Confined Space Entry Program

A Reference Manual

WorkSafe BC

WORKING TO MAKE A DIFFERENCE

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About WorkSafeBC

WorkSafeBC (the Workers' Compensation Board) is an independent provincial statutory agency governed by a Board of Directors. It is funded by insurance premiums paid by registered employers and by investment returns. In administering the *Workers Compensation Act*, WorkSafeBC remains separate and distinct from government; however, it is accountable to the public through government in its role of protecting and maintaining the overall well-being of the workers' compensation system.

WorkSafeBC was born out of a compromise between B.C.'s workers and employers in 1917 where workers gave up the right to sue their employers or fellow workers for injuries on the job in return for a no-fault insurance program fully paid for by employers. WorkSafeBC is committed to a safe and healthy workplace, and to providing return-to-work rehabilitation and legislated compensation benefits to workers injured as a result of their employment.

WorkSafeBC Prevention Information Line

The WorkSafeBC Prevention Information Line can answer your questions about workplace health and safety, worker and employer responsibilities, and reporting a workplace accident or incident. The Prevention Information Line accepts anonymous calls.

Phone 604 276-3100 in the Lower Mainland, or call 1 888 621-7233 (621-SAFE) toll-free in British Columbia.

To report after-hours and weekend accidents and emergencies, call 604 273-7711 in the Lower Mainland, or call 1 866 922-4357 (WCB-HELP) toll-free in British Columbia.

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WorkSafeBC Publications

Many publications are available on the WorkSafeBC web site. The Occupational Health and Safety Regulation and associated policies and guidelines, as well as excerpts and summaries of the *Workers Compensation Act*, are also available on the web site: WorkSafeBC.com.

Some publications are also available for purchase in print:

Phone:	604 232-9704
Toll-free phone:	1 866 319-9704
Fax:	604 232-9703
Toll-free fax:	1 888 232-9714
Online ordering:	WorkSafeBC.com and click on Publications; follow the links for ordering

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Introduction

Accidents in confined spaces may be rare, but they can result in severe injury or death. The majority of deaths in confined spaces are caused by hazardous atmospheres such as toxic gases or lack of oxygen. The remaining deaths are the result of physical hazards, where workers may be crushed, struck by falling objects, or buried in materials.

In British Columbia, WorkSafeBC (the Workers' Compensation Board) reports 18 deaths in confined spaces over a 15-year period. Some of the incidents resulted in the death or injury of several workers, including those trying to rescue the first worker in distress.

Workers must not enter a confined space until hazards have been identified, workers are trained, and all procedures to eliminate or control the hazards are implemented. A confined space entry program for your workplace will describe what needs to be done before workers can safely enter and work in a confined space.

This book is written for employers, owners, managers, supervisors, and joint committees in workplaces where there are confined spaces. It can be used as a reference to develop your confined space entry program and to assist you with meeting the requirements of the Occupational Health and Safety Regulation. This book also will be helpful to workers who may need to enter a confined space, but it is not a substitute for the specific training needed before entering such a space.

This book describes measures used to control hazards in confined spaces. However, it also directs you to seek the assistance of the qualified person to assess the hazards of the confined spaces in your workplace and to provide safe work procedures. This book **does not include** the detailed safe work procedures that the qualified person with the proper training and experience can provide. A glossary is included at the end of this book which provides definitions for terms used.

This book should be used with *Hazards of Confined Spaces* (BK80), a general book that provides workers and employers with information on the hazards of confined spaces. *Hazards of Confined Spaces* is also available in three versions for different industries:

- *Hazards of Confined Spaces for Shipping and Transportation Industries* (BK81)
- *Hazards of Confined Spaces for Food and Beverage Industries* (BK82)
- *Hazards of Confined Spaces for Municipalities and the Construction Industry* (BK83)

This book will be helpful to workers who must enter a confined space, but it is not a substitute for the specific training needed before entering such a space.

The Occupational Health and Safety Regulation, Part 9, Confined Spaces, sets out specific requirements that apply to confined space entry. The Regulation can be found at WorkSafeBC.com. The guidelines available from the Regulation web site provide information about recent changes and give helpful suggestions for compliance.

You can purchase print copies (see ordering information in the WorkSafeBC Publications section), or download these publications from WorkSafeBC.com.

For more information on confined space entry, contact a WorkSafeBC prevention officer or your nearest WorkSafeBC office (see the list on the back cover).

Confined space entry program

A **written** confined space entry program is a requirement of the Regulation. The program identifies who has responsibilities for confined space entry and a general description of how confined spaces are dealt with in your workplace. The program should also identify who must be trained, the type of training required, and the frequency of training. This specific information is necessary to ensure that all workers understand the requirements for entering a confined space.

As you read this book, take note of what is required in a confined space entry program and think about who will be carrying out each of the necessary tasks. This is the primary benefit of a written program. It clearly identifies each element in the management of confined spaces and also identifies those responsible for each requirement.

A confined space entry program is ongoing and will need to be revised as the workplace and work activities change.

The written program must be implemented to be effective. This means that workers must be trained, the required equipment must be provided, and all work procedures must be followed.

Regulation requirements for a confined space entry program

Section 9.5 of the Occupational Health and Safety Regulation sets out the requirements for a confined space entry program. The page numbers that follow each requirement refer to locations in this book where relevant information can be found.

Section 9.5

Before a worker is required or permitted to enter a confined space, the employer must prepare and implement a written confined space entry program which includes

(a) an assignment of responsibilities, [page 9]
(b) a list of each confined space or group of similar spaces and a hazard assessment of those spaces [page 8, pages 14–16], and
(c) written safe work procedures for entry into and work in the confined space, that addresses, where applicable
  (i) identification [pages 4–8] and entry permits [pages 58–59]
  (ii) lockout [pages 42–43] and isolation [pages 43–49]
  (iii) verification and testing [pages 17–26]
  (iv) cleaning, purging, venting or inerting [pages 27–34]
  (v) ventilation [pages 34–38 and 63–65]
  (vi) standby persons [pages 51–52]
  (vii) rescue [pages 53–57]
  (viii) lifelines, harnesses and lifting equipment [pages 56–57]
  (ix) personal protective equipment and other precautions [pages 39–40, 50, 60–61]
  (x) coordination of work activities [page 62]

Identifying confined spaces

In the Regulation

The Occupational Health and Safety Regulation, section 9.1, defines a confined space as follows (note that the phrase "Except as determined by the Board" is clarified in the Glossary and explained more fully in the OHS Guidelines Part 9):

"*confined space*," except as otherwise determined by the Board, is an area, other than an underground working, that has *all* of the following characteristics:

(a) is enclosed or partially enclosed

(b) is not designed or intended for continuous human occupancy

(c) has limited or restricted means for entry or exit that may complicate the provision of first aid, evacuation, rescue, or other emergency response service, and

(d) is large enough and configured in such a way that a worker could enter to perform assigned work

Read this section for information on how to identify confined spaces and what to do when you have identified such spaces in your workplace. This section covers:

- Examples of possible confined spaces in the workplace
- Characteristics of confined spaces
- Requirements for listing the location of confined spaces and identifying them for workers

Confined space entry: shipping

Confined spaces in the workplace

Do you have confined spaces in your workplace? Here are some examples of confined spaces:

- Tanks
- Boilers
- Vats
- Kilns
- Vaults
- Silos
- Pipelines
- Sewers
- Manure pits
- Storage bins
- Double hulls
- Pumping stations
- Pits, sumps
- Vessels
- Manholes
- Water reservoirs
- Other similar places

Think about your workplace and find out whether there are any confined spaces. Employers may need to rely on the qualified person to ensure all the confined spaces have been identified.

Confined space entry: municipalities

Characteristics of confined spaces

Here are some examples and helpful explanations of these requirements:

- **is enclosed or partially enclosed**
  The word "confined" may seem to imply only a small, tight, fully enclosed space. This is not true about all confined spaces in the workplace. They can be large or small and may not be enclosed on all sides. Even if workers can move freely inside the space and the space is only partially enclosed, it may still fit this definition of a confined space. If in doubt, consult the qualified person.

- **is not designed or intended for continuous human occupancy**
  As confined spaces are not designed or intended for continuous human occupancy, they are not sites of regular or ongoing work activity. Workers usually enter confined spaces only for purposes such as inspection, maintenance, repair, or construction. This often means the space is not normally ventilated and may have an atmosphere that is not safe to breathe.

Confined space entry: food and beverage industry

- **has limited or restricted means for entry or exit that may complicate the provision of first aid, evacuation, rescue, or other emergency response service, and**
  Entry points may not be designed for easy walk-in. Other limitations include access by permanent or temporary ladders or by stairways that provide poor access because of restrictive slope, narrow width, or extreme length. Physical obstructions inside the space—such as bulkheads, collapsed material, or machinery—may impede exit. Limited means of entry and exit not only make escape or rescue difficult but can also restrict natural ventilation.

- **is large enough and configured in such a way that a worker could enter to perform assigned work;**
  A space that is too small for a worker to enter is not a confined space. For example, a narrow space between two walls may be an enclosed space, but unless the worker can fit inside the space, it is not considered a confined space, even if the worker can get a hand or foot into the space. Keep in mind that an enclosed space may still have hazards, atmospheric or otherwise, that need to be addressed.

  In the case of a space that has been identified as a confined space, a person is considered to have entered the space as soon as they place their head (breathing zone) across the plane of the opening.

Each situation may be different for each confined space in your workplace. Go through each of these four characteristics and see if the space you are thinking about fits each description. The space is only considered to be a confined space if it has all four characteristics. If you are not sure whether the space is considered to be a confined space, consult the qualified person.

Even if a space does not fit this definition, be aware that it may have other hazards that need to be assessed and controlled before workers can enter. For example, a space may have a toxic atmosphere even if it does not fit the definition of a confined space because entry and exit are not limited or restricted.

Listing the confined spaces in your workplace

The employer must identify and make a list of each confined space in the workplace. Similar spaces may be grouped together. This list forms the basis of the hazard assessment and safe work procedures that the qualified person must prepare for confined spaces.

Identifying confined spaces by a sign or other effective means

Many workers do not realize they are entering a confined space. Employers must ensure all workers are given adequate instruction and training on the location of each confined space and requirements for entry into the confined spaces in their workplace.

When a worker is required to enter a confined space, each point of access that is not secured against entry must be identified by a sign or other effective means to indicate the hazard and prohibit entry by unauthorized workers.

Secured against entry

Possible ways to secure against entry include bolting a piece of metal across the opening or requiring special tools to remove the cover.

Identified by a sign

A sign must indicate that the entrance marks a confined space, that there is danger, and that entry is only permitted by authorized persons.

Other effective means

A combination of instruction and marking a space may be effective. For example, tie hazard tape across the entrance and instruct workers not to go beyond the hazard tape without authorization.

If no worker entry is required, secure each access point to prevent entry.

In every space, even those that are not considered to be confined spaces by definition, a harmful or fatal exposure can occur from breathing the atmosphere.

A worker's head (breathing zone) crossing the plane of an opening can result in the worker being exposed to a harmful or fatal concentration of contaminant.

Responsibilities for the confined space entry program

Read this section for information on the employer's responsibilities to develop and implement a confined space entry program, who is qualified to do a hazard assessment and develop written procedures, and what is typically included in a worker education and training program.

This overview does not provide you with all the information you will need to develop a confined space entry program, but it will make you aware of what your responsibilities are and when the qualified person is needed.

