa.ca** or call 1-800-263-5024

What you do matters to the health and safety of your employees

EDUCATE

Educate yourself and your employees.

- Take advantage of IHSA's free training programs for members.
- Access hundreds of free products and downloadable resources.
- Learn about your rights and responsibilities under the *Occupational Health and Safety Act*.

ENGAGE

Engage your workers in health and safety.

- Give five-minute safety talks each morning. ihsa.ca/resources/safetytalks.aspx
- Conduct regular health and safety meetings.
- Keep a record of what happens on the worksite.

EVALUATE

Evaluate your current health & safety program.

- Find legislative requirements and best practices based on your firm size. ihsa.ca/smallbusiness.aspx
- Conduct hazard assessments and workplace inspections.
- Help workers understand the importance of reporting gaps in your health & safety system.

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Make safety work for you. IHSA is your first step.

IHSA serves the following industries:

- construction
- electrical
- utilities
- transportation
- aggregates
- natural gas
- ready-mix concrete

You are automatically a member of IHSA if you are employed with a firm that pays premiums to the WSIB in Ontario in one of the rate groups in these industries.

Find out what we can do for you at **ihsa.ca**

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Work Safe for Life

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