

CARBON MONOXIDE in the WORKPLACE



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About this Guide

Carbon monoxide (CO) is a leading cause of chemical poisoning in both the workplace and the home.

The purpose of this guide is to provide basic information about carbon monoxide, its hazards, detection and control. It will help you determine:

- if a problem with carbon monoxide exists in your workplace
- the extent of the problem
- options for control

What do you know about carbon monoxide?

To find out, we suggest you try to answer the following questions before reading further. They were prepared to assist you in understanding the important points of carbon monoxide. The answers are found in the guide.

1. What is carbon monoxide?
2. How does carbon monoxide affect the body?
3. What is the workplace standard for carbon monoxide?
4. What are some sources of carbon monoxide in the workplace?
5. How does the build-up of carbon monoxide occur indoors?
6. How can carbon monoxide be measured?
7. How can exposure to carbon monoxide be controlled?

Properties of Carbon Monoxide

What is carbon monoxide?

Carbon monoxide is the product formed by the incomplete combustion of materials containing carbon. The molecular formula is CO. Carbon monoxide is usually present in the workplace as a gas. It can, however, be liquefied and solidified. Carbon monoxide is produced in large amounts by several industrial processes.

How is carbon monoxide produced?

Aside from a small number of production processes and laboratory activities, carbon monoxide is produced by the **incomplete combustion** of materials containing carbon. This means that it is produced from anything that will burn. Solid, liquid or gaseous materials are converted into other substances called **combustion products**. Burning (or combustion) may be **complete** (if only water, carbon dioxide and other oxides are formed) or **incomplete** (if carbon monoxide is produced as well).

What are the physical and chemical properties of carbon monoxide?

The physical and chemical properties of carbon monoxide form the basis of its health and safety hazards. The most important properties are listed on the next page. Carbon monoxide is a gas at room temperature and normal atmospheric pressure. Compressed carbon monoxide can pose extreme health and flammability hazards following rapid release.

The **specific gravity of carbon monoxide** is almost identical to that of air, so it can disperse easily through the workplace; however, **pockets of carbon monoxide** can form in areas with little air movement.

Exhaust gases produced by engines can contain large amounts of carbon monoxide. These gases are cooled rapidly to the temperature of the surrounding air, which helps to disperse the carbon monoxide.

Hazardous levels of carbon monoxide can develop when fuel-powered vehicles or stationary engines are operated in buildings or other enclosed spaces.

Carbon monoxide is flammable. Mixtures of carbon monoxide and air in the **flammable range** will ignite if a flame or a spark is present. Flammable mixtures containing carbon monoxide and other gases can be ignited easily by heated surfaces, open flames and even by the burning tip of a cigarette. The serious nature of the flammability hazard is reflected in the extensive flammable range of carbon monoxide in air (see Table 1, below).

Table 1: Physical Properties of Carbon Monoxide

Physical Properties		
Melting (freezing point)	-205 °C	-337 °F
Boiling Point (normal atmospheric pressure)	-192 °C	-313 °F
Vapour Density (air = 1)	0.9678	
Flammability		
Flammable Range (in air by volume)	12.5 to 74%	
Auto-ignition Temperature	610 °C	1130 °F

Do not attempt to put out a fire involving carbon monoxide unless the flow of gas can be stopped because a more explosive mixture of gas and air may form. To reach the valve to shut off the flow of gas, **use a carbon dioxide or dry chemical extinguisher**. Use a water spray to keep the area cool and to prevent ignition of other materials. Do not use a water jet.

Carbon monoxide is chemically reactive at temperatures over 90 °C. This reactivity and **chemical incompatibility** can be of great concern in laboratories and process operations where compressed carbon monoxide is present (see Table 2 on the next page).

Table 2: Incompatibility of Materials

Materials to avoid:
<ul style="list-style-type: none">• Metal oxides (e.g., iron oxide, nickel oxide) – reduced to lower metal oxides, metals or metal carbides at elevated temperatures• Some heavy metals (e.g., nickel, iron, chromium) – formation of explosive metal carbonyls• Alkali and alkaline earth metals (e.g., sodium, potassium, magnesium) – react to produce salts• Aluminum powder – ignition can occur• Iodine heptafluoride – ignition can occur• Sulfur – carbon monoxide reacts slowly with the liquid and rapidly with the vapour to give carbonyl sulfide• Chlorine – can form phosgene in the presence of light or a charcoal catalyst• Bromine – can form carbonyl bromide in the presence of light or a charcoal catalyst• Bromine trifluoride, bromine pentafluoride, chlorine dioxide or peroxodisulfuryl difluoride – react explosively• Oxidizing materials – increased risk of fire and explosion

Carbon monoxide has no odour, taste, or colour, and it is also non-irritating. Pure carbon monoxide provides no warning about its presence. But in many circumstances, carbon monoxide is present in combustion products or exhaust gases which are themselves irritating. Where carbon monoxide may be produced or present, steps must be taken to prevent overexposure.

