Infrastructure Health & Safety Association™

Work Safe for Life

Entry and Work in a Confined Space

Safe Practice Guide

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Infrastructure Health and Safety Association

Safe Practice Guide

Entry and Work in a Confined Space

Foreword

This Guide designates the practices that should be followed by the member firms of the Infrastructure Health and Safety Association (IHSA) when entry and work in a confined space is required. This Guide is not designed as a training manual, but contains information, best practices and general recommendations deemed appropriate to perform a job in a responsible and safe manner.

The contents of this Safe Practice Guide, including all advice, recommendations and procedures, are provided as a service by the Infrastructure Health and Safety Association. No representation of any kind is made to any persons whatsoever with regard to the accuracy, completeness or sufficiency of the information contained herein. Any and all use of or reliance on this Safe Practice Guide and the information contained herein is solely and entirely at the user's risk. The user also acknowledges that the safe practices described herein may not satisfy all requirements of Ontario law.

The Infrastructure Health and Safety Association wishes to express its appreciation to those who assisted in the preparation of this Guide.

TABLE OF CONTENTS

SECTION I
GENERAL

100	Safe Execution Of Work	6
101	Competent Personnel	6
102	Job Planning	6
103	Work Methods	6
104	Equipment in Good Repair	7
105	Teamwork	7

SECTION II
ENTRY AND WORK PROCEDURES

200	General	10
201	Barriers And Tents	14
202	Ladders	15
203	Outside Attendant	15
204	Setup Procedures	16
205	Rescue Equipment And Procedures	18

SECTION III
TEST EQUIPMENT AND PROCEDURES

300	General	22
301	Explosive Gases	22
302	Oxygen Deficiency	25
303	Oxygen Enrichment	25
304	Toxic Gases	26
305	Gas Detectors	27
306	Test Procedures	29
307	Procedures When Gas is Present	30
308	Procedures Following Initial Tests	31

SECTION IV
VENTILATION

400	General	34
401	Air Exchange	34
402	Ventilation Guidelines	35
403	Ventilation Equipment	38
404	Ventilation Procedures	38

SECTION V
HAZARDOUS MATERIALS

500	General	42
501	Substances Regulated or Under Review	45
502	Asbestos	46
503	Lead	47

NOTE: Throughout this Guide, the terms "confined space" and "maintenance hole" are used interchangeably.

SECTION I
GENERAL

100 SAFE EXECUTION OF WORK

101 COMPETENT PERSONNEL

102 JOB PLANNING

103 WORK METHODS

104 EQUIPMENT IN GOOD REPAIR

105 TEAMWORK

SECTION I
GENERAL

100 SAFE EXECUTION OF WORK

The safe entry into any confined space requires:

- competent personnel
- job planning
- work methods
- equipment in good repair
- teamwork

101 COMPETENT PERSONNEL

Workers involved in the installation or maintenance of underground systems and, more specifically, the entry into a confined space, must have been previously instructed, or under instruction, in the safe work practices to be implemented, all the potential or actual hazards to health and safety in the work, and the existing regulations covering the procedure.

102 JOB PLANNING

As in all other phases of work, job planning is of prime importance so that the work is performed safely and efficiently.

103 WORK METHODS

Entry into a confined space should be attempted only after the worker has completed all tests and procedures required to ensure a safe work environment.

Setting up equipment, barricades, warning signs, etc. outside the place of entry should be completed prior to entry.

When work is to be carried out in a confined space containing energized electrical apparatus, obtain hold-off protection on the affected apparatus.

This Guide outlines general practices only. It is not intended to solve specific system problems. Work methods implemented should be in accordance with existing legislation.

104 EQUIPMENT IN GOOD REPAIR

It is critical to test for, and establish, a safe work environment prior to entery in a confined space. Therefore, testing must be performed by competent personnel and the test equipment should be maintained in the best possible working condition.

105 TEAMWORK

The best teams are made up of people who will work compatibility with one another. Effective communication is essential while the work is being performed.

SECTION II
ENTRY AND WORK PROCEDURES

200 GENERAL

201 BARRIERS AND TENTS

202 LADDERS

203 OUTSIDE ATTENDANT

204 SET UP PROCEDURES

205 RESCUE EQUIPMENT AND PROCEDURES

SECTION II
ENTRY AND WORK PROCEDURES

200 GENERAL

1. For a confined space entry definition, consult current applicable legislation.
2. An appropriate type of lifting tool for the particular design of cover should be used to remove lids and/or grates covering confined spaces. Employees should ensure that they have a good, firm stance and use proper lifting techniques to help prevent the possibility of an overexertion type injury. The use of picks or other tools not designed for the removal of these covers should be discouraged.
3. Care should be taken when removing other than round covers, as it is possible for these covers to fall into the enclosure.
4. Prior to entry into a confined space, tests should be conducted to determine if a hazardous atmosphere exists. A probe is available for many gas detectors that will allow the operator to test the atmosphere inside the confined space prior to lifting the lid. Pre-entry tests should be conducted for:
   (a) oxygen content
   (b) toxic gases
   (c) explosive gases

   Record the results in a confined space entry log. Keep a permanent record of the results for future reference. (See Figure #1)
5. When it is necessary to remove water from a confined space, care should be taken in the placement of hoses, to prevent trips and falls to

7651 A

Date _____ **Time work commenced** _____

Time of test _____ **Time work completed** _____

Utility/Firm _____

Test conducted by _____

Type of confined space entered _____

Location _____

_____

Unusual Conditions _____

_____

Before entering, tests were conducted and the results recorded below:

Oxygen content _____ per cent

Toxic gas concentration _____ parts per million

Explosive gases _____ per cent of lower explosive limit

A constant monitor tri-detection device . . . . . ☐

or mechanical ventilation . . . . . ☐

was used during work to help prevent the likelihood of a hazard developing.

Recording by _____

ORIGINAL

Sample page from Confined Space Entry Log Book

Figure #1

workers or members of the general public. In cold weather, extra lengths of hose should be used to permit the water to flow directly to a catch basin or sewer, thus preventing the spread of water over a sidewalk or roadway surface. This water could

freeze, causing a slippery surface which might become hazardous to vehicular and pedestrian traffic.