Employer's responsibilities

The employer is responsible for preparing and implementing a written confined space entry program, which includes:

- Assigning **responsibilities** for ensuring requirements are met (for example, a list of the responsibilities assigned to specific job titles)
- Listing each confined space or group of similar spaces and ensuring that there is a **hazard assessment** of those spaces. The hazard assessment must be prepared by the qualified person.
- Selecting the qualified person who is competent to provide a hazard assessment and safe work procedures.

The employer must ensure that all confined space hazards are eliminated or minimized and that work is performed in a safe manner. There may be ways to do the work from outside the space or finding ways to reduce the time workers spend inside the confined space. For example, a system for flushing and cleaning tanks automatically may be practicable. Some employers have installed remote control cameras inside spaces to provide inspection of hard-to-see areas, which helps to eliminate or reduce the need for entry.

Eliminating or reducing entry into any confined space is the most effective means of reducing risk. (For example: re-engineering so that a space can be effectively cleaned from outside or changing equipment so that it can be lifted to outside the space for maintenance)

Administration of the program

The employer must assign overall responsibility for the administration of the confined space entry program. The person responsible for administering the program must be adequately trained to do so. The administration may be undertaken by one of the employer's own workers or assigned to another person. Those responsible must be given the authority and means to ensure the program is implemented effectively.

Who is qualified to prepare the hazard assessment and written procedures?

The Occupational Health and Safety Regulation, section 9.11, states that the hazard assessment and written confined space entry procedures must be prepared by a qualified person. The following qualifications are acceptable as evidence of adequate training and experience:

- Certified industrial hygienist (CIH)
- Registered occupational hygienist (ROH)
- Certified safety professional (CSP)
- Canadian registered safety professional (CRSP)
- Professional engineer (P.Eng.)

provided that the holders of these qualifications have experience in the recognition, evaluation, and control of confined space hazards.

Others who have experience working with confined spaces and have a combination of education and training acceptable to WorkSafeBC may qualify to prepare the hazard assessment and written procedures.

The employer has to exercise due diligence in the selection of the qualified person to undertake the hazard assessment and production of confined space entry procedures. Whenever a seriously deficient confined space hazard assessment or work procedure is encountered, this is an indication the author was not qualified to do the hazard assessment and/or develop the written confined space entry procedures.

The administrator's duties generally include liaison with the joint health and safety committee, with management, and with the qualified person writing the safe work procedures. This will ensure the procedures are implemented as written and the equipment is available. The administrator's duties also include evaluating the effectiveness of the program and ensuring changes are made if required.

Supervision of the entry

The person responsible for supervising the entry must be adequately trained before any worker enters a confined space. The supervisor of the entry typically is responsible for ensuring that the following are done for each entry at that site:

- Entry does not occur unless absolutely necessary.
- Pre-entry testing and inspections are conducted according to written procedures.
- The precautions and control measures identified in the written safe work procedures are in place and are being followed.
- Other precautions not directly related to the confined space entry but required by the Occupational Health and Safety Regulation, such as traffic control, are in place and are being followed.

- Only authorized, trained workers enter a confined space.
- An entry permit is completed and posted at the entry to the confined space, where required.
- Workers are removed from the space and the adequacy of the safe work procedures are reviewed if changes occur during entry that affect the safety of workers.

Instruction and training

Specific instruction and training must be given to those who enter a confined space as well as to those contributing to the work activity but not entering the space, such as standby workers and rescue personnel. Workers must be instructed and trained in:

- Hazards of the confined space
- Written safe work procedures to safely perform their duties, including safe entry into the space as well as procedures for working inside

Workers must be trained to immediately leave the confined space when the standby person indicates evacuation is necessary, when the continuous monitor alarm goes off, or when any unsafe work environment develops.

Instruction, or education, often takes place in a classroom setting, where the worker must be able to demonstrate knowledge of the subject. **Training** often occurs in a mock setting or simulated setting, where the worker must be able to demonstrate proficiency using specific procedures and equipment. (For example, the worker should be able to use a specific monitoring device, apply locks, place ventilation equipment appropriately, use a radio or other communication device, and use rescue equipment.)

Base your education and training program on the specific hazards identified in the confined space. Workers attending the education portion of the program will be instructed on the types of hazards that may exist and the effects of exposure to those hazards. The training portion of the program should be comprehensive and include a section requiring familiarization with the equipment required for entry. It is the responsibility of the employer to ensure the instruction and training are effective and that retraining occurs often enough for workers to remain competent.

Remember to keep records of all instruction and training and make them available, upon request, to a WorkSafeBC prevention officer.

The following sample training program outline is provided to give you information about the types of training required. This sample cannot be used for your workplace without ensuring specific hazards are covered. Specific workers must receive training according to their responsibilities—for example, rescue workers and workers who provide monitoring equipment will require additional training in those tasks (see page 21).

Sample training program outline for confined space entry

Training objectives

Training objectives describe the knowledge and skills workers must be able to demonstrate after completing the training program. The following is an example of a set of training objectives.

Workers who successfully complete this program will be able to:

- Identify a confined space, describe what it is, and explain its dangers
- Identify warning properties of harmful air contaminants and symptoms of overexposure
- Follow written procedures, including entry permits (where used)
- Use and respond to alarms on an air-testing device
- Follow isolation and lockout procedures
- Properly use mechanical ventilation systems, including knowing the appropriate placement of the outlet/inlet to the ventilator to maximize the movement of air into the space or contaminants out of the space
- Properly use personal protective equipment
- Properly perform a seal-check if a face-sealing respirator is required
- Communicate with standby person(s)
- Follow emergency exit and rescue procedures

Qualifications of instructors

Instructors should have basic teaching skills and a thorough working knowledge of:

- Types of confined spaces at the worksite
- Hazards likely to be encountered, both atmospheric and physical hazards
- Specific work practices and techniques to be used in the space
- Appropriate ventilation for the work being done
- Duties and responsibilities of the supervisor of the entry, workers entering the space, and standby person(s)
- Monitoring requirements, including knowledge of monitoring equipment
- Spaces that require entry permits
- Safe limits for oxygen, flammable materials, and possible air contaminants

Sample training program outline for confined space entry (continued)

- Rescue procedures and equipment
- Health and safety requirements from other parts of the Regulation that apply, or the requirement for safe work procedures for limited or restricted visibility
- Selection, care, use, and maintenance of personal protective equipment

Selection of trainees

Train all workers involved with your confined space program. This includes:

- Workers who prepare a confined space for entry
- Workers who are required to enter a confined space
- Workers who test or monitor the atmosphere
- Standby persons
- Rescue workers
- Supervisors of any of the above
- Any workers who may be required as back-up to already trained workers

Frequency of training

Provide training whenever:

- Workers have not previously done confined space work
- New confined spaces have been added to your operation
- New job procedures, equipment, or controlled products are to be used in confined spaces
- Evaluation shows that workers who have received training are no longer able to apply such training (it may be necessary to redesign your training program if it is found to be ineffective)

Hazard assessment

Read this section for information on what a hazard assessment is and who is qualified to prepare one.

Hazards in confined spaces

For general information on the hazards of confined spaces, employers and workers should read the booklet *Hazards of Confined Spaces* available at WorkSafeBC.com. It describes the main hazards of confined spaces, including hazardous atmospheres (such as toxic gases and oxygen deficiency) and physical hazards (such as unstable materials and moving parts of equipment).

Many of these hazards can cause serious injury or death if they are not identified, assessed, and controlled. Employers must ensure that a qualified person prepares the hazard assessment (see page 10 for acceptable qualifications).

Preparing a hazard assessment

The qualified person must prepare a hazard assessment for each confined space (or group of similar spaces) and for the work activities to be performed. The qualified person must have training and experience in recognizing, assessing, and controlling the hazards of confined spaces and must consult with the program administrator and the joint committee (or worker health and safety representative).

The employer must have a list of all confined spaces in the workplace. The employer may have the qualified person review the list to ensure all the confined spaces have been properly identified. For each confined space or group of similar spaces, the qualified person will identify potential hazards and assess the likelihood of each occurring.

The hazard assessment must consider conditions that may exist in the confined space (before workers enter) due to the design, location, and use of the confined space. The assessment must also consider the hazards that may develop during work activity in and around the confined space.

When conducting a hazard assessment, the qualified person must consider the potential for

- Oxygen enrichment or deficiency
- Flammable gas, vapour, or mist

- Combustible dust
- Other hazardous atmospheres

Based on this assessment, the qualified person will rate the confined space as a low-, moderate-, or high-hazard atmosphere space. The employer must know the hazard rating because it affects the control measures selected, including level of standby services, entry permit requirements, and rescue. See the glossary for definitions of *low-hazard atmosphere*, *moderate-hazard atmosphere*, and *high-hazard atmosphere*.

The hazard assessment will also look at other potential hazards:

- Lines containing harmful substances requiring lockout and isolation
- Workers becoming engulfed or entrapped in materials
- Slipping and tripping hazards
- Drowning
- Exposure to noise
- Other hazardous conditions such as thermal extremes and radiation

What is the difference between *engulfment* and *entrapment*?

Engulfment results when a substance, liquid, or solid flows around a person and encloses them, hindering their ability to escape and often making it impossible for them to breathe because they become immersed in the substance. A sudden release of water into a confined space might cause engulfment. A sudden release of sawdust, sand, or grain may also cause engulfment.

Entrapment can occur in any space that has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section.

Engulfment and entrapment are serious health and safety hazards that require the highest level of standby services, specific controls such as lifelines, and an entry permit.

The qualified person will prepare a hazard assessment and develop written procedures to eliminate or minimize all the hazards likely to prevail. Once the assessment has been done for a specific activity within a particular space or group of similar spaces, it may provide the basis for procedures for every occasion when workers enter those spaces.

On each occasion, the supervisor of the entry should consider whether the circumstances of the proposed job are substantially the same as the conditions upon which the hazard assessment is based. If the conditions are different from those in the hazard assessment (for instance, if a worker is required to do hot work in a confined space and the hazard assessment and written work procedures were based on inspection of the space without any hot work), then the circumstances must be reviewed and entry procedures revised as necessary by the qualified person.

When conditions change

Work inside the space must not continue if the safe work procedure does not take changing conditions into account. Workers must exit the space. Workers must stay out of the space until required control measures for the changed conditions are put into place. For example, the qualified person may have provided a hazard assessment and resulting written work procedures for "inspection" of a confined space. During the inspection, it may be discovered that repairs require welding inside the space. The hazard assessment and written safe work procedure for welding inside the space will be different than a written work procedure for inspection. Because a new set of conditions exist in the space, a new written procedure must be followed. The new written work procedure must include control measures for welding fume and all other associated risks.

Written safe work procedures

Read this section for information on written safe work procedures that must be included in the confined space entry program and who is qualified to prepare them.

Purpose of a written procedure

Before workers enter a confined space, there are a number of precautions that must be taken. The written procedure must explain the means to eliminate or minimize the risk of all hazards identified. For instance, a written procedure for a specific confined space will explain, where required:

- What to include in the entry permit
- Lockout and isolation
- Verification of all precautions and testing the atmosphere, including how to set up specific air-monitoring device(s) for the identified hazards (such as oxygen deficiency and the contaminants present), where the monitoring is to occur, and how frequently
- Cleaning, purging, venting, or inerting
- Ventilation required, including proper placement of the ventilating system
- The standby person's duties, including numbers to call for emergency help
- Rescue personnel and procedures
- Lifelines, harnesses, and lifting equipment
- Personal protective equipment (for example, fall protection, safety headgear, or respirators)
- Other precautions required by the Occupational Health and Safety Regulation (such as keeping hazardous compressed gas tanks outside the space, ensuring hoses do not block the entranceway, ensuring electrical tools and equipment are grounded or double-insulated, protected by a ground fault circuit interrupter, and CSA-approved for hazardous locations such as use in spaces that have flammable or explosive gas, ensuring ladders, scaffolds, work platforms meet the requirements of WorkSafeBC, and control measures required when there is reduced visibility)
- Coordination of work activities (for instance, ensuring that contractors are well informed of procedures and ensuring specific tasks will not harm other workers)

- Equipment required for entry and instructions for use (for example, the ladder size, tie-off point, and tool bucket for lowering tools to workers inside the space)

The qualified person must write procedures specific to each confined space entry based on the hazard assessment. (See page 10 for acceptable qualifications.) The hazard assessment takes into account the conditions of the space prior to entry as well the work activities that will take place inside the space. The written procedures therefore will also consider both. Workers must be trained in the precautions identified in the written procedures.