Table 3: Industrial Hygiene Aspects of Carbon Monoxide

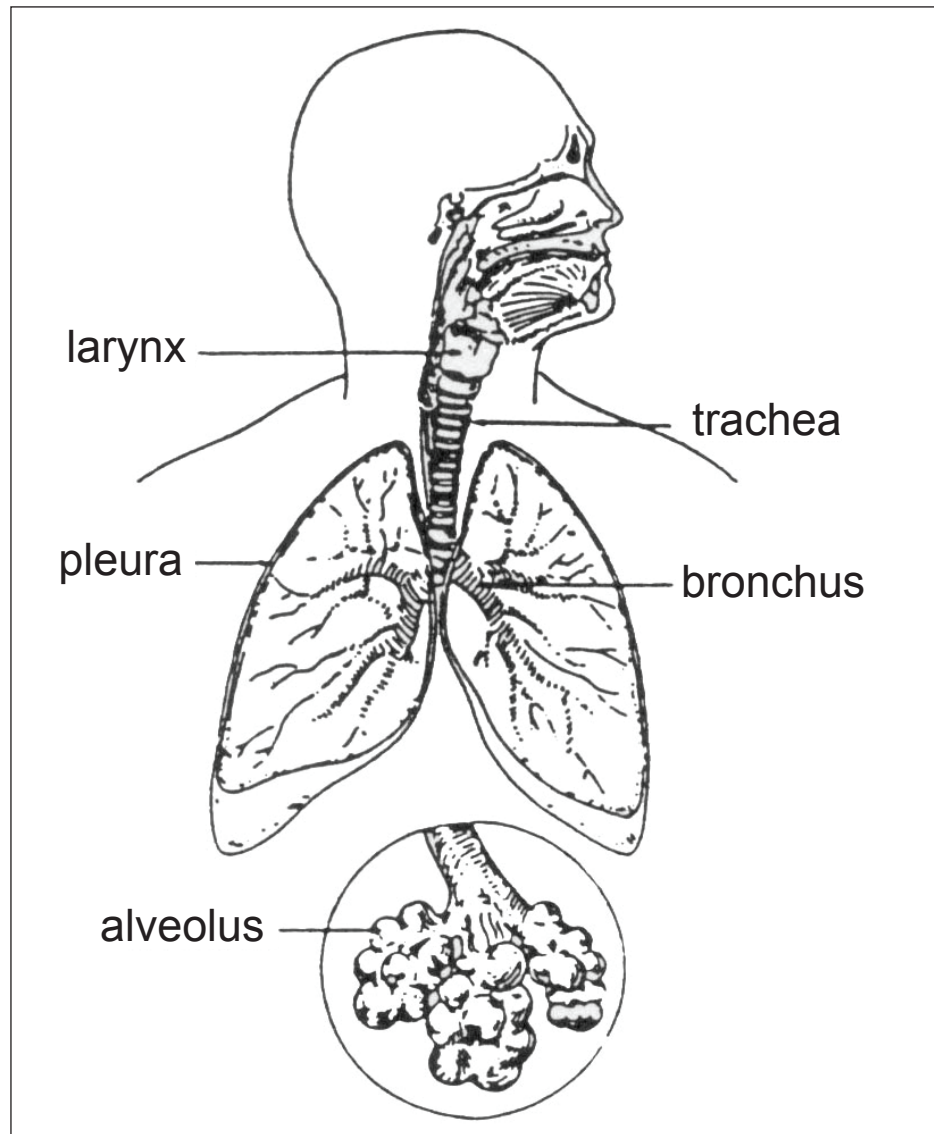
Odour Threshold	None
Colour	None
Taste	None
Irritating Properties	None
Concentration that is Immediately Dangerous to Life and Health (“parts per million” – ppm)	1200 ppm
Source: NIOSH Documentation for IDLH Concentrations: Carbon Monoxide, 1996.	
Time Weighted Average Exposure Value (8 hrs.)	25 ppm
Short-Term Exposure Value (15 mins.)	100 ppm
Source: Control of Exposure to Biological or Chemical Agents Regulation (O. Reg. 833)	
CHECK THE MATERIAL SAFETY DATA SHEET FOR SPECIFIC DATA	

Health Effects of Carbon Monoxide

How does carbon monoxide enter the body?

Carbon monoxide is inhaled, and passes through the upper respiratory system and down into the lungs.

Figure 1: The Human Respiratory System



Almost all the carbon monoxide entering the body leaves the lungs and passes directly into the bloodstream through the alveoli (air sacs). Carbon monoxide is not changed chemically while in the body.

What does carbon monoxide do while in the body?

Carbon monoxide interferes with the ability of the blood to transport oxygen. Haemoglobin, a protein present in the red blood cells, normally binds oxygen (to form oxyhemoglobin) and transports it to all parts of the body. Carbon monoxide competes with oxygen and binds to haemoglobin (to form carboxyhemoglobin or COHb) much more easily. Carbon monoxide is therefore a **chemical asphyxiant**. This means that it prevents sufficient oxygen from reaching the tissues of the body (see Table 4 below). Insufficient oxygen can cause **DEATH**.