6. Whenever water is removed from a confined space, gases that may have been trapped in the ducts could be displaced into the enclosure. (See Figure #2)

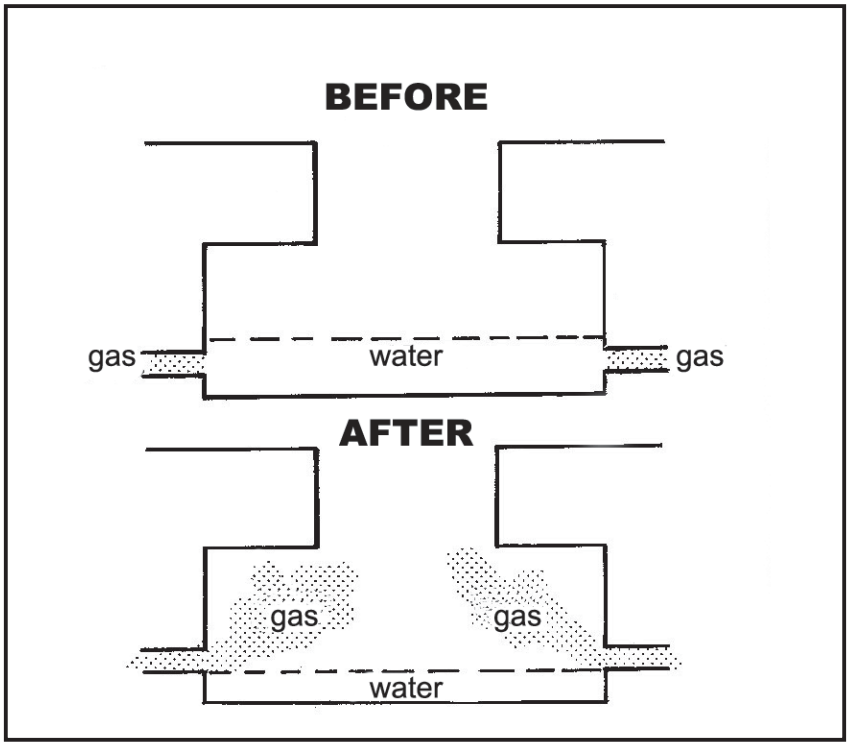


Figure #2

Tests for the presence of gases at the duct openings should be included in the pre-entry tests. A confined space that has been drained of water should not be considered safe until the atmosphere has been retested.

7. If an employee is to carry out work in a confined space, the atmosphere in the confined space should be either:
   (a) continuously monitored for oxygen content and toxic and explosive gases, by an instrument having audible alarms
   (b) continuously replenished using approved mechanical ventilation equipment. If a confined space has been drained of water covering the duct openings, a test to ascertain whether gas is entering through the ducts should be performed
8. Whenever a confined space is vacated and the covers are replaced, regardless of the length of time involved, tests should be conducted and the test results entered in the log book, before re-entering the space.
9. If, at any time, a person in a confined space becomes aware of a toxic gas, or develops symptoms such as lightheadedness, ringing in the ears, irritation of the eyes, nose or throat, dizziness etc., all personnel should get out of the confined space. No one should re-enter the enclosure until it has been retested and certified as safe.
10. If work, which requires the use of an open flame or produces a temperature which could ignite combustible materials (hot work), is to be carried out in a confined space, in addition to normal tests required, adequate forced ventilation should be provided and suitable fire extinguishing equipment made available. Oxygen and/or flammable gas cylinders or containers should be secured in an upright position outside the enclosure. This

equipment should be fitted with hoses and appliances (valves) that are in proper working order.

11. Hand-held flammable gas cylinders may be used in a confined space, provided the supply tank is an integral part of the appliance. These appliances should have an operational control valve and the appliance should be removed from the confined space when no longer required.

201 BARRIERS AND TENTS

1. Suitable barriers or tents should be erected around the opening of a confined space. These barriers serve three purposes:
   (a) a visual means of showing that the confined space entrance is open
   (b) assist employees in entering and exiting a confined space by providing a hand support
   (c) use of maintenance hole collars to help prevent toxic gases such as vehicle exhaust from entering the confined space and prevent objects from being inadvertently dropped into the enclosure
2. Tents are another type of barrier. They prevent moisture from the outside atmosphere from entering the enclosure. These tents are generally compact and easy to place over the entrance to a confined space.
3. Where the entrance to a confined space poses a possible hazard to workers from vehicular traffic, suitable work area protection should be set up to divert vehicles around the work area.

202 LADDERS

1. Some confined spaces have fixed ladders which should be inspected prior to use for signs of wear or deterioration.
2. Whenever electrical apparatus is contained within the confined space, and portable ladders are used, they should be made of a nonconductive material
3. Portable ladders should be CSA approved, equipped with nonslip bases and positioned in such a way to minimize slipping and turning.
4. Portable ladders should be left in position while the confined space is occupied.
5. When the ladder is required to be removed, the attendant should be stationed nearby and be capable of immediately lowering the ladder into the confined space as required.

203 OUTSIDE ATTENDANT

1 . Whenever a confined space is occupied, a competent employee should be stationed outside the confined space for emeregency purposes (unless exempted by legislation). A means of communication between a worker in a confined space and the person outside should be maintained.
2. The attendant outside should be competent in artificial resuscitation, first aid and rescue procedures.
3. When a confined space contains energized electrical apparatus, the outside attendant should have successfully completed Year Two of formal Powerline Technician Apprenticeship training or familiar and competent in the work being per-

formed.

4. The attendant outside should ensure that the work area around the confined space is protected. Pedestrian traffic should be diverted safely around the open entrance to a confined space.
5. If mechanical ventilation equipment is used, the attendant outside should ensure that the blower (intake) is placed in a position to eliminate the possibility of carbon monoxide or other toxic fumes entering the confined space.