See the Appendix for examples of two partially written confined space procedures. The first example shows a poorly written procedure. The second example shows how specific the information must be so that workers are able to follow all required control measures prior to and during entry.

Testing the atmosphere

Before a worker enters a confined space, the atmosphere must be tested in accordance with the written procedures developed by the qualified person. Read this section for information on:

- Testing initial conditions
- Continuous monitoring
- Proper test procedures and equipment
- What to test for (oxygen, explosive conditions, and contaminants)
- When and where to test

Testing initial conditions

Confined spaces may contain explosive, toxic, or oxygen-deficient atmospheres. Whenever possible, test the atmosphere *before* opening hatches or starting ventilation. This will help identify whether or not an explosive atmosphere exists or help prevent the venting of a hazardous atmosphere out of the space into areas occupied by workers. Where there is an explosive gas just under the surface of the cover, creating a spark could cause an explosion.

Even if it is not possible to test before opening up the space, do pre-entry testing before any ventilation is applied to the space. This provides a record of:

- Conditions and the contaminants that normally exist in the space
- The amount of ventilation required for the space
- The extent to which the air inside the space is hazardous to workers

Pre-entry testing is testing the atmosphere before workers enter a confined space. Pre-entry testing is often conducted more than once. It should be done before the space is ventilated and must be done not more than 20 minutes before a worker enters the space. The results must be recorded and posted at all points of entry to the confined space (whether or not a continuous monitor or single-test device is used). See page 22 for information on what to test for, page 25 on when to test, and page 25 on where to test.

Testing must be conducted to verify that the required precautions have been effective at controlling the identified hazards and that the atmosphere is safe for a worker to enter a confined space. (Note that pre-entry inspection for physical hazards is also required; see page 41.)

Continuous monitoring

A continuous monitor must be used whenever practicable to ensure the safety of workers. The monitor will typically provide continuous readings of the oxygen level and level of any explosive gases or vapours, if present. In addition, many monitors have the capability of being configured to test for other harmful gases that may be present, such as carbon monoxide (CO) or hydrogen sulphide (H_2S). The monitor provides an alarm if any of these go beyond preset limits. The qualified person will investigate the reason for the alarm before workers re-enter (see also Oxygen level page 22). Some contaminants cannot be monitored using a continuous monitor. The concentration of these contaminants must be monitored using other devices described in the written work procedure provided by the qualified person.

A properly calibrated and maintained continuous monitor will register any change in the atmosphere and an alarm will sound at preset limits. If a wide enough margin of safety is applied to the alarm settings, the alarm can be used to indicate that workers must leave the space. Alarm level settings should be determined by the qualified person.

The employer must use a continuous monitor if an atmosphere in excess of 20% of the lower explosive limit (LEL) could develop. Note that some sources use lower flammability level (LFL) instead of LEL; the terms are interchangeable.

The qualified person will ensure appropriate monitoring equipment is used for contaminants whose concentrations could exceed the protection provided by respirators.

Proper test procedures and equipment

Testing must be conducted in accordance with written procedures and the following requirements:

- Each confined space atmosphere test must be carried out by an adequately trained worker.
- Use reliable equipment that has been properly serviced, calibrated, bump tested, and maintained according to the manufacturer's instructions.
- Keep a testing record that shows the
  - Date and time of the test
  - Tester's initials
  - Concentrations of vapours, gases, or other conditions

- Test results must be posted without delay at all points of entry to the confined space

The monitor should be tested first in clean outside air. If the reading is above or below 20.9% oxygen, there may be a problem with the oxygen sensor or with the calibration of the unit. Do not use this monitor for testing inside the confined space, and do not enter the confined space until a properly calibrated monitor is used. In conditions of high humidity, refer to the manufacturer's instructions.

Qualifications of testers

A trained worker, as identified in the written work procedures, may test the atmosphere in the confined space. Training should include:

- Reliability and limitations of the testing equipment
- Requirement to use calibrated testing equipment
- The manufacturer's instructions for use and maintenance
- Sampling techniques and methods to test the atmosphere (for example, use of a pump device and a probe to determine the concentration of contaminants from *outside* the space, and ensuring enough testing time for a continuous monitor to register an accurate reading)
- Allowable limits of exposure for each contaminant
- How to use the monitor to obtain and interpret readings from a continuous monitor (for example, when to take peak readings)
- Substance-specific monitoring equipment, when used

Selection of monitoring equipment

Recommended features include:

- Accurate, reliable, and specific readouts
- Immediate readout capability
- Remote sensors or extension tubes to minimize the need for the tester to enter the confined space
- Continuous monitoring capability, with an alarm for use in spaces where a hazardous atmosphere could develop after entry
- Continuous monitor with datalogging capability to record conditions in the space
- Capability of obtaining peak readings

Calibration of equipment

Calibration refers to setting the test instrument to a standard to make sure it is reading accurately through a range of concentrations. Calibration is done by comparing the instrument's reading to a range of known concentrations and adjusting the monitor to read accurately.

The manufacturer's instructions specify the calibration requirements, including calibration frequency and "bump" tests. A bump test uses a known concentration to verify that the instrument is responding correctly to a known concentration. Monitoring equipment must be calibrated according to the frequency specified in the manufacturer's instructions and must be bump tested or spanned as required prior to use. For example, manufacturers may require calibration every 30 days and bump testing daily at the start of the shift.

What to test for

Before entry into a confined space, test for the following:

1. Oxygen level (measured as a percentage of oxygen in the air)
2. Explosive conditions and flammable gases (measured as a percentage of the LEL or as mg/m^3)
3. Contaminants that have been identified in the hazard assessment (measured as the concentration in parts per million, or ppm or as mg/m^3)

Oxygen level

The amount of oxygen in the air is usually tested first since oxygen deficiency can cause serious injury or death. In addition, a low percentage of oxygen may affect the flammability reading on the monitor. Be aware that many oxygen meters are affected by high relative humidity. When checking for oxygen in moist atmospheres, keep the probe pointed downward and wipe water droplets from the probe when they develop.

Clean outside air contains about 20.9% oxygen. The hazard assessment should state if the confined space is expected to contain less than 20.9%. If the oxygen reading is less than 20.9% and this was expected, then proceed using the required control measures stated in the written work procedures. If the oxygen reading is less than 20.9% and this decrease in oxygen was not addressed in the hazard assessment, the reason must be investigated by the qualified person to ensure the space is safe to

enter. It is vitally important to understand what is causing the change in oxygen level. The reason must be identified before workers are allowed to enter the space. For example, many toxic gases present a high hazard to workers even when the concentration is low enough to cause only a very small displacement of oxygen.

Entry by workers into a confined space containing less than 19.5% oxygen may be life-threatening. Every effort must be made to bring the level of oxygen above 19.5%. Procedures to do this will be in the written work procedures provided by the qualified person. In certain situations, the work procedures may include use of a self-contained breathing apparatus (SCBA) or a supplied-air respirator with escape bottle.

With some common solvents, a 0.1% change in the OXYGEN READING could mean the presence of enough toxic vapour to cause death or serious injury.

Explosive conditions and flammable gases

Explosions or fires can result from gases, vapours, and dusts in a confined space. Test for flammable gases such as methane, hydrogen, ethane, and propane. Be aware that flammability tests do not measure the concentration of toxic contaminants. Gases or vapours that are both toxic and flammable must be measured with a monitor capable of measuring both the concentration and the flammability.

It is also important to measure the concentration of dusts such as coal and grain dusts, which may explode when a certain level of dust in the air is reached. The qualified person should be consulted to ensure the correct measuring device is used.

Workers must not be not allowed to enter a confined space under any circumstances when the flammability is greater than 20% of the LEL. It is good practice to prohibit hot work in atmospheres providing a reading on the flammable gas meter above 1%.

Air contaminants

Measure all potential air contaminants identified in the hazard assessment. This includes measuring contaminants already in the space, those that are brought into the space, and those that are generated in the space during work activities. Here are some examples of measurements that may be required:

- Carbon monoxide, if there is any combustion of fuel—for example, in welding, generators, or equipment that is run by internal combustion engines—either inside or adjacent to the confined space

Respiratory equipment is to be considered a second choice for exposure control. The first choice MUST BE changing the air inside the space to breathable air.

- Styrene, if there is fibreglassing
- Sensitizers, when using any products such as epoxies, urethanes, or isocyanate-containing paints or coatings
- Vapours of the toxic component in cleaning products being used in the space
- Dusts—particularly allergenic dusts, wood dust, and grain dust—for contaminant levels and the potential for explosion
- Hydrogen sulfide, where there are any connections to a sewer or sour gas line or where any material will be rotting inside or adjacent to the space
- Benzene or other hydrocarbons in contaminated soil
- Other contaminants that could be found inside the space or may be brought into the space through the ventilation system

The qualified person will know what tests are required and the allowable limits for these contaminants.

Many testing devices test several gases and vapours simultaneously. If the sensors on the monitor do not test for *all* the contaminants identified in the hazard assessment, use additional monitoring equipment appropriate for the contaminants and conditions.

Workers must not be required to wear respirators to reduce their exposure if clean respirable air can be supplied to the confined space. Respiratory equipment is to be considered a second choice for exposure control. The first choice must be changing the air inside the space to breathable air. In some cases, it may be impractical to use ventilation, or the nature of the contaminants inside the space may require both ventilation and respirators. The work procedures written by the qualified person will outline what is required. Properly trained and protected workers may need to enter a poorly ventilated confined space for rescue purposes.

For information on allowable exposure limits, refer to OHS Guideline G5.48-1, part of the Occupational Health and Safety Regulation materials available at WorkSafeBC.com.

When to test

Test the atmosphere:

- Before opening access to the space, if possible
- Immediately after the space has been opened
- At hazard points during line disconnect or other isolation procedures
- Immediately before initial entry into the confined space (within 20 minutes of entry)
- While workers are inside the space, at close enough intervals to ensure the continuing safety of workers
- Before workers re-enter a space after it has been vacated for more than 20 minutes
- Before and after procedures such as cleaning and purging
- When there is a change in work
- During work that causes contaminants to be generated in the work space
- If a change of atmosphere is suspected or it is possible that control measures cannot or do not ensure a safe atmosphere
- If a hazardous substance is accidentally released into the confined space
- If a worker indicates symptoms of exposure to air contaminants, for example a “light-headed” feeling, headache, a choking or coughing feeling, nausea, burning or fogging eyes
- If ventilation fans have been shut down for any reason

Where to test

Test in the following places:

- Around the opening while making a first approach to the confined space
- At locations where transfer pipes lead to the confined space
- Around irregular features such as baffles, bulkheads, and sumps in the confined space
- At locations where workers perform work
- At all elevations inside the confined space, and in those areas where gases and vapours are likely to accumulate

Immediately dangerous to life or health (IDLH)

Some situations are considered immediately dangerous to life or health. IDLH atmospheres contain hazardous substances at a concentration that places the worker in immediate danger because they either:

- Impair the worker's ability to leave the area ("self-rescue") or
- Lead to irreversible health effects, serious injury, or death in minutes

Some gases and vapours will have an immediate effect on the body. Workers exposed to a high enough concentration of a contaminant will experience nausea, vomiting, dizziness, and loss of consciousness. Workers who experiences these symptoms are likely being exposed to the IDLH concentration, meaning the worker's life is in danger and escape may be impossible. Some substances have very low IDLH concentrations—for example, the IDLH level for hydrogen sulfide is only 100 ppm (parts per million). Allowable exposure limits are generally well below the IDLH concentration.