Table 4: Effects of Varying Levels of Carbon Monoxide

CO Level		Effects
PPM in Air	% COHb in Blood	
1-3	0.8-0.7	Normal
25		Time Weighted Average Exposure Value (8 hrs.) Source: Control of Exposure to Biological or Chemical Agents Regulation (O. Reg. 833)
30-60	5-10	Exercise tolerance reduced; heavy smoker has these levels or higher. Ten percent COHb is maximum allowable body burden
60-150	10-20	Frontal headache. Shortness of breath on exertion
150-300	20-30	Throbbing headache, dizziness, nausea, manual dexterity impaired
300-650	30-50	Severe headache, nausea and vomiting, confusion and collapse
700-1000	50-65	Coma, convulsions
1000-2000	65-70	Heart and lung function impaired, fatal if not treated
Over 2000	Over 70	Unconsciousness and death

The effects of carbon monoxide in the body are determined by the amount inhaled (dose). Factors which affect the dose include:

- concentration of carbon monoxide in air
- length of exposure
- rate of work (how much air we inhale)

Three other factors that determine the effect carbon monoxide has on the body are:

- age
- individual susceptibility
- smoker versus non-smoker (smokers have higher levels of carbon monoxide in their blood and may experience harmful effects at lower concentrations)

How do high levels of carbon monoxide affect the body?

Carbon monoxide in the blood prevents the tissues from receiving adequate oxygen. The most sensitive tissues are those of the nervous system and the heart, and the most susceptible people are those with heart and lung problems.

What about low levels?

Prolonged or repeated exposure to low levels of carbon monoxide are typical workplace exposures. Sources include cigarette smoking and motor vehicles. At airborne concentrations of about 50 ppm, specific effects may not be immediately noticeable but exposure may reduce:

- alertness
- perception
- performance of fine motor tasks

These subtle effects may not be recognized by the person affected. They usually occur at or above standards established for workplace exposure. Similar effects are produced by other causes which may be confused with those produced by carbon monoxide. These include:

- common drugs
- beverages
- food
- fatigue

Who is affected most easily by carbon monoxide?

The following people are at highest risk in the workplace. This is because of their greater need for oxygen or an impaired ability of their bodies to provide an adequate supply:

- pregnant women
- the physically active
- older workers
- heavy smokers
- sufferers from respiratory diseases
- sufferers from heart disease

What long-term effects are caused by exposure to carbon monoxide?

Effects produced by exposure to carbon monoxide are generally reversible. That is, the effects disappear following removal from exposure. In addition, effects produced during one exposure are usually independent of those produced during any other. Massive overexposure can cause **permanent** damage. Damage is most likely to occur in the nervous system. These effects can include:

- loss of memory
- increased irritability
- impulsiveness
- mood changes
- violent behavior
- verbal aggression
- personality changes
- learning disabilities
- mental deterioration
- instability when walking

What should be done if overexposure is suspected?

- Ensure your own safety before attempting a rescue (wear protective equipment).
- Move the victim to clean, fresh air or remove the source of carbon monoxide.
- Call the emergency number for help (911 in many cases).
- Perform rescue breathing, if breathing has stopped and if trained to do so.
- Perform cardiopulmonary resuscitation if the heart has stopped and if trained to do so.
- Keep the victim warm.
- Keep the victim lying down and inactive.
- If exposure is severe, oxygen should be administered by a person trained in its use. Administration of oxygen may be considered a medical act in some jurisdictions.

Begin treatment as soon as possible because damage to the nervous system occurs rapidly. Medical treatment is recommended in all cases in which carbon monoxide poisoning is suspected. A period of rest may also be recommended.

Exposure Standards

Standards for allowable exposure to carbon monoxide are designed to prevent adverse effects in nearly all workers in Ontario. The legal standard established by the Ontario Ministry of Labour for an 8 hour work day and 40 hour work week is **25 parts per million (ppm)**. The Short-Term Exposure Value (15 min.) is 100 parts per million (ppm). Please see the revised Ontario Regulation 833/90, Control of Exposure to Biological or Chemical Agents for specific data on airborne exposure standards.

Recognition and Evaluation of Carbon Monoxide

Is carbon monoxide present in your workplace?

Carbon monoxide is both used as a raw material and produced by certain industrial processes. It can be produced as a waste product by many types of equipment and activities at the same time. Carbon monoxide is present in almost every workplace. The challenge is to recognize, evaluate and control sources of emission. The following are the major industrial uses of carbon monoxide:

- fuel gas mixtures
 - water gas (44% carbon monoxide)
 - blast furnace gas (30% carbon monoxide)
 - producer gas (34% carbon monoxide)
 - coal gas or illuminating gas (7.4% carbon monoxide)
- chemical manufacturing
 - methanol
 - formaldehyde
 - other alcohols and aldehydes
 - ethylene
 - acids
 - esters
 - hydroxy acids
 - aryl esters
 - carboxylic anhydrides
 - amides
 - acrylic acid
- recovery of metals from ores
 - nickel, cobalt
- production of powdered metals of high purity
- production of special steels
- production of reducing oxides
- powder metallurgy for molding
- research and teaching
- manufacture of metal carbonyl catalysts used in
 - hydrocarbon synthesis
 - hydrogenation of fats and oils

Is carbon monoxide present in waste or exhaust gases?