204 SETUP PROCEDURES

1. Establish protection around the work area.
   (a) When a vehicle is at the work site it should be positioned in the most advantageous position to aid in protecting the work area. (The vehicle's engine should be shut off or the vehicle positioned to prevent exhaust fumes from entering the confined space.)
   (b) When a confined space is located in a roadway, appropriate means should be implemented to divert vehicular traffic away from the work area.
2. Assemble the test equipment and ensure that it is in good working order. This should be done in accordance with the manufacturer's guidelines.
3. Tests should be completed to determine if a combustible gas is present prior to removing the cover of a confined space.
4. Note and record the atmosphere sample reading.
5. If no hazard is indicated, remove the confined space cover, using proper tools for the particular design of the cover and proper lifting techniques.

6. Establish work area protection around the maintenance hole using tents, barriers, collars, etc. Where darkness or poor visibility is encountered, consideration should be given to the use of warning lights.
7. Conduct pre-entry tests (see Section 306 of this guide). These tests should be taken at three levels: just below the ceiling, at the midpoint of the enclosure and just above floor level.

   NOTE: If water is present, remove it before conducting the tests [see Section 306(e) of this guide].
8. Record all test results in the appropriate log book.
9. If the test results indicate that a hazardous gas exists, the appropriate supervisor should be informed and the area barricaded. All planned work should cease and steps should then be taken to rectify the situation.

   If test results indicate a concentration of hazardous gas and/or unacceptable oxygen levels, approved mechanical ventilation equipment should be used until the tests show that the confined space is safe to enter.
10. If no hazard is indicated, the confined space may be entered to complete tests in corners and at duct openings. If tests prove that a safe environment exists, work may commence, but one person should remain outside.
11. While the confined space is occupied, constant monitoring equipment or mechanical ventilating equipment is required.
12. If it is necessary to enter a confined space containing harmful gases, provided the gases are

not explosive, approved respiratory equipment must be used. A life line must be attached to a full-body harness worn by the employee(s) and available outside the confined space, enabling employee(s) to be removed in case of an emergency.

205 RESCUE EQUIPMENT AND PROCEDURES

1. When a rescue is necessary from a confined space, the rescuer should immediately request assistance from an emergency response team.
2. A person performing a rescue should not attempt to enter a confined space without proper breathing apparatus.
3. Where rescue from a confined space is necessary and an emergency response team is not available, additional help should be obtained. Radio communication should be clear and concise, giving the exact location of the accident site and any other pertinent information that will help rescue crews arrive on the scene as quickly as possible.
4. Tripods or other retrieval equipment can be used as a rescue device. They should be of an appropriate size to provide good stability and should be equipped with a mechanical means to assist the rescuer in removing a victim from the confined space. (See Figure #3) Where tripods are set up at the maintenance hole, a worker, prior to entry, should be equipped with a full body harness.

   NOTE: A life line must be attached to the worker while the confined space is occupied. In most instances, this will

allow the victim to be retrieved without the rescuer entering the confined space.

5. When the victim is removed from the confined space, suitable first aid should be applied by persons competent in first aid procedures, and the victim transported by an emergency medical service to the hospital.

Figure #3

SECTION III
TEST EQUIPMENT AND PROCEDURES

300 GENERAL

301 EXPLOSIVE GASES

302 OXYGEN DEFICIENCY

303 OXYGEN ENRICHMENT

304 TOXIC GASES

305 GAS DETECTORS

306 TEST PROCEDURES

307 PROCEDURES WHEN GAS IS PRESENT

308 PROCEDURES FOLLOWING INITIAL TESTS

SECTION III
TEST EQUIPMENT AND PROCEDURES

300 GENERAL

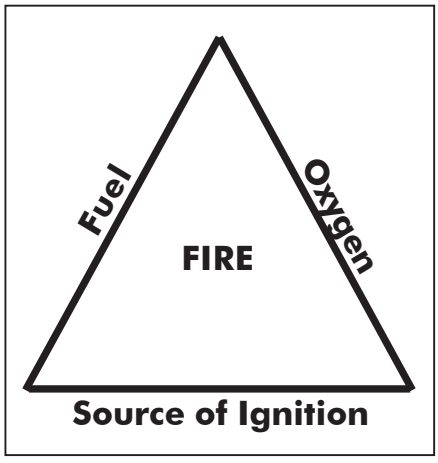
Employees working in confined spaces should be properly trained in safe entry and work procedures. They should maintain safe working conditions while in the confined space and observe all safe work practices.

NOTE: Smoking, open flames, torches, trouble lights, cell phones or any source of ignition are not permitted in a confined space until it has been established that no explosive gas hazard exists. Keep in mind that fire depletes oxygen as it burns.

Employees should be familiar with the hazards of explosive gases, oxygen deficiency or enrichment and toxic gases, and be provided with the equipment and training necessary to test for these hazards.

301 EXPLOSIVE GASES

It takes only the right combination and concentration of explosive gases to create a life-threatening situation. When the right fuel, oxygen and a source of ignition are present at the same time and in the right mixture, an explosion or fire will occur.

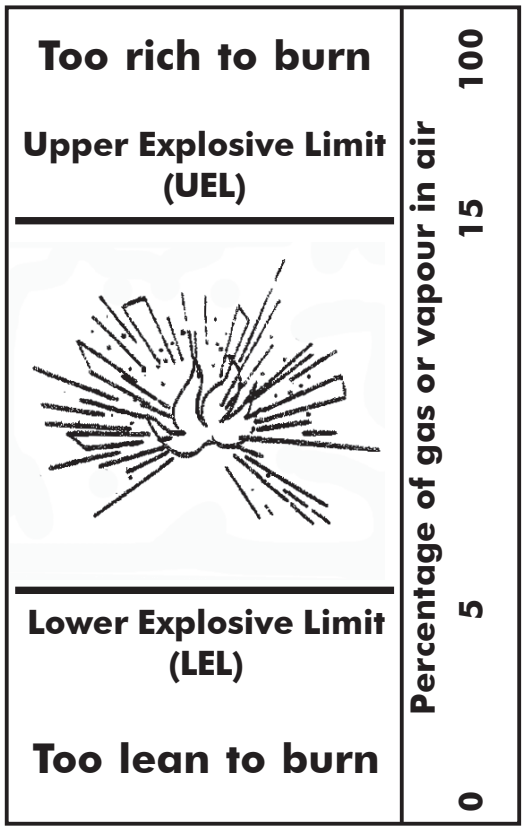


Explosive gases include naturally-occurring gases such as methane and hydrogen, as well as the vapours of a large group of liquids used as fuels and solvents (e.g. naptha, gasoline, kerosene, etc.).