A list of IDLH concentrations can be found in the *NIOSH Pocket Guide to Chemical Hazards (NPG)*, from the U.S. National Institute for Occupational Safety and Health. The *Pocket Guide* can be ordered from NIOSH or downloaded from their web site <http://www.cdc.gov/niosh/npg/npg.html>.

Other conditions considered IDLH include an oxygen-deficient atmosphere and atmospheres with contaminants at or above 20% of the LEL. Any untested confined space is considered IDLH.

Making the atmosphere safe

Read this section for information on how to make the atmosphere inside a confined space safe for workers to enter and perform their work activities. It covers:

- Cleaning the space to remove contaminants
- Replacing an unsafe atmosphere with clean respirable air by purging and ventilating the space
- Preventing fires and explosions
- Inerting the space
- Using continuous ventilation to keep the atmosphere safe
- Using respirators if clean respirable air cannot be maintained

The goal is to have clean respirable air in the confined space before entry. Clean respirable air is defined in terms of having sufficient oxygen, no flammable substances, and an acceptable level of air contaminants. Therefore pre-entry testing includes tests for all three of these conditions.

If it is known or shown by pre-entry testing that a confined space does not contain clean respirable air, the hazard must be eliminated or controlled before workers enter the space. The control measures depend on the hazard. For example:

- If the atmosphere is oxygen-deficient, be sure the space is clean and replace the air with clean respirable air.
- If there is a toxic atmosphere, or there is a possibility of a toxic atmosphere from work inside the space, be sure the space is clean, and remove the contaminants and replace the air with clean respirable air.
- If the atmosphere is explosive or flammable, be sure the space is clean and replace the air with clean respirable air or fill the space with an inert gas.

The atmosphere must be retested after any of these procedures. **The goal is to ensure that the space contains clean respirable air before a worker enters** (except in the case of deliberately inerting the atmosphere). If it is not practicable to eliminate the hazard in the atmosphere, other controls such as the appropriate respirator will be needed. Even if the air tests as clean and respirable, further controls (such as ventilation) may be needed to ensure the atmosphere remains safe while workers are in the space.

In the Regulation

"*clean respirable air*" when used to describe the atmosphere inside a confined space, means an atmosphere which is equivalent to clean, outdoor air and which contains

(a) about 20.9% oxygen by volume,

(b) no measurable flammable gas or vapour as determined using a combustible gas measuring instrument, and

(c) no air contaminant in concentrations exceeding either 10% of its applicable exposure limit in Part 5 (Chemical and Biological Substances) or an acceptable ambient air quality standard established by an authority having jurisdiction over environmental air standards, whichever is greater

Cleaning

Cleaning should always be done prior to entry and whenever practicable from outside the confined space. Here are some examples of how to clean a confined space from the outside:

- Use a vacuum and hose to remove contaminants such as sewage sludge or petrochemical sludge.
- Rake sludge from a brewery tank.
- Pressure wash the space from outside.
- Use a tank with a drain hole in the bottom and an agitator, and continually flush the space.

This photo shows a confined space being cleaned prior to set up of equipment required for entry.

The cleaning procedures and products used will be determined by the qualified person. The procedures may include steam or water cleaning, neutralization, descaling, and special solvent application. High-pressure washing is often needed. Cleaning should always be done with a product that will not react adversely with any residues in the tank. Thorough cleaning will remove harmful residues. If airborne contaminants remain after cleaning, they must be removed before entry.

The qualified person will provide written procedures for:

- Cleaning the space and removing waste before entry
- Removing standing water or other liquids before entry—an extremely important precaution in confined spaces that contain harmful atmospheres (workers could pass out and drown in small pools of liquid)
- Controlling all ignition sources—for example, cleaning equipment, lighting, communications equipment (cell phones or radio), and photography equipment—by bonding or grounding, explosion proofing, or prohibiting use where there are flammable residues
- Keeping internal combustion engines that power equipment at a safe distance away from the flammable residues
- Providing ventilation, to control air contaminants such as vapours produced by high-temperature steam cleaning or off-gassing from sludge that has been disturbed

Steam cleaning requires additional precautions. The qualified person will also consider:

- The auto-ignition temperature of the residues
- Adequate outlets to relieve pressure
- Requirements for grounding and bonding
- Prevention of heat exposure
- Safe disposal of waste water

It may be necessary to repeat cleaning to achieve a confined space with clean respirable air. If further cleaning will not be effective, the qualified person will determine if additional control measures are required.

Replacing the unsafe atmosphere with clean respirable air before entry

If the confined space has an oxygen-deficient or toxic atmosphere, then the first control measure is to replace the unsafe air with air that is safe to breathe before any workers enter. (The next step, discussed on pages 34–37, is to ensure the air remains safe while workers are inside.)

Purging is removing the unsafe air from the confined space and replacing it with clean respirable air *prior to entry*. This is commonly accomplished by blowing air into the confined space using portable mechanical ventilators. Purging is most effective if there are no contaminants being generated within the space. If there are contaminants, the space must first be cleaned and then purged.

Venting is opening up a confined space to allow clean air to enter and circulate without the use of mechanical ventilation. Use of this method as a means of controlling contaminants can be authorized only by the qualified person and never for a space with a high-hazard atmosphere. The minimum air flow for low-hazard atmospheres is 85 cubic metres per hour (50 cubic feet per minute) of clean respirable air for each worker in the space.

Replacing the unsafe atmosphere before entry usually involves mechanical ventilation to blow fresh air in and continuously move it throughout the space. When no contaminants are being generated by existing conditions inside the space, blowing air into the space equivalent to five times the volume of the space will result in approximately 95% of the original air inside the space being replaced, as long as the air is blown in at a high enough speed to mix well with the air inside the space. The specific procedure written by the qualified person will determine the amount of air required to make a confined space safe prior to entry and while workers are inside the space.

Preventing fires and explosions

Fire prevention requires control of one or more of the three elements needed for a fire or explosion: flammable substances, oxygen, and a source of ignition.

Controlling flammable substances

When a space contains or may contain flammable substances, the qualified person will consider the following when developing the written work procedures:

- Minimizing quantities of flammable materials inside the space at all times
  - Isolating the confined space from flammable substances
  - Cleaning all flammable residues prior to entry
  - Using non-flammable cleaning solvents where possible
  - Controlling any flammable materials that must be used
  - Keeping cylinders of acetylene, propane, and other flammable gases outside the confined space
- Wetting down spontaneously combustible residues before removal
- Maintaining the atmosphere as far below 20% of the LEL as possible
- Checking welding and cutting hoses
- Removing oxyacetylene welding torches and hose assemblies from confined spaces when not in use, whenever practicable
- Checking the other side of the surface for other workers or for combustible materials before using a torch or similar welding equipment on walls, bulkheads, etc.

Common misconceptions about flammability

People sometimes have misconceptions about what levels of flammability are safe.

Misconception #1

Some employers and workers believe that if flammability is kept below 20% of the LEL in a confined space nothing more must be done to prevent fire or explosion prior to entry. This is not true.

The first approach is to eliminate any flammable vapours or gases. If this cannot be achieved, then the written procedures by the qualified person must outline that all sources of ignition must be eliminated or adequately controlled and continuous monitoring must be in place to ensure flammable gases and vapours are maintained below 20% of the LEL.

Misconception #2

Some employers and workers believe that keeping the flammability below 20% of the LEL will give them enough warning of a toxic environment. This is not true.

Even a small increase in flammability (1%) could mean the atmosphere has become extremely toxic to breathe. For example, if the monitor reads 1% of the LFL during use of methanol in a confined space, even though the reading of 1% is well below the flammability limit and the continuous monitor will not alarm, this concentration of methanol is three times the allowable exposure limit.

Preventing oxygen enrichment

Air normally contains 20.9% oxygen, enough oxygen for a fire; so a higher level of oxygen increases the likelihood of material burning. Air is considered oxygen-enriched at levels above 23%. Enrichment can be caused by improper isolation of oxygen lines, ventilation of the space with oxygen instead of air, or leaks from welding equipment. To prevent oxygen enrichment, follow these precautions:

- Isolate the space from any oxygen lines.
- Never ventilate a confined space with oxygen.
- Keep cylinders of oxygen outside the confined space (except for medical emergencies).
- Remove oxyacetylene torches and hoses from the confined space when not in use, whenever practicable.

Controlling sources of ignition

If flammable substances are present, eliminate or control all sources of ignition.

- Use electrical equipment and lighting approved for hazardous locations classified under *CSA Standard C22.1-94, Canadian Electrical Code*.
- Use intrinsically safe air-testing and communications equipment, cameras, or any other equipment used in the space.
- Prohibit cigarettes, matches, and lighters.
- Do not use heaters in a confined space.
- Bond steam nozzles and ventilation systems to metal structures, and ground the structures.
- Use non-sparking or low-sparking tools. Non-sparking materials include leather, plastic, or wood; low-sparking metals include copper-beryllium alloy, nickel, and bronze.
- Wear non-sparking footwear (that is, no exposed shoe nails).
- Do not use internal combustion engines in the confined space unless these are approved in the written procedures (through the use of appropriate control measures).
- Where practicable, torches and hoses used for welding, brazing, or cutting must be removed.

Inerting

Inerting is the process of intentionally replacing the atmosphere inside a confined space with an inert gas such as nitrogen. *Inert* means that the gas will not react or cause an explosion or fire. Inerting creates an oxygen-deficient atmosphere because the air (with its oxygen) has been replaced by another gas.

Inerting is used to eliminate hazards such as chemical reactions, flammable vapours, and the possibility of explosions. It is also used to prevent oxidation (rusting) of equipment or the walls of the confined space.

When considering inerting the confined space, the employer must notify WorkSafeBC in writing and submit a copy of the proposed work procedures at least seven days before a worker enters the confined space. (This does not apply when entry is required to perform emergency rescue duties.) After reviewing the proposed work procedures for inerting a confined space, WorkSafeBC may require additional precautions.

Why is an inert atmosphere immediately dangerous to life and health?

Every one of our body cells requires oxygen. With each breath, the oxygen is continuously supplied to each cell. One breath of an atmosphere that does not have enough oxygen will reverse this process, and the oxygen required for movement of muscles will be stripped from the cells. The first breath will make it impossible for movement, including escape.

A confined space with an inert gas is deadly. The following requirements are essential:

- All entry precautions for high-hazard atmospheres must be followed, except the requirement for continuous ventilation.
- Every worker entering the confined space must be equipped with an SCBA or a supplied-air respirator equipped with an escape bottle. Respirators must meet the requirements of the Occupational Health and Safety Regulation, Part 8, Personal Protective Equipment.
- The atmosphere inside the confined space must remain inerted while workers are inside.
- In the event the inert blanket is inadvertently lost, all ignition sources must be controlled.
- Escaping inert gas must not cause a hazard outside the confined space.

Using continuous ventilation to keep the atmosphere safe

Ventilation is the active movement of air. It may bring clean air into a space or exhaust contaminated air out of the space. (See page 30 for information on ventilating a space *before* workers enter.) Ventilation is used to ensure that the air *remains* safe to breathe while workers are inside.