Carbon monoxide is produced as a waste gas by many industrial processes. It is also produced during the operation of fuel-powered equipment or the burning of flammable or combustible materials. This applies to almost every workplace including:

- process specific emissions
- general industrial sources

General industrial sources cause the most widespread exposure to carbon monoxide. These sources which occur in a variety of industries include:

- fuel-powered vehicles
- fuel-powered portable or stationary equipment
- process equipment
- welding and cutting operations
- fuel-burning heaters
- heated enclosures
- faulty exhaust venting
- back drafting down flues
- contaminated compressed breathing air
- exhaust gases from explosives

Does the nature of the workplace affect exposure levels?

Workplaces vary greatly in area, shape and volume. However, workplaces can be divided into two general categories:

- open spaces
- confined spaces

Open spaces usually are large areas that have adequate air flow which can remove carbon monoxide as it is generated. Open spaces have no confining walls or overhead surfaces. The simplest example of such a workplace is a flat lawn. During grass cutting, for example, movement of both the air (wind) and the person work to prevent the build-up of carbon monoxide. **Confined spaces** are spaces with little airflow. Restricted movement of air increases the risk of exposure. As workspaces become confining, small sources of carbon monoxide become significant because the concentration builds up more rapidly.

Many circumstances in the workplace can contribute to the build up of carbon monoxide. They include:

- faulty venting of process equipment
- improper maintenance
- weather conditions
- close proximity of the person to the source
- ineffective or insufficient ventilation
- lack of make-up air

In confined spaces, the hazard from these circumstances is even greater than for open spaces. For this reason, people working in confined spaces must be even more aware of the hazards. Other factors applicable to confined spaces include:

- inappropriate or lack of ambient air testing
- insufficient respiratory protective equipment
- ineffective training
- insufficient emergency response procedures

How do I find out if there is a problem in my workplace?

- prepare a floor plan for the workplace
- identify all actual or potential sources of carbon monoxide:
 - equipment
 - processes
 - bulk storage
- conduct hazard analyses of jobs associated with carbon monoxide sources
- determine worker exposure
- indoor air quality assessment (i.e., sample/monitor air)

How can exposure to carbon monoxide occur in the workplace?

There are two types of exposure:

- **acute** or short-term exposure
- **chronic** or long-term exposure

Acute exposures often occur during accidents or sudden releases of carbon monoxide. These conditions are usually short-lived but can produce high concentrations of carbon monoxide. **Chronic** exposures are more typical of workplace exposures to carbon monoxide. These are generally more predictable and controllable. Depending upon the concentrations generated, these exposures may produce no signs or symptoms under normal circumstances. Serious problems may occur when the control of low-level sources breaks down and higher levels are then produced. This may happen with fuel-burning equipment or fuel-powered engines.

How can concentrations be determined?

Since carbon monoxide has no odour and is not visible, the only way to determine its presence and concentration is to sample or monitor the air. The purposes of monitoring (sampling on a regular basis) workplace air are to:

- evaluate exposure
- evaluate effectiveness of control measures
- provide warning about excessive emissions

Several technologies are available for measuring carbon monoxide. These can be classified as **grab samplers**, **long-term samplers** and **continuous samplers**. Each technology has its own strong and weak points.

Grab samplers act like cameras. They take a picture of a situation. The result is valid only at the time the sample is taken. These devices are inexpensive and easy to use. They provide almost instantaneous indication of a problem. Grab samplers do not usually provide alarms, and they are not very accurate.

Long-term samplers provide an average of the overall concentration present during a period of time. This information is useful for determining time-weighted average exposures or emission rates. As with grab samplers, no alarm is usually given during the sampling period.

Continuous samplers take samples at fixed intervals or continuously during the sampling period. Continuous samplers can detect rapid changes in the concentration of carbon monoxide. These instruments can provide warning that the concentration has exceeded a preset level.

While samplers have many desirable features, they may suffer from lack of specificity to carbon monoxide. That is, they may respond to other air pollutants. Samplers are ideally suited to provide warning to people working in potentially hazardous atmospheres containing carbon monoxide.