Some of these liquids vapourize easily. Both gases and vapours, when mixed with the correct amount of air and a source of ignition, will either burn or explode. The proper mixture needed for this to happen depends on the type of gas – explosive gases and vapours have different explosive ranges – but in all cases is defined as a range with a Lower Explosive Limit (LEL) and an Upper Explosive Limit (UEL).

The lowest concentration at which a gas will ignite is called the Lower Explosive Limit (LEL). The highest concentration at which a gas will ignite is called the Upper Explosive Limit (UEL). A gas is only combustible between the LEL and the UEL. When the fuel and air mixture is below the LEL, ignition will not take place.

Likewise, if the fuel and air mixture is in excess of the UEL, ignition will not occur. (See example: methane)



Example: methane

Concentrations of less than 5 per cent methane in air fall into the range below the LEL because the mixture does not have enough fuel (methane) to support combustion. That is, the air/fuel mixture is too lean.

If the methane concentration exceeds 15 per cent in air, the air/fuel mixture is too rich for combustion and again ignition will not occur. Only when the methane concentration is between 5 per cent (LEL) and 15 per cent (UEL) does the potential for fire or explosion exist.

It is important to realize that when combustible gas or vapour concentrations rise above the UEL, the atmosphere still cannot be considered safe, as the rich gas may dissipate quickly and the concentration drop into the combustible range between the LEL and the UEL.

Other types of explosive gases do not have the same characteristics as methane. Some have a wider range between their lower and upper explosive limits, making them even more hazardous. See table below.

Explosive Range for Common Gases and Vapours

Gas/Vapour	Lower Explosive Limit (%)	Upper Explosive Limit (%)
Acetone	**2.8**	**12.8**
Ammonia	**16.0**	**25.0**
Benzene	**1.3**	**7.1**
Ethyl Alcohol	**3.3**	**19.0**
Gasoline	**1.4**	**7.8**
Hexane	**1.1**	**7.5**
Propane	**2.4**	**9.5**
Toluene	**1.2**	**7.1**
Xylene	**1.1**	**7.0**

302 OXYGEN DEFICIENCY

Some common causes of oxygen deficiency in confined spaces are oxidation of metals (rusting), curing concrete, bacterial action, combustion, and displacement of oxygen by other gases.

Normal air is made up of approximately 21per cent oxygen. Human life cannot exist without oxygen. Oxygen content in the air can become fatally low in a very short time and can lead to asphyxiation. Adding to the danger of asphyxiation is the inability of humans physiologically to detect and diagnose it.

With oxygen levels below 16 per cent, a person begins to feel drowsy and is unable to think clearly. A person will experience some slight difficulty breathing and may experience a ringing in the ears. Although none of these symptoms is likely to cause harm, more serious symptoms may follow.

One particularly dangerous development of oxygen deficiency is a false sense of well being which occurs, lulling a person into inactivity.

If the level of oxygen falls below 12 per cent, humans will rapidly lose consciousness and die unless removed from the area.

For specific oxygen level requirements for safe work operations consult current applicable legislation.

303 OXYGEN ENRICHMENT

Atmospheres containing more than 21 per cent oxygen are often the result of a leak in an oxyacetylene torch. Combustion is greatly accelerated in oxygen enriched atmospheres. If the concentration exceeds 23 per cent, the confined space should not be entered and steps should be taken to reduce the concentration to an acceptable level.

304 TOXIC GASES

Toxic substances are not generated by industry alone. Many, such as carbon monoxide, carbon dioxide, hydrogen sulphide and sulphur dioxide, occur naturally. All gases and vapours which are known to produce disease, acute discomfort, bodily injury or death, are toxic. Allowable exposure levels/time may be obtained from the Ontario Ministry of Labour, Occupational Health and Safety Branch.

Carbon monoxide is perhaps the most common toxic gas encountered in industry. It is colourless and odourless and is formed by incomplete combustion of fuel containing carbon. It is also produced in large quantities by internal combustion engines such as those found in automobiles, diesel-powered tractors and compressors. It can be fatal in very low concentrations in air.

Hydrogen sulphide is even more toxic than carbon monoxide. Air containing as little as 100 parts per million of this substance may cause death within hours. Major sources of hydrogen sulphide are industrial and petroleum refining processes, sewage disposal or any large concentrations of decomposing organic matter. Since hydrogen sulphide is heavier than air, it will collect in low places.

There are many gases and combinations of gases that can cause a toxic atmosphere in confined areas. (See Figure #4) However, in maintenance holes and vaults, carbon monoxide and hydrogen sulphide are the most common. In addition, unlike most toxic gases, these two become toxic before their concentration reaches explosive levels and their presence cannot be detected during tests for explosive gases before an extremely toxic condition exists.