Confined spaces must be continuously ventilated to control hazardous atmospheres, except for certain low-hazard atmospheres, inert atmospheres, and in emergency rescue. This is most effectively done with mechanical ventilation, such as air movers, fans, and local exhaust systems. In limited situations, natural ventilation—the flow of air without mechanical assistance—is acceptable on its own (see page 38). Natural ventilation is frequently used to supplement mechanical ventilation.

Mechanical ventilation

The two main types of mechanical ventilation are:

- Local exhaust ventilation
- General ventilation

Local exhaust ventilation uses exhaust fans or ducts to remove contaminated air at its source before it has a chance to spread throughout a confined space. Local exhaust ventilation is useful where

air contaminants are generated from a point source, for example, at a waste sump during welding or during concrete grinding operations. Local exhaust ventilation is generally used to supplement general ventilation.

General ventilation uses mechanical equipment such as fans, blowers, and ducting to deliver clean air into a space or to remove contaminated air from a space. General ventilation is sometimes referred to as "dilution" ventilation or positive-pressure ventilation. When air is blown into a space, air currents are created and the outside air mixes with air in areas that might normally have stagnant air. The faster the air moves, the more air mixing will occur. As the mixed air exits the space, contaminants are carried out. To ventilate a long space, you may need a ventilator that draws air out at one end and another ventilator that pushes air in at the opposite end. Ventilators that draw air out of a space minimize air currents and therefore reduce the possibility of generating dust. (See pages 63–65 for more information on ventilation set-up.)

Air-moving devices

There are two types of air-moving devices commonly used to purge or ventilate confined spaces: fans and venturi eductors.

- Fans are usually electrically powered and can be divided into two main types: axial and centrifugal. As a general rule, axial fans are used for higher flow rates in systems with lower resistance. Centrifugal fans are used for lower flow rates in systems with higher resistance.
- Eductors (also known as air horns, air blowers, and air ejectors) operate with compressed air on the principle of the venturi effect. Eductors have the advantage of fitting into small openings and have no moving parts. Usually, they are unable to move large volumes of air. A sufficient volume of compressed air and enough pressure are needed to achieve rated flow rates.

Rated capacity versus actual air flow delivered

The quantity of air delivered by an air-moving device is reduced by the resistance in the ventilation system. Long ducts, ducts with interior roughness, tight bends, and numerous bends all increase resistance and decrease air flow. When selecting an air-moving device, it is important to know the rated capacity of the device in the conditions of use. The amount of air delivered by an air-moving device at the outlet without any

duct work attached is called the "free air delivery." The actual amount of air delivered at the end of a flexible duct is called the "effective blower capacity." Manufacturers should provide information on both the free air delivery and the effective blower capacity with specified length of duct and with bends. Selection of the proper fan can be a complicated task and should be done in consultation with the qualified person.

This ventilation kit comes with a hose attachment. By placing the hose attachment through the entrance of a confined space, bends in the hose are reduced and access through small openings can be achieved.

The appropriate ventilation system for confined spaces in your workplace

Ventilation systems for control of airborne contaminants in a confined space must be designed, installed, and maintained according to established engineering principles. The minimum air flow for low-hazard atmospheres is 85 cubic metres per hour (50 cubic feet per minute) of clean respirable air for each worker in the space. The written work procedures provided by the qualified person must describe the ventilation system required for safe entry. The written work procedures should also include the appropriate placement of the ventilators and hoses to

adequately ventilate every occupied area inside the confined space, to prevent restricted access, and to leave no pockets of contaminated air. Keep in mind that any bends in the hoses will affect the air flow. It is good practice to strive for the maximum ventilation for the space while maintaining worker comfort.

Here are some general precautions for ventilation systems:

- Do not locate air inlets close to outlets or contaminated air may be drawn in.
- Do not draw contaminated air past workers inside the space.
- Do not impede access or egress.
- Where flammable atmospheres could be present, use explosion-proof fans and bond ventilation equipment to confined space structures made of metal.
- Ensure contaminated air discharged from the confined space is not a hazard to workers outside the space. Redirect such air a sufficient distance away from the space, the standby person, and any other workers. If this is not possible, ensure any exposed workers use the appropriate respirator.
- Ensure that the system cannot be shut off without the knowledge of workers inside the space. For example, provide an automatic alarm or an alarm operated by a standby person.
- Ensure that hatchways or entranceways to the space cannot be accidentally closed if they are being relied on to maximize the air circulation.
- Never use oxygen for ventilation. A high level of oxygen in the air increases the risk of an explosion or fire.

Tables 1 and 2 on pages 63–65 in the Appendix list some common errors with mechanical ventilation systems and some possible solutions.

The following air flows for exhaust ventilation are based on recommendations from the American Conference of Governmental Industrial Hygienists (ACGIH).

Welding ventilation movable exhaust hoods		
Activity	Rate of Exhaust	
	Plain duct (cfm)	Flange or cone hood (cfm)
Welding with hood less than 6 inches from arc	335	250
Welding with hood 6–9 inches from arc	755	560
Welding with hood 9–12 inches from arc	1335	1000
— Face velocity = 1500 fpm — Minimum duct velocity = 3000 fpm	entry loss = 0.93 VP_d	entry loss = 0.25 VP_d
• Locate work as close as possible to hood • Hoods perform best when located to side of the work • Ventilation rates may be inadequate for toxic materials—respiratory protection may be required • Velocities above 100–200 fpm may disturb shield gases		

Source: ACGIH, *Industrial Ventilation, A Manual of Recommended Practice, 21st Edition*

Natural ventilation

Natural ventilation is ventilation of a space by natural air movement resulting from wind or convection currents. Using natural ventilation is prohibited as a control measure in the following situations:

- If a confined space has a high-hazard atmosphere
- If natural ventilation could draw air other than clean respirable air into the confined space

The qualified person will provide written work procedures that identify where and when natural ventilation can be used to maintain clean respirable air in a low-hazard atmosphere. Under these circumstances, the air flow must be monitored. The minimum air flow for low-hazard atmospheres is 85 cubic metres per hour (50 cubic feet per minute) of clean respirable air for each worker in the space. Configuration of the space may make measurement of the quantity of air difficult; however, air flow measuring devices are available at safety supply stores. In addition

to continuously measuring the amount of air that is flowing through the space, workers must continuously monitor the atmosphere using a gas monitor to make sure the space contains clean respirable air.

Using respirators if clean respirable air cannot be maintained

If clean respirable air in a confined space cannot be assured before workers enter, or if it cannot be maintained while workers are inside, the employer must provide the appropriate respirators for workers to safely enter and remain in the space. Respirators are to be used only if it is impracticable to provide clean respirable air or if the confined space has an inert atmosphere. In these situations, workers rely on respirators either to remove contaminants from the air they inhale or to provide a safe source of air.

If a respirator is required, the qualified person will specify in the written work procedures the type needed. All workers entering the space must wear the appropriate respirator.

- A respirator with a filter removes particles from the air. Different classes of filters are available for different types of dusts and fibres.
- A respirator with a cartridge will remove gases and vapours to "clean" the air. There are different cartridges for different contaminants. The worker must have the right cartridge for the contaminant. Not all gases can be "cleaned" by a cartridge respirator.
- An air-supplied respirator provides clean respirable air. These must be used when the atmosphere is oxygen-deficient or when filters or cartridges are not able to remove the contaminant to a safe level.

If respirators are required, the employer must have a respirator program. WorkSafeBC's *Breathe Safer: How to Use Respirators Safely and Start a Respirator Program* (BK75) provides more information on a respirator program.

Common misconceptions about respirators

Misconception #1

Workers may believe they are being protected from harmful atmospheres by putting on a cartridge respirator. This may not be the case. A cartridge respirator will only protect against certain contaminants listed on the cartridge itself. Common cartridge respirators will not protect against an atmosphere with carbon monoxide, and there are no cartridge respirators that will protect against an oxygen-deficient atmosphere.

Misconception #2

Workers may believe that a single strap dust mask will fully protect them against harmful particles. This is not true. Only certain types of filtering respirators will provide enough protection against harmful particles in the air. A common type is the N95 respirator. The qualified person will provide written instructions regarding the type of respirator to wear. Always check the cartridge or the manufacturer's instructions to determine whether or not it has been designed to protect you from the hazardous substance with which you are dealing.

Making the confined space safe from physical hazards

Read this section for information on minimizing entrapment, engulfment, and crushing hazards, and for information on using controls such as lockout and isolating piping. This section also discusses electrical safety.

Physical hazards must be identified and controlled to make sure the space is safe for workers to enter. The qualified person will have identified all physical hazards in the hazard assessment and will have provided the required precautions and written procedures to control those hazards (including lockout and isolation). The supervisor of the entry must verify that all required precautions are in place before any worker enters a confined space.

There are many types of physical hazards, including crushing hazards, heat and cold stress, radiation, vibration, and noise. Confined spaces with a hazard of entrapment or engulfment and any situations requiring lockout or isolation procedures should be considered a very serious hazard. In these cases, an entry permit is required (see pages 58–59; 70–73). A risk of engulfment or entrapment requires the highest level of standby service (see pages 51 and 52).

Loose and unstable material

Whenever there is a danger of entrapment or engulfment, do not enter unless absolutely necessary. If entry is necessary, the qualified person will provide a written procedure. The written procedure will consider the following:

- Inspection prior to entry
- Use of kickers or probe bars to dislodge bridges and hung-up material prior to entry
- De-energization and lockout of all operating process equipment inside the confined space prior to entry
- Isolation and/or lockout prior to entry to prevent engulfment
- Requirement for lifeline and harness and provision for immediate rescue of a worker in distress
- Other protective equipment that may be needed, such as personal flotation devices or fall protection

Where workers could be exposed to danger from falling objects, follow these requirements:

- Schedule work activity so that no worker is working above another
- Provide suitable protection from overhead hazards
- Provide workers with safety headgear

It is the employer's responsibility to provide the required personal protective equipment and ensure that workers are trained to use it. (See the Occupational Health and Safety Regulation, Part 8, and pages 11–13 and 60–61 of this manual for more information.)

Moving parts of machinery

Lockout means the use of a lock or locks to render machinery or equipment inoperable or to isolate an energy source in accordance with a written procedure. Hazardous energy is any electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other source of energy that could potentially injure a worker. For example, machinery or equipment with moving parts has mechanical energy, and steam in a pipe has thermal energy.

Locks are generally used to prevent the inadvertent startup or movement of machinery and equipment. Lockout is a two-step process. The first step is isolation. Isolation is a process used to stop the flow of energy or any other hazard. Some examples of this are disconnecting a line, setting a switch in the up or down position or closing a valve. The second step is to affix a lock to the isolating device in order to prevent others from removing or changing the isolation. Affixing a personal lock is a very important step to ensure that the device controlling the energy or other hazard, remains in its set state or position.

The consequences of not properly controlling hazards inside of a confined space are often more severe than the failure to control a hazard in a non-confined space situation. It is for this reason that a confined space generally requires isolation that is more effective than normal lockout. For instance, the closing of a valve (with a lock if necessary) is generally adequate to lockout a hydraulic pump but is not adequate to control the flow of a fluid into a confined space.

The employer's lockout program will outline the procedures required to make each confined space in the workplace safe to enter. The supervisor of the entry must ensure that all lockout precautions are in place before a worker enters a confined space. An entry permit is required for all spaces that require lockout. Part 10 of the Occupational Health and Safety Regulation lists when lockout is required and the required lockout procedures. For more information, refer to the WorkSafeBC publication *Lockout* (which can be found at WorkSafeBC.com).