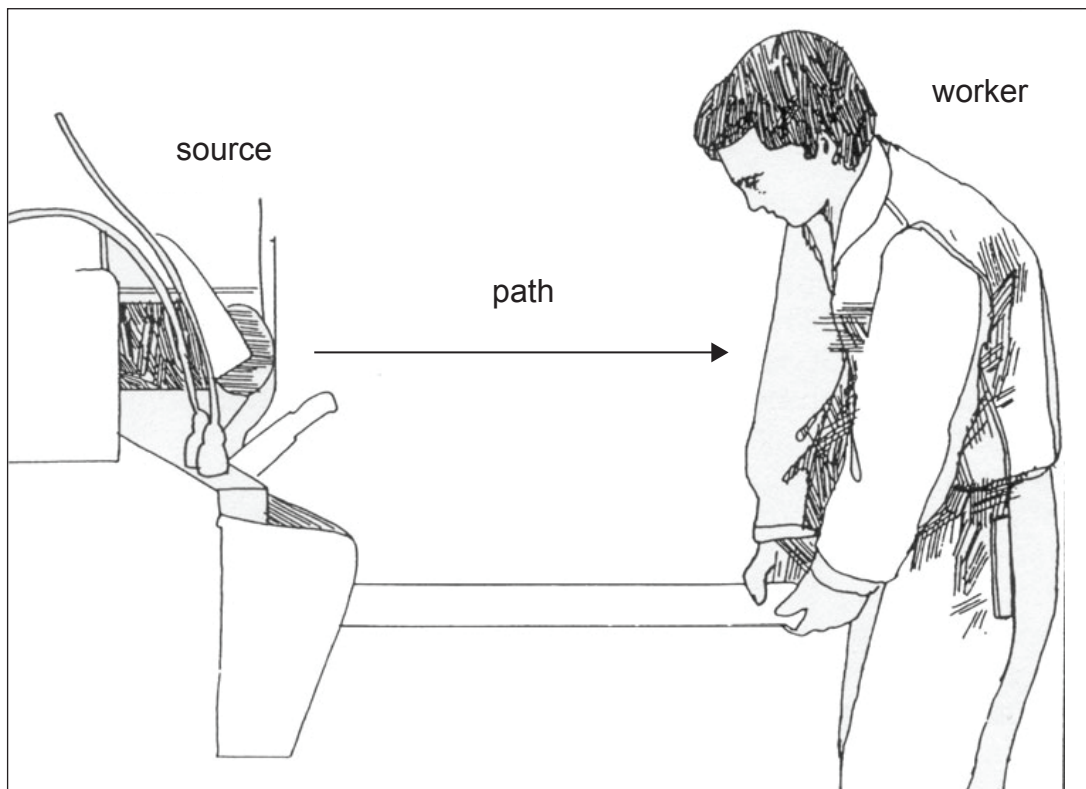
Please contact an air sampling equipment supplier for more specific information on these types of systems. For more information, on carbon monoxide, please call 1-800-406-IAPA (4272).

Controlling Exposure to Carbon Monoxide

The effects of exposure to carbon monoxide, both short-term and long-term, can be prevented. This is achieved by using control procedures and practices.

Ideally, the hazard should be eliminated completely; however, this may not be practical. The aim is to limit or reduce exposure below the legislated standard and keep the exposure as low as possible. This is achieved through a combination of controls at the source, along the path, and at the worker (see figure 2 below).

Figure 2: Methods of Controlling Exposure to Carbon Monoxide



Controls at the Source

Engineering controls are the most effective method of reducing carbon monoxide exposure in the workplace. They include:

Process selection/workplace design

- gas handling systems
- process venting
- use of closed versus open system design

Equipment selection

Ensure that equipment selected for systems contain emissions as much as possible and provide venting points capable of being connected to local exhaust ventilation systems. Performance specifications can be proposed by the purchaser and submitted as part of the purchasing requirements. Ensure that the specifications are met at the time of installation.

Modification of existing equipment or processes

Control of emissions into the workplace can be achieved by modifying or upgrading existing processes or equipment. Any change should be examined carefully to ensure that other problems are not created by this action.

The most effective way to prevent exposure to carbon monoxide is to eliminate it. Replacing gasoline or propane-powered equipment by electrically powered forklifts, for example, can eliminate the source of exposure in many plants.

Less hazardous materials can be substituted in processes. The substitution of natural gas for synthetic gas mixtures containing carbon monoxide is one way to reduce poisoning in the workplace.

The most common modification of existing processes is isolation. Sources can sometimes be enclosed or separated from workers by barriers or walls.