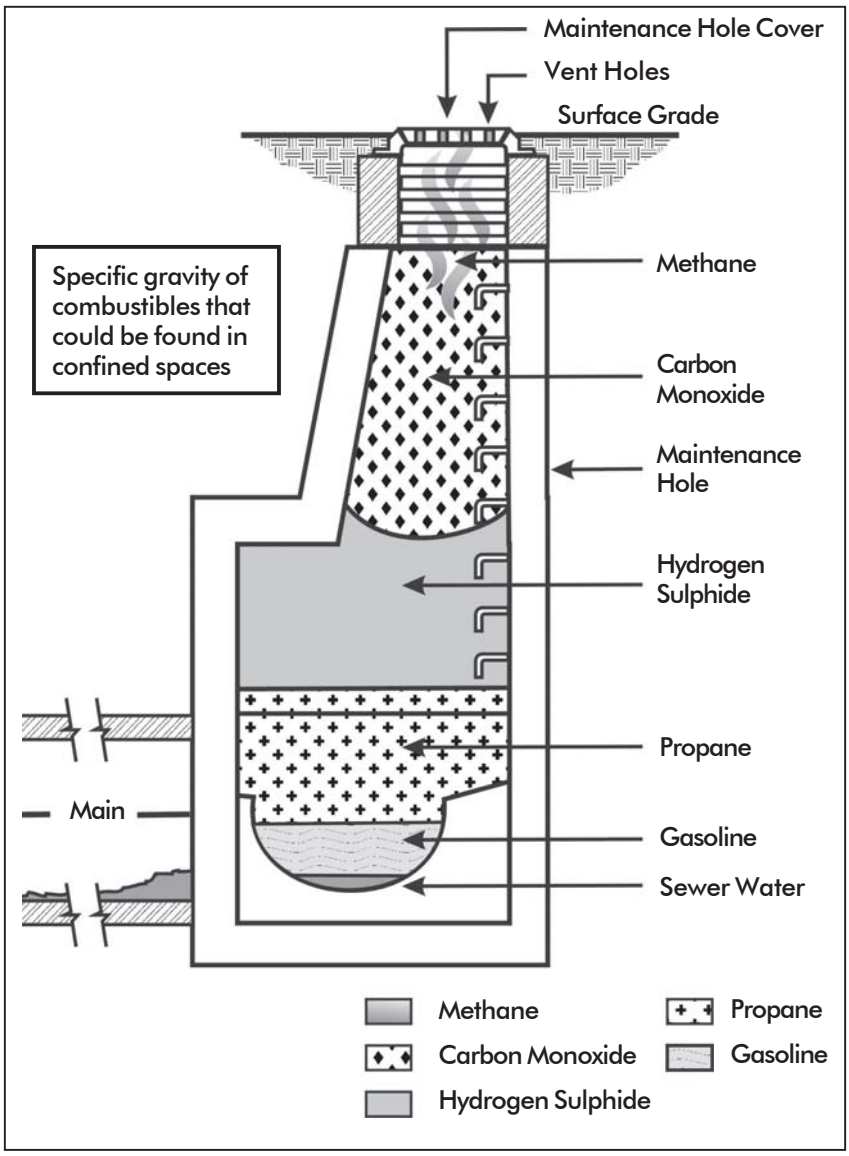


Figure #4

305 GAS DETECTORS

1. Various types of portable instruments are available for determining atmospheric conditions. They should be easy to operate and accurately calibrated for field use. Employees should be

properly trained to operate these instruments before using them.

2. Single function detectors are available from various manufacturers and range from simple, manually-operated detectors to continuous monitoring with audible alarms and/or direct read-out features. Although these instruments are generally very dependable, the main disadvantage is the necessity of having three different units to monitor for all hazards, as required.
3. Dual function detectors are quite common, with most designed to monitor oxygen in per cent by volume and combustible gases in per cent of lower explosive limit (LEL). They are used in conjunction with a toxic gas detector equipped with either a carbon monoxide or hydrogen sulphide sensor.
4. Several types of multi-function detectors are available. They have individual sensors enabling them to continuously monitor several hazards at once. Some have both audible and visible alarms. It is important to note they are sensitive and, in order to remain dependable, they require the utmost care during use and storage.
5. REMOTE SAMPLING
   Remote sampling is advisable during initial testing prior to entering a confined space. Most types of gas detectors are equipped (or can be equipped) for remote testing. Some have manually-operated aspirators while others feature built-in pumps that automatically draw air samples to the sensors through a length of small diameter plastic hose.

6. All gas detectors should be maintained and re-calibrated according to manufacturers' recommendations.
7. TROUBLESHOOTING
   The common problems affecting the performance of most gas detectors are listed below:
   (a) low battery voltages
   (b) improper calibration
   (c) air leaks in remote sampling lines
   (d) worn out sensors
   (e) abnormal temperatures and humidity

306 TEST PROCEDURES

1. The proper testing and entry procedures for a confined space, such as a maintenance hole, include the following steps:
   (a) Determine that the portable testers are in proper working order and that necessary pretest procedures have been carried out according to the manufacturers' instructions (ie bump test). This step should be taken if accurate results are to be expected.
   (b) Test for explosive gases wherever possible, before removing the maintenance hole cover, by inserting the probe (if the tester is so equipped) through the small opening in the cover.
   (c) If the initial test reveals no explosive gas hazard, remove the maintenance hole cover, using the proper tool. Install a suitable barrier around the opening to protect both the workers and the general public.
   (d) Additional tests for all three types of hazards should be taken, before anyone enters the

maintenance hole. If the test equipment cannot be fitted with a remote sampling device, use a rope to lower the unit into the maintenance hole. Be sure the unit does not come in contact with any water that may be in the maintenance hole. This will damage most atmospheric monitoring equipment.

(e) If the water level in the maintenance hole is above the duct openings, pump it out and take additional tests after it has been removed. Gas may be trapped in ducts by the water, then leak back into the maintenance hole after the water has been pumped out. Only if these additional tests are negative can the maintenance hole be considered safe to enter.

(f) Record the results of all tests in a permanent record book. The person performing the tests should evaluate them and indicate in writing in the record book that a hazard does not exist and is not likely to develop while a person is working in the confined space.

307 PROCEDURES WHEN GAS IS PRESENT

1. Take the following steps if testing shows a confined space unsafe to enter due to an unacceptable concentration of explosive gas:
   (a) cease all work in the confined space until the situation has been rectified
   (b) barricade the area
   (c) notify the supervisor immediately
2. If a confined space is found to be unsafe, due to a toxic gas or oxygen content, it should be suitably ventilated until it is proven safe by additional tests.

NOTE: Efforts should subsequently be made to identify the source of the toxic gas.