Substances entering through piping

Adjacent piping means a device such as a pipe, line, duct or conduit which is connected to a confined space or is so located as to allow a substance from within the device to enter the confined space. Workers must be protected from harmful substances (solids, liquids, and gases) that could be discharged from pipes or conduits adjacent to or leading to the confined space.

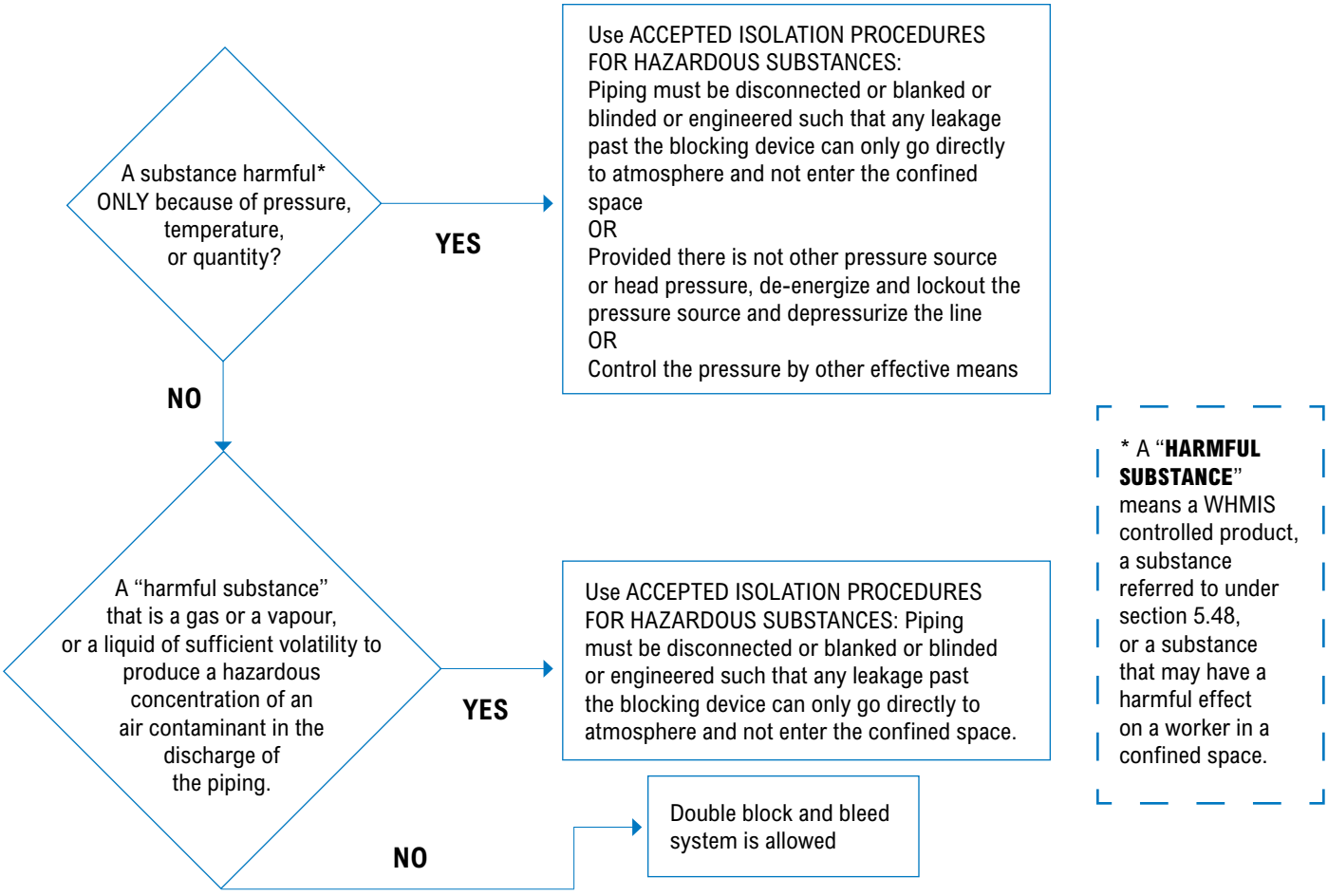
If adjacent piping contains (or has contained) a harmful substance that has the potential for entering the confined space, the substance must be controlled using isolation procedures. Isolating means ensuring contaminants inside piping will not enter a confined space. The following are means of isolating:

- Disconnecting the piping
- Inserting a blank or blind in the piping
- Using an equivalent engineered system to isolate the piping from the confined space
- Using a double block and bleed system in certain circumstances

Closing one or more valves and locking them in the "off" position is not considered to be adequate isolation (except when it is used as part of a double block and bleed system).

Adjacent piping with a HARMFUL* substance?

Start:



The qualified person must develop the isolation system for a specific space in accordance with the hazard assessment. When a line is disconnected or when a blank or blind is installed, workers must follow written work procedures that will prevent them from being exposed to any hazardous substance in the line. Before a worker enters a confined space, every isolation point must be visually checked or otherwise verified to ensure that the confined space is effectively isolated.

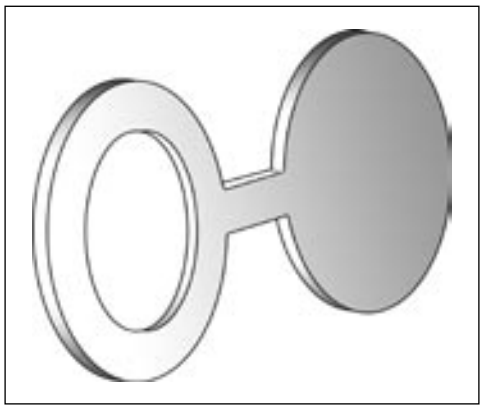
The employer must keep a record that identifies the location of every isolation point. If locks are used, the written lockout procedure must include instructions for applying and removing locks. Employees must be trained in lockout, including use of a lockout board.

Disconnecting a pipe

Isolating includes disconnecting a pipe, which can be done by removing the bolts that hold the pipe flanges together or by loosening unions that connect threaded pipe sections. If the piping will be left disconnected, the sections of the pipe that have been disconnected also must be misaligned to prevent overflow material from getting into the space.

Blanks and blinds

A **blank** is a solid plate installed through the cross-section of a pipe, usually at a flanged connection. A **blind** is a solid plate installed at the end of a pipe where it has been physically disconnected from a piping system. The point of installation must have a visual indication that a blank or blind has been installed. Typically a "spectacle" (as shown in the following diagram) is used as a visual indication that a blank has been installed.



A blank or blind must be:

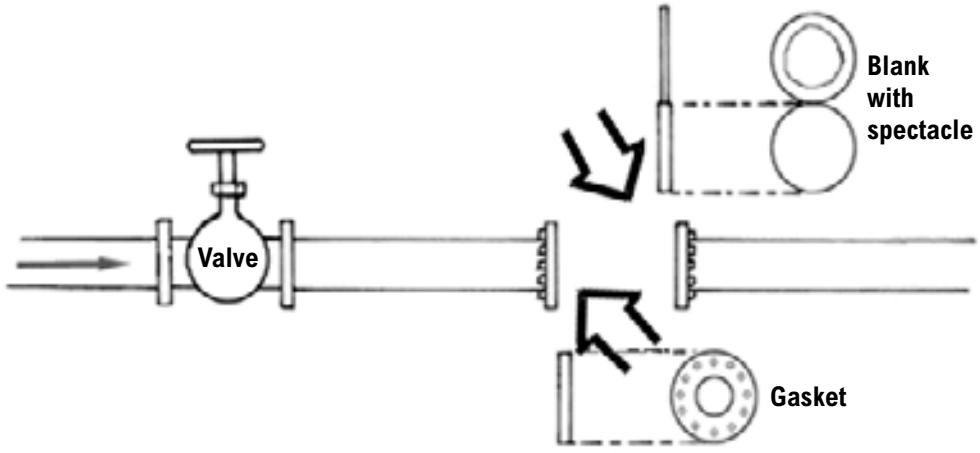
- Designed with an allowance for corrosion if it will be used in conditions where it can corrode
- Stamped with its pressure rating or otherwise indicate its pressure rating

When necessary to prevent leakage, install gaskets on the pressure side of a blank or blind. Flanges must be tightened.

A blank or blind must be manufactured according to the specifications of one of the following standards or other standard acceptable to WorkSafeBC:

- *ANSI Standard API 590-1985, Steel Line Blanks*
- *ANSI Standard ASME/ANSI B16.5-1988, Pipe Flanges and Flanged Fittings*
- *ANSI Standard ASME B31.1-1992, Power Piping*
- *ANSI Standard ASME B31.3, Chemical Plant and Petroleum Refinery Piping*

Blanks and blinds not meeting these standards may be used if a professional engineer has certified that they will provide adequate safety for the particular conditions of anticipated pressure, temperature, and service. If one of these alternative blanks or blinds is used, the employer must keep a record of its certification, location, and conditions of service.



A blank must be able to withstand the pressure of the substance inside the piping system. A gasket is often inserted on the upstream side to prevent leakage.

Written procedures for blanking and blinding must be specific to the confined space, the location of the pipe, and the hazards involved. The following simple example gives basic instructions for installing a blank in a pipe carrying caustic soda. Specific instructions for the situation would be needed, such as those suggested after each step.

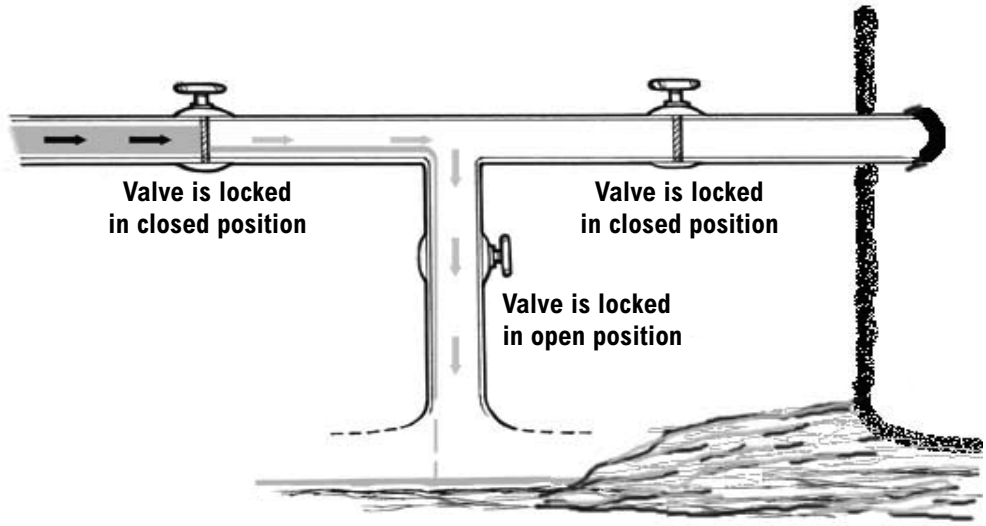
Procedure for installing a blank in a six-inch piping system carrying caustic soda

1. Provide atmospheric testing, warning devices, and protective equipment if toxic or flammable air contaminants could be discharged at a disconnect point. (For example, wear goggles, neoprene, PVC, or rubber coveralls, gloves, and boots to protect against contact with caustic soda.)
2. Shut off the appropriate upstream valve. (For example, shut off valve #5 in west end valve chamber.)
3. Apply personal lock to ensure no one will turn the valve while a blank is being installed. (For example, apply lock to valve #5 by placing lock in position on valve cover.)
4. Depressurize the line. (For example, open relief valve #6.)
5. Clear the line. (For example, open drain valve #7.)
6. Remove the gasket(s) while preventing the worker from being exposed to any toxic contents that may remain in the piping system. (For example, remove gasket(s) at flange #1101. Ensure personal protective equipment is worn including goggles, neoprene, PVC, or rubber coveralls, gloves and boots to protect against contact with caustic soda.)
7. Insert and secure the blank in the pipe. (For example, insert spectacle #25 rated for 200 psi pressure with closed end across opening of pipe.)
8. Insert a gasket on the pressure side to ensure no leaks.
9. Tighten flanges to make the blank effective.