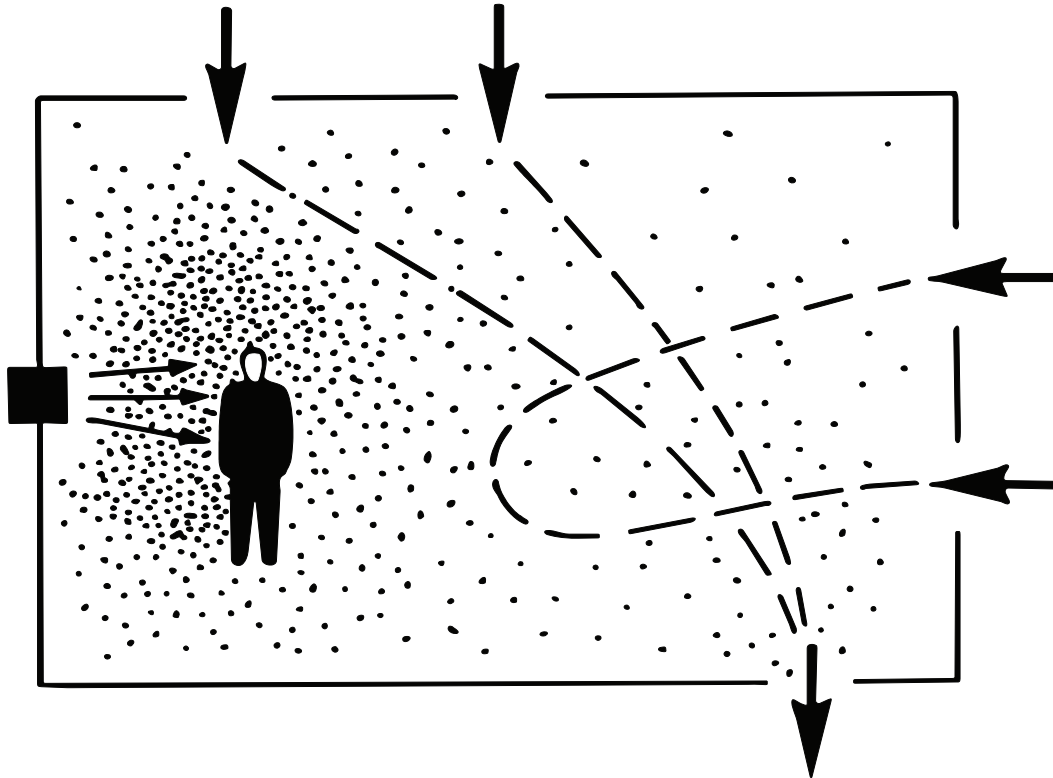
Ventilation

Ventilation is one of the most common engineering controls for airborne contamination. It is also one of the most poorly understood. Some ventilation systems are designed to move fresh air in, around and out of rooms. Other systems move air in order to provide a comfortably cooled or heated environment. Still other systems move air to remove airborne contamination from the work environment.

There are two types of ventilation:

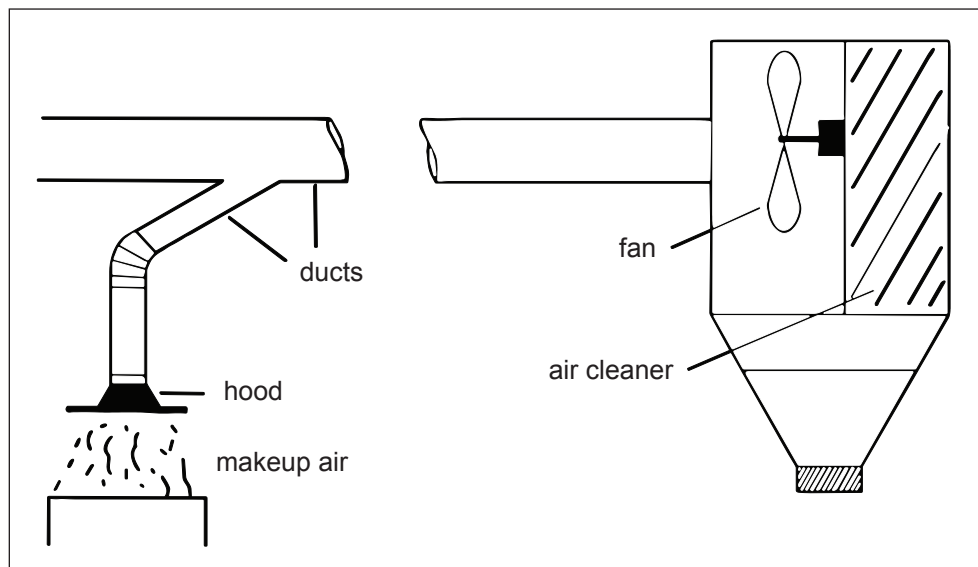
- 1) **General or dilution ventilation** supplies clean air to the workplace to dilute the concentration of the contaminated air after it has been released into the workplace. The contaminants are still present in the workroom air, although diluted. For this reason such ventilation is not acceptable for controlling moderately or highly toxic materials (see figure 3 below).

Figure 3: Dilution Ventilation



- 2) Local exhaust or extraction ventilation collects and removes the contaminated air at its source before it is released into the workplace. The air is then filtered, using either a particulate filter, activated carbon, or scrubber system. After removing the contaminant, the air is then exhausted out of the workplace or is recirculated (see figure 4 below).

Figure 4: Local Exhaust Ventilation



Rules for good ventilation:

- Direct air flow away from the worker's breathing zone.
- Do not position a worker in the path of contaminant discharge.
- Exhaust contaminated air from the workplace.
- Place the exhaust hood opening of the ventilation system as close as possible to the source of the contamination.
- Avoid cross drafts.
- **Supply clean, fresh make-up air** to replace the air exhausted by the system.
- Discharge the contaminated air away from openings which draw air into the plant.
- Avoid polluting the community.

The chart on the next page compares dilution and local exhaust ventilation, and lists the advantages and disadvantages of each.

Table 5: Comparison of Dilution and Local Exhaust Ventilation

DILUTION VENTILATION	
<p>Advantages:</p> <ol style="list-style-type: none"> 1. Low equipment and installation costs. 2. Effective control for small amounts of low and medium toxicity solvents. 3. Effective control for flammable and combustible gases and vapours. 4. Requires little maintenance. 	<p>Disadvantages:</p> <ol style="list-style-type: none"> 1. Does not eliminate exposure to contaminated air. 2. Should not be used for high toxicity gases and vapours. 3. Should not be used for large amounts of any gases or vapours. 4. Ineffective for particulates (dusts, metal particles, fumes). 5. Requires large volumes of heated or cooled make up air. 6. Not effective for handling surges of gases or vapours or irregular emissions. 7. People working close to contaminants can still have large exposures.