308 PROCEDURES FOLLOWING INITIAL TESTS

If the initial tests for explosive gases, oxygen content and toxic gas prove the confined space is safe to enter, it cannot be considered safe to work in unless the air is either:

(a) continuously monitored for oxygen content, toxic and explosive gases, by an instrument or instruments having audible alarms

(b) continuously replenished, using approved ventilation equipment

SECTION IV
VENTILATION

400 GENERAL

401 AIR EXCHANGE

402 VENTILATION GUIDELINES

403 VENTILATION EQUIPMENT

404 VENTILATION PROCEDURES

SECTION IV
VENTILATION

400 GENERAL

The use of forced ventilation does not preclude the necessity of testing the confined space before entering. The purpose of forced ventilation (a viable alternative to constant monitoring) is to:

(a) provide a complete change of atmosphere between the confined space and the outside atmosphere (air), or

(b) exhaust contaminants which could be produced by work procedures

NOTE: If respirable air is supplied by a mechanical ventilator, the air should be free of dust, oil vapour and toxic or noxious fumes.

401 AIR EXCHANGE

1. A minimum of 2.5 litres per second (5.3 ft./min.) per person is required to provide normal breathing requirements in a confined space. Although there are no uniform standards for air exchange rates at the time of the printing of this Guide, changing the air every three minutes (20 air changes per hour) has been accepted by industry as providing effective ventilation.
2. To calculate cubic air measurement of a confined space, multiply its height times its width times its length. For example, in a confined space 2.5 metres high by 2 metres wide by 3 metres long (7.5 feet X 6 feet X 10 feet), we must replace 15 cubic metres (450 cubic feet) of air to provide one complete air exchange. (See Figure #5)

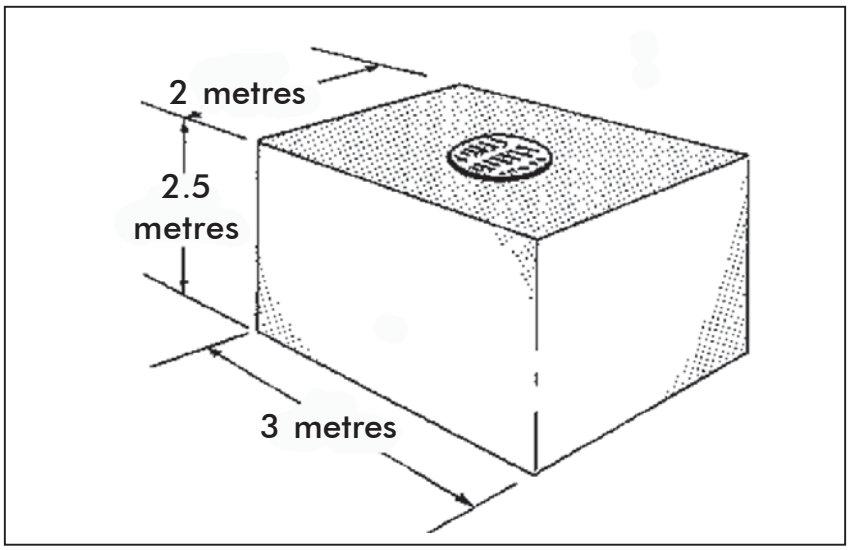


Figure #5

402 VENTILATION GUIDELINES

The following guidelines are general suggestions for ventilation when common work processes are being conducted in a confined space. Additional ventilation may be required if large amounts of contaminants are being produced (such as when spray painting) or unusual ventilation problems exist.

Dilution Ventilation

Dilution ventilation is a process of:

(a) exhausting contaminated air from, and drawing fresh air into, the confined space from any available opening

(b) forcing (blowing) fresh air into a confined space and displacing contaminated air through any available opening (See Figure #6)

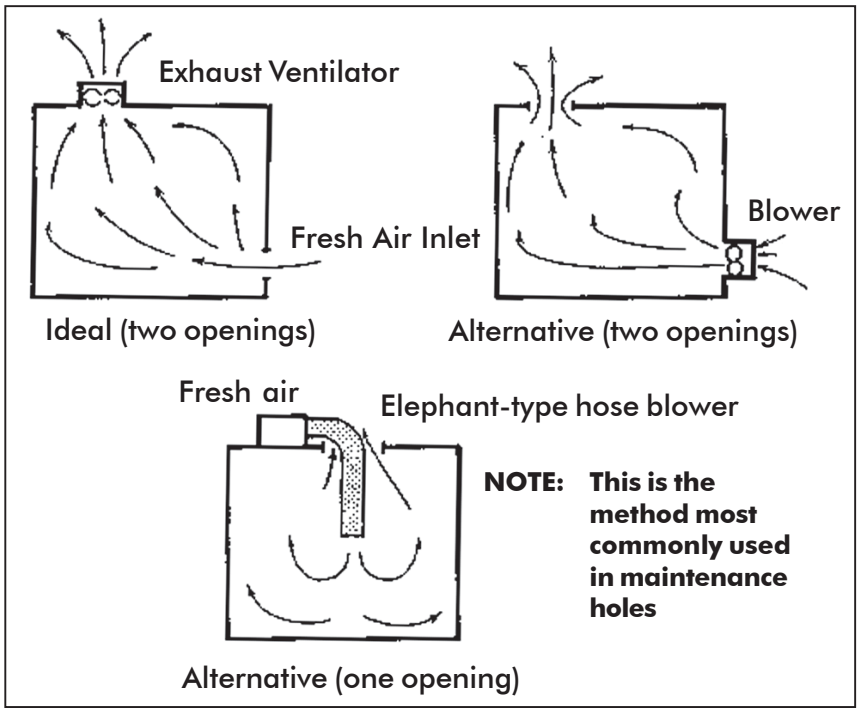


Figure #6

Dilution ventilation gradually decreases the concentration of contaminants in the confined space.

The blower is the preferred method for use in maintenance holes because the turbulence produced by blowing gives a much more effective air exchange than extraction. However, the extraction, or exhaust method would be preferred when contaminated particles in the area (e.g. dust) would be less disturbed by lower turbulence. To ensure contaminated particles do not become airborne in the atmosphere, an approved, disposable filter placed in the exhaust system is recommended.

Dilution ventilation is more effective when it is necessary to eliminate an existing contaminated atmosphere, or to control contaminants which will be produced over a larger area.