Double block and bleed

You may use a double block and bleed system if the harmful substance in the piping is not one of the following:

- A gas
- A vapour
- A liquid volatile enough to produce a hazardous concentration of an air contaminant from the discharge from the piping



As shown in the drawing, double block and bleed involves closing valves in the piping by locking out a drain or vent valve in the open position in the line between two locked-out valves in the closed position. The written lockout procedures must identify the specific lockout points and valves by name. The names on the procedure must match the markings on the piping system.

The following requirements must be met when using double block and bleed:

- The downstream block valve must be checked to ensure that it is capable of safely withstanding the line pressure. This could be done by shutting the downstream valve first and checking to see if there is any flow.
- The diameter of the bleed line must be no less than the diameter of the line being isolated, unless an engineer certifies otherwise.
- The bleed for a liquid system must be at a lower elevation than the block valves.
- All valves must be locked out in their proper open or closed position.
- The bleed must be checked to ensure that it is clear and remains clear of obstructions while the confined space is occupied. This can be done either by continuous automatic monitoring or by manually checking within 20 minutes before worker entry (or before re-entry after the confined space has been vacated for more than 20 minutes).
- If the bleed line discharges because of failure of the upstream block valve, there must be a system in place that notifies those who have entered the confined space. All workers must immediately exit the confined space and the pipe must be effectively re-isolated before a worker enters the space.

Other procedures acceptable to WorkSafeBC

If isolation using the measures outlined in this section is not practicable, the employer may implement alternative methods. Prior to undertaking the work, the alternative procedures must be submitted to and accepted by WorkSafeBC. All workers affected by alternative methods must be informed of the measures taken and instructed in safe work procedures.

Electrical shock

Electrical tools and equipment used in a confined space must be grounded or double-insulated and so marked. If wet or damp conditions exist inside the confined space, electrical tools and equipment must be protected by an approved ground fault circuit interrupter or other acceptable means of protection. It is always better to substitute equipment that will not be hazardous inside the confined space.

Pneumatic tools

In some cases, the potential for electrical hazards can be eliminated by substituting pneumatic equipment such as air-driven grinders and sanders. If these pneumatic tools present a risk of exposure to hazardous contaminants from the exhaust, the compressor system must be located in an area where the exhaust will not contaminate the air inside the space. If other utility lines are being used adjacent to the confined space (for example, lines containing gases such as nitrogen, acetylene, or oxygen), precautions must be taken to prevent the pneumatic tools from being attached to those lines.

Grounded tools

Properly grounded hand tools are equipped with a means of directing a ground fault back to the service entrance panel where it will blow a fuse or trip a circuit breaker. If properly grounded tools are not used, the resulting shock could be severe or even fatal.

Double-insulated tools

Double-insulated tools are housed in a non-conductive plastic casing with a non-conductive on-off switch, which prevents the operator from coming in contact with any metal parts.

Ground fault circuit interrupter (GFCI)

A ground fault circuit interrupter is a type of circuit breaker that detects any difference (greater than 5 milliamps) between the current being supplied to a tool and the current that returns from the tool. If this difference is detected, the circuit breaker shuts off the flow of electricity. If the difference between the flow of electricity to and from the tool was because it was passing through a person the person would be protected from any further current flowing through them by the ground fault circuit interrupter.

Do not disconnect the tool from the GFCI because it keeps on tripping (sometimes called "nuisance trips"). The GFCI **IS** operating properly. The reason for the GFCI "tripping" can usually be traced to electrical devices in need of repair, including the extension cords, or the tool or cord is being used in a wet or damp location.

A three-pronged plug or the wider spade terminal on the machinery/tool or the extension cord plug ensures that ungrounded devices (such as double insulated tools) are plugged in with the correct polarity. Never remove the ground pin (third prong) from the cord of a tool or three prong extension cord. This ground pin provides grounding protection and it also ensures that double insulated tools are plugged in with the correct polarity.

Electrical tools and equipment used in a confined space where flammable or explosive gases, vapours, or liquids are present must be CSA-approved for hazardous locations classified under *CSA Standard C22.1-94, Canadian Electrical Code Part 1*, as Class I, Division 2, Groups A, B, and C, or other standard acceptable to WorkSafeBC.

Standby persons

Read this section for information on the duties of standby persons and the different requirements for confined spaces with atmospheres rated as low, moderate, and high hazard.

For every confined space entry, a worker must be assigned as a standby person, who checks on the well-being of workers inside the space by visually observing them or using another method of checking. The standby person also summons help in the event of an emergency. Workers inside the space must be able to contact the standby person at any time, either through voice or visual contact. The standby person must be stationed *outside* the confined space, never inside.

The location and functions of the standby person differ, depending on whether the hazard assessment gave the atmosphere a hazard rating of low, moderate, or high.

In a **low-hazard atmosphere**:

- There must be a means for workers inside the confined space to summon the standby person at all times. Radio or telephone contact, or other means, can be used. The standby person does not need to be located at or near the entrance.
- The standby person must check on the well-being of the workers inside the confined space every 20 minutes.
- The standby person must have a means of summoning rescue personnel.

In a **moderate-hazard atmosphere**:

- The standby person must be stationed at or near the entrance to the space. The standby person may have other duties if they do not interfere with remaining at or near the entrance and checking on the well-being of workers.
- Workers inside the confined space must be able to summon the standby person at all times.
- The standby person must check on the well-being of the workers at least every 20 minutes, or more often if the nature of the work requires it.
- The standby person must have a means of summoning rescue personnel.

In a **high-hazard atmosphere** or where there is a risk of engulfment or entrapment, or any other serious health or safety hazard:

- The standby person must be stationed at the entrance.
- Workers inside the space must be able to summon the standby person at all times.
- The standby person must check on the well-being of the workers continuously and have no other duties except monitoring the well-being of the workers.
- The standby person must be equipped and capable of immediately initiating rescue, using lift equipment if required, or otherwise perform the duties of a rescue person.
- The standby person must be trained in rescue procedures.
- The standby person must prevent the entanglement of lifelines and other equipment.
- The standby person must have a means of summoning rescue personnel.

Standby persons are not permitted to enter the space for rescue purposes unless they have rescue training and only if another worker is located outside to render assistance.

A first aid attendant sometimes needs to enter a confined space to attend to a worker with injuries such as a cut or broken ankle. If the standby person is also the first aid attendant, the standby person must ensure that another fully trained standby person takes over before entering the space to provide first aid.

Rescue

By definition, confined spaces have limited or restricted access that may make rescue difficult. There must be written rescue procedures for confined spaces. Read this section for information on the responsibilities of rescue personnel and on rescue procedures and equipment.

Some employers believe that having a good rescue team is the most important part of a confined space entry program. A rescue team and rescue procedures should not be used as a substitute for making a confined space safe to enter. It is essential that the air is safe to breathe before entry so that a rescue team is not required, except for serious injuries or medical emergencies.

Studies have shown that over 60% of confined space deaths occur among would-be rescuers. Rescue plans and proper training for rescuers must be in place *before* any confined space entry. This will prevent well-meaning workers who are untrained in rescue from entering confined spaces to assist workers in distress and themselves becoming victims.

It is essential that the air is safe to breathe before entry so that a rescue team is not required, except for serious injuries or medical emergencies.

Provision for rescue

The employer must provide for the services of rescue persons when a worker enters a confined space. If the rescue persons are employees of another firm or an agency, there must be a written agreement detailing the services to be provided.

A rescue plan includes practicing the plan. This helps to ensure that personnel, equipment, and procedures are in place to effect rescue. The written rescue plan provides a step-by-step means of ensuring all possibilities are considered. Practising the plan provides information about where improvements must be made. For example, the plan may state that a gurney will be used to remove workers from a confined space. Practice may reveal that the stretcher will not fit into the space, the workers cannot lift the injured worker from inside the space, or the winch apparatus needs to be replaced. The more often the rescue plan is practised, the less likely something will go wrong if a rescue is required. A practice drill must be held at least once each year.

If rescue cannot be effected by the standby person(s) using harnesses, lifelines and lifting equipment, then one or more additional workers must be stationed at the entrance to the confined space and these workers must be equipped and capable of entering the space and effecting rescue.

Every person assigned rescue duties must be properly equipped and adequately trained to carry out these duties. Employers may use their own trained workers or another firm or an agency. In such cases, there must be a written agreement detailing the services to be provided. If additional rescue services may be required, there must be prior planning and pre-entry discussions with the rescue services.

Records of training and practice drills must be maintained by the employer of the rescue persons.

Supervisor of the entry, or the standby person

The supervisor of the entry, or the standby person, must notify rescue personnel of work to be done before a worker enters a confined space. If more than one confined space is to be entered at the same time, rescue personnel need to know this and be on alert status. The supervisor of the entry or standby person must also notify rescue personnel when all workers have completed their work and left the space.

Note: Notification requirements do not apply if a written agreement with the rescue agency indicates that rescue personnel are available on a 24-hour basis.

Employer

The employer must ensure that rescue personnel are monitoring any signaling system that will be used to summon them in an emergency.

The employer must ensure rescue procedures include every possible means of eliminating, controlling, or reducing the risk to emergency personnel, including the use of mechanical ventilation.

All employers are responsible for the provision of first aid equipment, supplies, facilities, and services, as determined by an assessment that would meet the requirements of section 3.16 of the Occupational Health and Safety Regulation.

Person directing the rescue

The person who directs the rescue or evacuation must be adequately trained in such procedures and must be the supervisor of the entry or

a qualified rescue person. There must be voice communication at all times between the person directing the rescue and the workers who are performing the rescue.

Rescue workers

Trained rescue workers will know how to conduct a rescue and will consider the following:

- Additional workers located outside to assist
- Rescue from the outside (if possible)
- Requirements for use of a safety harness and lifeline

Trained rescue workers will also know that if IDLH conditions exist or could develop, they must enter only with an SCBA or supplied-air respirator equipped with an escape bottle. Small-diameter openings will require special consideration for rescue workers who are encumbered with SCBA apparatus. A key objective is to correct atmospheric hazards prior to entry, and supply adequate ventilation to ensure a safe atmospheric environment whenever practicable.

Written procedures for rescue

Written procedures for rescue must be in place before every confined space entry. The procedures will consider:

- All hazards of the space as specified in the hazard assessment
- Dimensions of the space, location of entry and exit points, and obstacles to removing an injured worker
- Rescue equipment required for each space
- Personal protective equipment for rescuers, including appropriate respirators for any contaminants or IDLH conditions
- Communication between workers, rescuers, the supervisor of the entry, and standby persons
- Procedures to follow immediately after an incident has occurred
- Possible hazards that may arise during rescue, the appropriate evaluation of these hazards, and control methods recommended by the qualified person
- Rescue methods for a worker who is unconscious, unresponsive (on or off of a lifeline), or distressed

Contact protocols

Do not rely on a call to 911 to provide the rescue services unless you have a specific written agreement with your local public emergency service provider. You are required to pre-arrange any rescue services. However, if you unexpectedly find you need additional medical or rescue services (911), then the contact person must be prepared to provide as much information as possible in order to inform the responders who will be attending the emergency:

- **Exact location:** If the address is hard to find, provide easy access instructions—for example, "from the intersection of Highway 10 and Main Street, follow Route 7 for 3 km and then turn left at the crossroads."
- **Exactly what was being done and what happened to the worker:** Not all people understand specific names of equipment, such as a "batch digester." So, simplify the description without losing the necessary information. For example, "the worker was applying a coating inside a tank and he lost consciousness and fell off a 2-metre-high platform."
- **State what you need:** For example, "We require a hazmat team, a rescue team, and emergency medical services."