LOCAL EXHAUST VENTILATION	
<p>Advantages:</p> <ol style="list-style-type: none"> 1. Captures contaminants at source and removes them from the workplace. 2. Can handle all types of contaminants including dusts and fumes. 3. Requires small amounts of make up air since it exhausts low volumes of air. 4. Low ongoing energy costs because of low amounts of make up air. 5. Only alternative for highly toxic airborne materials. 	<p>Disadvantages:</p> <ol style="list-style-type: none"> 1. System design and installation can be expensive. 2. Requires regular cleaning, inspection and maintenance.

Controls Along the Path

Work practices and procedures

The practices and procedures used in the workplace are critical for controlling exposure to carbon monoxide and other toxic substances. Installed engineering controls are only as effective as the practices and procedures built around them.

Procedures must ensure the safe handling, use and disposal of toxic substances. In order to ensure consistency when training new employees, all procedures should be documented in writing. When preparing written procedures, the task is examined to ensure that the methods to be included will minimize exposure when properly carried out. Effective workplace procedures address normal operating conditions as well as situations arising from accidental release of carbon monoxide into the workplace.

Cylinder storage of compressed carbon monoxide

- Store cylinders at or above ground level in a cool, dry, well-ventilated area, out of direct sunlight and away from heat and ignition sources.
- Ground all cylinders and secure them upright.
- Leave valve caps on cylinders.
- Close all valves when not in use.
- Label empty containers.
- Store separately from incompatible materials.
- Consider a leak detection and alarm system for storage and process areas.

Maintenance

Proper functioning of emission control equipment is only as good as the maintenance which it receives. Performance is reduced as equipment:

- ages
- is damaged
- is improperly serviced
- is altered in a manner not provided for in its original design

Controlling process emissions depends on maintaining performance standards. The most efficient means to achieve this is a program of regularly scheduled maintenance that includes documented procedures and performance records. This permits prompt diagnosis of problems prior to breakdown of equipment.

The ventilation system plays an essential role in controlling exposure to carbon monoxide. For this reason, repairs to this equipment should be carried out when carbon monoxide is not being used or generated (i.e., during off-shifts and weekends, if possible).

Exposure of maintenance workers must be considered. Exposure may arise from solvent or gases trapped in equipment under repair, or from emissions produced by equipment operating nearby. Written procedures that identify the appropriate protective equipment are necessary.

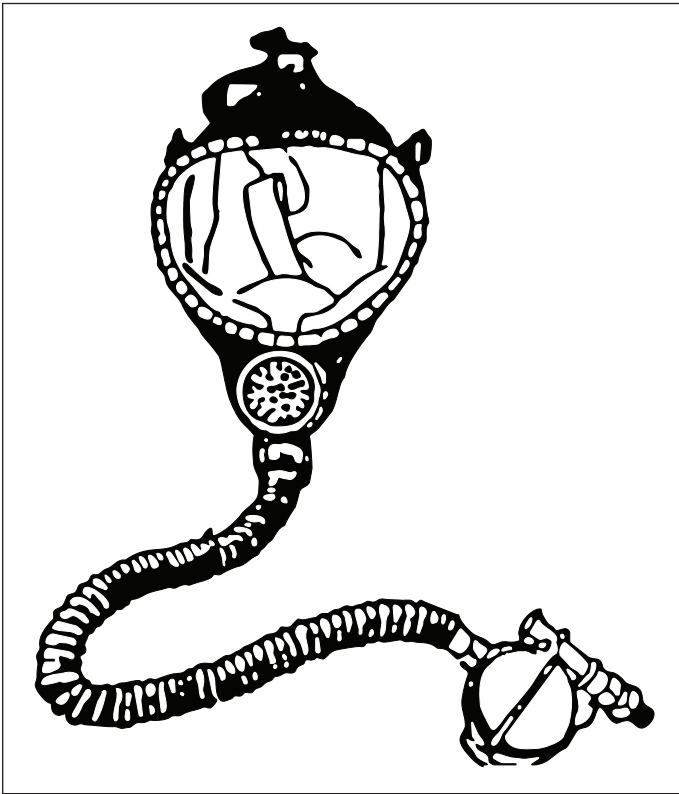
Controls at the Worker

Respiratory protection

Carbon monoxide provides no warning of its presence or concentration. This limits the selection of respiratory protection. For example, the use of a chemical cartridge respirator is NOT recommended because there is no way of knowing when the cartridge is saturated. Canister-type respirators (gas masks) are permitted in some areas but are NOT recommended for the same reason. Those which are recommended are supplied air respirators, including:

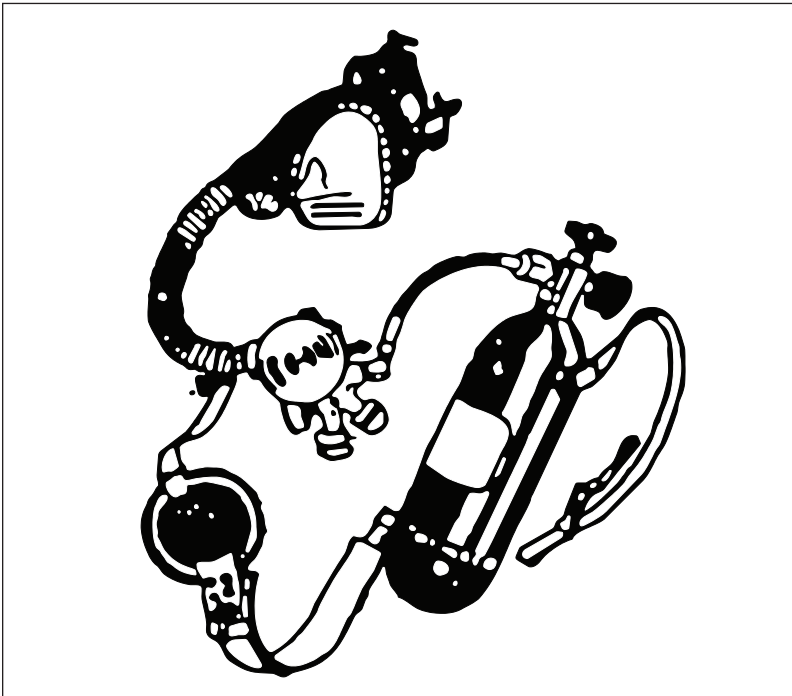
- airline respirators

Figure 5: An Airline Respirator



- self contained breathing apparatus

Figure 6: Self Contained Breathing Apparatus



The use of respirators as the primary control measure to protect workers should only be used when engineering and administrative controls are not available or practicable, and in emergencies. If respiratory protection is required, implement a complete respiratory protection program, including selection, fit testing, training, maintenance and inspection. Refer to the CSA Standard Z94.4-02, “Selection, Use and Care of Respirators”, available from the Canadian Standards Association, 1-800-463-6727 or www.csa.ca.

Education and Training

One of the most important parts of a program to control exposure to carbon monoxide involves education and training. This training is required under R.R.O. 860/90, the Workplace Hazardous Material Information System Regulation, made under the *Occupational Health and Safety Act*.

Training should cover the following:

- how to recognize the hazard symbol on supplier labels
- how to understand the hazard warning information on a label
- where to find additional hazard information on the material safety data sheet
- health and safety hazards involved in use, handling and storage of carbon monoxide
- safe working procedures
- how to use control equipment
- how to use and take care of respirators
- the limitations of respirators
- housekeeping procedures
- procedures on how to minimize loss of containment
- first aid measures for carbon monoxide overexposure

Training is an on-going process of continued updating and re-evaluation. This is necessary to ensure continued success of the control program.

Putting the Control Program into Effect

A joint effort by management and workers is the best way to ensure successful control of carbon monoxide. This process starts with feasible options. These are followed by feedback and input from the workers. Consensus of both groups is essential to ensure success.

Measuring and evaluating the control program

Like a chain, the control program is only as effective as its weakest link. There are several ways to evaluate its effectiveness:

- review of air monitoring results
- evaluation of procedures
- evaluation of equipment and facilities

These are incorporated into an **audit of the workplace**, which includes an evaluation of procedures against actual performance. It is essential that the audit be done in a spirit of cooperation. Therefore, the joint health and safety committee should have the opportunity to participate. The results of the audit should be reported to all affected workers.

Procedures may be checked by direct observation of workers. This examination compares the level of expected performance detailed in procedures with that actually achieved. This section of the audit should examine:

- worker knowledge of the hazard
- compliance in use of protective equipment, and
- adherence to established procedures.

These findings must be interpreted objectively and then remedial measures must be implemented. The co-operation of all is required to ensure the control program's continuing success.

Improving the program and recognizing performance

Management should periodically review evaluation, audit results and initiate immediate action to correct deficiencies and make improvements in the control program, as needed. These reviews should also be an opportunity to recognize good performance.

Review Questions

Congratulations! You have now completed **Carbon Monoxide in the Workplace**. We hope that it has been both interesting and informative, and that you will keep it for further reference. It contains a large amount of information that may have a direct bearing on the well being of your employees. The following review questions were prepared to help focus your attention on the most important points. Please take a few minutes to make sure that you can answer them?

1. What are the sources of carbon monoxide to which we may be exposed?
2. How does carbon monoxide affect the body? Acute exposure? Chronic exposure?
3. What are the most likely sources of carbon monoxide in your workplace?
4. Are employees likely to be exposed? If so, which jobs are most affected?
5. How is exposure to carbon monoxide measured?
6. What control measures are available to reduce exposure to carbon monoxide?
7. If respirators are used, are they the correct type?
8. What can you do to reduce the exposure of your employees to carbon monoxide?

Applicable Legislation

- *Occupational Health and Safety Act* of Ontario
- Regulations for Industrial Establishments, R.R.O. 851/90 as amended
- Regulation Respecting Control of Exposure to Biological or Chemical Agents R.R.O. 833/90, as amended
- Workplace Hazardous Material Information System Regulation, R.R.O. 860/90

Resources

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Handbook of Compressed Gases, 4th edition. Compressed Gas Association Inc., 1999.

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Revised: May 2008

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