Local Exhaust Ventilation

Local exhaust ventilation is a system in which the exhaust intake is positioned close enough to the point of contaminant generation to draw contaminants in, and carry them away from, the work area. It is most effective in removing contaminants which are collected close to where they are produced, such as dust in abrasive blasting or fumes during welding or soldering operations.

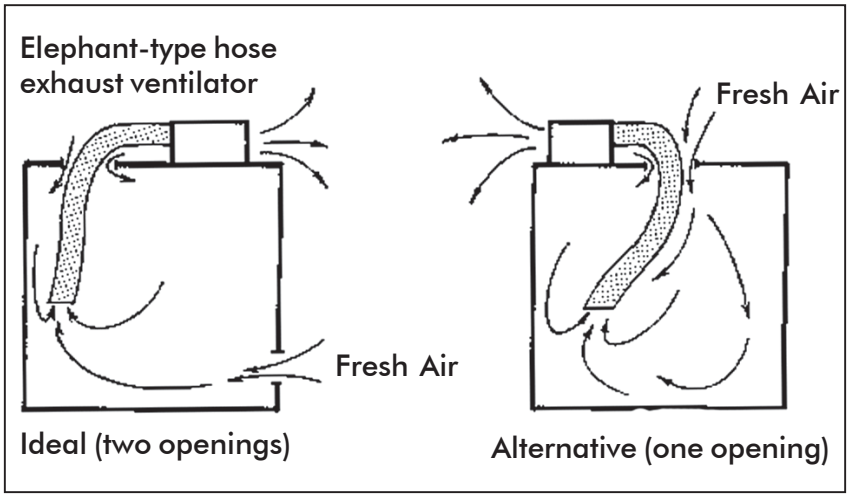


Figure #7

When applied in situations to which it is suited, local exhaust ventilation will generally prove more effective than dilution ventilation. It requires less time and less air volume to remove the contaminant.

NOTE: Exhaust ventilation creates a negative pressure in a confined space, which may allow gases to enter through ducts and/ or other breaches in the confined space walls. Adequate "make-up" air should be provided.

403 VENTILATION EQUIPMENT

1. Ventilation equipment should be approved for the purpose for which it will be used. The unit selected should provide adequate ventilation while work is in progress. Certified air movement ratings, in cubic metres or cubic feet per minute, are available from the manufacturers.

   NOTE: Air movement ratings are reduced by length, diameter and number of bends in the hose.

2. Heaters used in conjunction with blower equipment should be checked and maintained on a regular basis to ensure that they are kept in good operating condition. The use of a heater reduces the air movement rating of the blower.

404 VENTILATION PROCEDURES

1. Place the ventilator in the most advantagous location, taking care to ensure contaminated air does not re-enter the confined space.
2. Lay the ventilating hose on the ground and purge it for at least one minute prior to placing in the confined space.
3. Drop the hose into the confined space. Do not fasten. Purge the confined space for ten minutes.
4. When purging or ventilating, the bottom of the hose should be at least 0.6 metres (2 ft.) above the floor of the maintenance hole and suspended at least 0.3 metres (1 ft.) below the roof of the maintenance hole.
5. Complete further atmospheric tests (e.g., all levels, corners, etc.).

6. Place the blower hose against a side wall, centred between the end walls approximately midway between the floor and the maintenance hole roof. The outlet of the blower hose should be directed away from the work area and toward the floor.
7. If, at any time, the ventilator is stopped, the hose should be removed from the confined space.

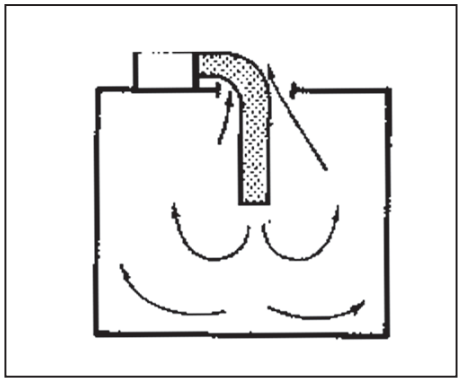


Figure #8

SECTION V
HAZARDOUS MATERIALS

500 GENERAL

501 SUBSTANCES REGULATED OR UNDER REVIEW

502 ASBESTOS

503 LEAD

SECTION V
HAZARDOUS MATERIALS

500 GENERAL

There are numerous materials or processes used in construction, industry and society which may have adverse effects on the health of workers or members of the general public.

Solvents, paints, coatings and adhesives form one of the larger groups of hazardous materials. Processes such as welding and flame cutting pose another hazard.

Further hazards that face workers may be present in any of the following forms: (examples only)

(a) gases - carbon monoxide, methane

(b) vapours - solvents

(c) dusts - asbestos

(d) mists - spray painting

(e) fumes - welding, lead pots

(f) liquids - epoxy resins

(g) radiation - sunlight, welding

(h) noise - drill rigs, chain saws

(i) biological hazards - bacteria, viruses

Routes of Entry

In order for a hazardous material to cause an adverse effect, it must contact the target organ or body cell. Depending on the material, this may occur by:

(a) absorption through the skin

(b) inhalation

(c) ingestion or inadvertent swallowing

(d) injection from puncture type wounds

Effects of Hazardous Materials

The classes of hazardous materials are varied but can generally be divided into the following groups:

IRRITANTS	Skin irritants include fibreglass, epoxy resins, etc. Respiratory irritants include sulphur dioxide, chlorine, acid gases, etc.
NERVOUS SYSTEM DEPRESSANTS	The central nervous system controls virtually all body functions and can be interfered with by solvent vapours such as xylene, trichloroethylene, etc. Symptoms include nausea, drowsiness, headache and fatigue.
ASPHYXIANTS	These materials displace oxygen and can cause suffocation. Simple asphyxiants include inert gases such as nitrogen and argon. Chemical asphyxiants include carbon monoxide and hydrogen sulphide.
SYSTEMIC POISONS	These materials cause damage to specific body organs. It is a large group and includes carbon monoxide, hydrogen sulphide and many solvents.
CARCINOGENS	These are materials that cause or promote cancer in the body.
FIBROTIC MATERIALS	These materials, such as asbestos fibres, cause scarring of lung tissue (fibrosis).

Types of Control

Regardless of the type of hazard, route of entry or toxic effect of any material, the hazard posed can be eliminated or greatly reduced by the following measures:

(a) Engineering Controls

(i) Substitution - toxic substances replaced with non or low toxic materials (e.g., oil based paints replaced with latex paints).

(ii) Isolation - the material or process is isolated or enclosed to ensure that the gas or vapour does not contact a worker (e.g., water meter abrasive cleaner).

(iii) Ventilation - dusts, fumes, gases and vapours can be diluted to below harmful concentrations, or (preferably) collected and discharged away from potentially exposed workers (e.g., extraction of welding fumes).

(iv) Modification of the Process - in some cases, the hazard associated with a material depends primarily upon how it is applied, handled or used. Changing the process can minimize or eliminate a specific hazard (e.g., wet blade cutting versus dry blade cutting;

(b) Personal Protection

This type of control relies on wearing appropriate gloves, eye protection, respirators, clothing, etc. as the final line of defence against specific hazards. Training for the wearer and maintenance of the equipment is essential. All protec tive equipment has certain limitations which must be considered during the selection process.

(c) Education

This is a vital component of any control system. If the hazards and controls are understood, proper protection can be maintained. Conversely, if not understood, workers can become seriously injured.

501 SUBSTANCES REGULATED

Personnel required to enter confined spaces may be exposed to certain hazardous substances, if proper precautions are not taken. These are in addition to gases (explosive and/or toxic) or oxygen levels previously covered in this Guide.

Federal and provincial ministries have designated specific hazardous substances or activities and developed regulations to minimize or eliminate risk to the workforce. For a complete list if designated substances, refer to the most current Occupational Health & Safety Act (OHSA).

Ontario Ministry of the Environment and Energy

Guidelines regarding polychlorinated biphenyls (PCBs) handling, storage, disposal and cleanup of spills, have been published and are available. Check both provincial regulatory bodies and municipal by-laws and environmental protection agencies.

Federal Department of Transport

Legislation has been passed regarding the transportation of hazardous goods and is available to the public. Publications regarding this are available at www.publications.gov.on.ca.

Confined space workers could possibly be exposed to any or all of the designated substances. An assessment must be performed to identify the presence of hazardous substances and a program developed to deal with them.

502 ASBESTOS

Employees may be exposed to asbestos in many ways; most probably when removing asbestos wrap from cables or piping. Employees should be trained in the safe handling and disposal of asbestos prior to the execution of work. When the proper removal procedures are followed, the exposure level is well below the legislated allowable exposure limit.

Removal of Asbestos Wrap

1. Cable or pipe wrap to be removed should be soaked before removal, to minimize the possibility of asbestos fibres becoming airborne.
2. Immediately prior to removing asbestos cable or pipe wrap in a confined space, that space should be inspected for hazardous conditions by the supervisor.
3. The supervisor at the work site shall ensure that a safe work environment is established prior to wrap removal operations, giving consideration to energized electrical apparatus and other potential hazards.

4. Employees entering the confined space should wear disposable coveralls and gloves, and an approved respirator.
5. The confined space should be cleaned using an industrial type vacuum cleaner (equipped with an approved asbestos HEPA filter) to remove dust and dirt from the cables and surrounding areas.
6. The cable or pipe wrap should be removed with care, placed in plastic bags, tied, and properly disposed of.
7. After the wrap has been removed, the cables or pipe should be cleaned with scrubbing pads and mineral oil, then wiped with a clean cloth to remove residual asbestos fibres.
8. The used pads, cloths, coveralls and gloves should also be placed in plastic disposal bags.
9. The filled plastic bags should be removed from the confined space with care and placed in a container (drum). The container should be sealed, tagged and removed to a disposal storage area.
10. Storage and disposal of asbestos should be done in accordance with Ministry of the Environment and Energy directives.
11. Transport of hazardous waste should comply with the Ministry of Transporation regulations and be classified as hazardous waste.

503 LEAD

Several studies have been conducted to monitor the exposure of employees to lead and to determine the concentration of lead in the air during "worst case" job situations. Splicing lead cable in a confined space

was specifically selected for test purposes. In addition, airborne paint dust can contain significant levels of lead.

Conclusions drawn from the completed tests for splicing lead cable indicate that concentrations of lead in the air were well below Ontario standard safe exposure limits.

Several recommendations concerning personal hygiene and general work practices should be followed however, to ensure that lead levels are confined to as low a concentration as possible and to reduce the risk of lead ingestion:

(a) No food or smoking material should be allowed in the contaminated area.

(b) No eating or smoking should be permitted at the work site.

(c) Hands and face should be washed thoroughly before eating, unless outer protective clothing is used.

(d) Clothing and footwear worn in the contaminated work environment should not be worn home. Laundering of contaminated clothing should be done on the employer's premises. If this is not possible, other suitable arrangements should be made.

(e) Although concentration levels found in confined spaces tested were very low, the use of respirators, for certain work procedures, is recommended to allow for variations in concentration levels due to differences in maintenance hole configurations and other environmental factors, such as vehicle exhaust fumes, etc.

(f) Ventilators should be used to exchange the air in a confined space during work operations.

(g) Molten lead pots should be placed downwind from the maintenance hole.

NOTE: When the temperature of a pot of molten lead can be maintained below 500 degrees Celsius (868 degrees Fahrenheit), it is unlikely that the vapour concentrations could make a significant contribution to the lead vapour concentration in the air.

Available Safe Practice Guides

- Bare Hand Live Line Techniques
- Conductor Stringing
- Entry and Work in a Confined Space
- Excavating with Hydrovacs in the Vicinity of Underground Electrical Plant
- High Voltage Rubber Techniques up to 36 kV
- Hydraulics
- Ladder Safety
- Line Clearing Operations
- Live Line Tool Techniques
- Low Voltage Applications
- Pole Handling
- Ropes, Rigging and Slinging Hardware
- Temporary Grounding and Bonding Techniques
- Underground Electrical Systems

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