Not all fire departments have the equipment or the training necessary to enter confined spaces to rescue someone. It is essential that employers pre-plan rescue with a rescue service provider.

Lifelines, harnesses, and lifting equipment

Lifelines, harnesses, and lifting equipment must meet the requirements of standards acceptable under the Occupational Health and Safety Regulation. All rescue personnel must be trained in the use of all required equipment.

Harnesses and lifelines are required in confined space entries with a high-hazard atmosphere, with a risk of entrapment or engulfment, with any other recognized serious health or safety hazard, or if required by the written procedures. The standby person must be able to lift the person out using the lifting equipment provided, and the worker inside must wear the type of harness that will keep the worker in a position to permit rescue.

If there is a possibility that rescue will be required from an IDLH, oxygen-deficient atmosphere, or unknown atmosphere, the qualified person and the rescue service provider will discuss any requirement for SCBA or supplied-air respirator.

Rescue equipment

Harnesses

The type of harness depends on whether the worker must be rescued in a vertical direction or otherwise. If the rescue is anything other than a vertical rescue, the qualified person will consider the equipment required.

In a vertical rescue, a full-body harness must be used to keep the worker in an upright position. Safety harnesses with leg, waist, and shoulder straps must meet the requirements of *CSA Standard CAN/CSA Z259.1-M90, Full Body Harnesses*, or other standard acceptable to WorkSafeBC.

Wrist harnesses attached to each wrist of the worker are designed only to help prevent contact of the arms with hazard points. Safety lines attached to wrist harnesses must not be used as rescue equipment.

Lifelines and connections

Select lifelines for strength, chemical stability, abrasion resistance, and, where high voltages may be encountered, electrical resistance. For example, nylon has good breaking strength and abrasion resistance, but may not be a good choice around high voltages because of its ability to absorb moisture.

Lines must be free of knots and splices (except at the ends) and must be securely anchored. Connections to harnesses should be made with locking snaphooks or a locking-type carabiner.

Lifting equipment

Lifting-assist devices include the following:

- A worker-rated hand winch with a dog-action brake or a block and tackle to provide mechanical assistance, capable of both lifting and lowering
- A powered winch, when the length of lift is substantial, capable of both lifting and lowering, and with an effective means of control that has been tested before use
- Edge rollers to protect the lifeline from abrasion where the line encounters sharp edges
- A rope grab, brake bar, or other similar device to help prevent return slippage

Entry permits

Read this section for information on when an entry permit is required, what the permit contains, and when it can be altered.

The purpose of an entry permit is to formalize entry into a confined space and to name the supervisor of the entry. A permit also informs workers of the hazards and entry procedures and keeps a record of workers who have entered. The permit must be posted at the entrance to the confined space, verifying that a review of the requirements has been conducted.

Depending on the sophistication of the confined space entry program, information on specific work procedures may be stored in a database designed to automatically insert the information into an entry permit for the specific confined space.

The entry permit must be kept for one year.

When to post an entry permit

The Occupational Health and Safety Regulation requires an entry permit when:

- There is a high-hazard atmosphere
- Lockout or isolation procedures are required
- There is a hazard of entrapment or engulfment

Required information

The entry permit information must identify:

- The confined space and the work activities to which it applies
- Names of workers who are inside the space
- Control measures or precautions required prior to entry and while workers are in the space
- Time of expiration of the permit
- The signature of the supervisor of the confined space entry before workers enter the space

Some employers use the permit as a means of displaying and/or recording additional information, such as:

- Air monitoring results, including the tester's initials
- Lockout procedures
- The ventilation equipment and the air flow required
- The required air-testing equipment and contaminants that must be monitored

The sample entry permit on pages 70–74 shows more than the basic requirements.

Updating a permit

Once issued, only the supervisor of the entry, standby person, and tester may alter the information on the entry permit. The ***standby person*** may alter the permit to update the list of workers inside the confined space. The ***tester*** may alter the permit to record test results.

The ***supervisor of the entry*** who signed the permit may update it:

- If there is a change in the work crew
- After each shift change
- If another supervisor takes over supervising the entry

If the job situation changes significantly enough to affect the safe work procedures for entry into the confined space, only the qualified person can change the work procedures. The supervisor of the entry can change the permit to reflect the changes made by the qualified person.

Personal protective equipment

Read this section for information on the general responsibilities for personal protective equipment (PPE) and a brief description of a respirator program.

Responsibilities

The employer must ensure that all workers who may be exposed to danger in or around a confined space are provided with appropriate personal protective equipment (PPE). The supervisor of the entry must ensure the workers wear such equipment. (Workers may be required to provide their own safety footwear and headgear.) For specific requirements and standards for PPE, see the Occupational Health and Safety Regulation, Part 8: Personal Protective Clothing and Equipment. For hearing protection, see Part 7: Noise, Vibration, Radiation and Temperature.

The qualified person who prepares the hazard assessment and written work procedures will specify the PPE needed for each confined space (or group of similar spaces) and for the work activities that occur there. There may be different PPE requirements for workers inside the confined space, rescue workers, and standby persons.

General requirements for personal protective equipment include the following:

- All equipment must be used and maintained in accordance with the manufacturers' instructions. Equipment must be inspected regularly and kept in good working order.
- Workers must be instructed and trained in the use, limitations, and assigned maintenance duties of personal protection equipment so that they can use the equipment correctly.

Respirator program

The qualified person will specify the appropriate type of respirator in the written work procedures if respirators are needed for the confined space entry. Page 39 discusses when workers in a confined space might require respirators. If at all possible, clean respirable air should be provided before considering the need for respirators. Written rescue procedures must also consider respirator requirements for rescue personnel.

If workers are required to use respirators, the employer must have a written respirator program covering correct selection, use, and maintenance, and must provide effective training to workers. Respirators must meet the requirements of a standard acceptable to WorkSafeBC. Respirators approved by the National Institute for Occupational Safety and Health (NIOSH) are acceptable. For more information on respirators and a respirator program, refer to the WorkSafeBC publication *Breathe Safer: How to Use Respirators Safely and Start a Respirator Program* (BK75) at WorkSafeBC.com.

Workers who are required to wear respirators must be fit tested and instructed about the requirement to wear a respirator in the confined space. A fit test involves a trained person checking for leaks at the point where the respirator seals to the face. This can be done using different methods and equipment, but must be done to an acceptable standard. Fit tests are described in *Breathe Safer: How to Use Respirators Safely and Start a Respirator Program* (BK75). A written record of the fits tests must be kept for inspection.

Coordination of work activities

Coordination of work activities means the employer must ensure hazards of a work activity do not affect the health or safety of adjacent workers who are engaged in a different work activity. For instance, if welders are generating welding fume and it is not controlled at the source, it may be a hazard to adjacent workers who are working at a completely different task. Use of an effective exhaust system to control contaminants generated at a point source is a method that often works to protect the adjacent workers.

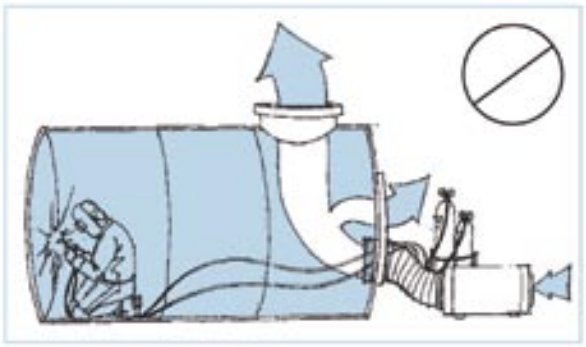
Some work, such as sandblasting, fibreglassing, or applying other coatings causes contaminants that are not localized but instead permeate the confined space. Sometimes, the dusts or vapours cannot be completely controlled by ventilation. The workers who are doing the work that is creating the contaminants must be protected against overexposure. Other crews could be scheduled at a different time so that other workers are not in the space during painting or fibreglassing. If that is not possible and there must be other workers inside the space, then they must be protected against overexposure.

It is critical that employers organize work activities ahead of time to prevent overlap of work areas and to prevent physical hazards from causing injuries to another group engaged in a different work activity inside the space. Restricting work areas by erecting barriers, restricting work times, and ensuring constant communication with all other adjacent work groups inside the space during work will help to prevent some common accidents (for example, being struck by falling materials, being struck by equipment or building materials, or tripping on cables or hoses that have been pulled through the work area).

Ventilation errors and suggested control measures

Table 1 lists some common problems with positive-pressure ventilation systems that blow air *into* the confined space. Table 2 lists some common problems with negative-pressure ventilation systems that draw air *out* of a confined space.

Table 1: General ventilation (positive-pressure system)

Ventilation Errors	Suggested Control Measure
The fresh air inlet is located near a source of air contamination such as an internal combustion engine.	Locate the air inlet away from any sources of contaminants so that contaminated air is not blown into the space.
Oxygen rather than air is blown into the space. Enriched oxygen is a fire and explosion hazard.	Blow only clean respirable air into a confined space. **Never** use oxygen for ventilation.
The system produces turbulence that disturbs dust or liquid residues in the space.	Change the direction, use exhaust ventilation, or lower the speed of air flow.
The blower does not move air into the deepest part of the space. Pockets of contaminated air remain.	Attach a hose to the outlet side of the fan, and place the hose inside the space at the far end. There is greater mixing of the air with a ventilation system that pushes fresh air into the space than with one that pulls air out at the same rate. Some companies use a combined air system, which pushes air into the space at one end and draws air out at the other end.
 The air inlet is located too close to the air outlet. Clean air exits the space without circulating through it (known as short-circuiting).	Use a hose that is long enough to take air into the deepest part of the confined space where workers are working.

Obstructions, including physical barriers or positive pressure inside the space, may push the fresh air back out the inlet opening before it can circulate throughout the space.	Use hoses to move clean air into the deepest part of the confined space where workers are working. Adjust the speed of the blower to increase the air flow.
Contaminated air re-enters the space after exiting.	Locate the outlet for local exhaust ventilation away from the air inlet. Ensure that fresh air is circulating and mixing thoroughly before air exits the space.
The direction of vented air is opposite to or across the natural air currents inside the confined space.	Vent air in the same direction as the natural air currents.
 The vented air draws or blows contaminated air from other areas of the space into workers' breathing zone.	Set up the ventilation system so that contaminated air is not drawn into the breathing zone of workers. Set up a local exhaust ventilation system.
Air is not getting from the blower through the hose to the work area.	Hoses must be laid out as straight as possible. A bend in a hose will cause less air to go through the hose and less clean air to reach the work area.

Table 2: Local exhaust ventilation (negative-pressure system)	
Ventilation Errors	**Suggested Control Measure**
Air contaminants are being drawn past the breathing zone of the worker or others working nearby.	Position the capture hood so that air contaminants are not drawn toward workers. Place the capture hood as close as possible to the source of contamination, ideally no farther away than the diameter of the duct.
Negative pressure draws air contaminants into the space from the ends of piping and through conduits from adjacent areas that are contaminated.	Remove the negative pressure ventilation and set up positive-pressure ventilation (fan) in locations where contaminants will not be drawn into the confined space.
The air flow is too low to remove contaminants.	Ensure the exhaust fan draws enough volume of air at a strong enough velocity to remove the air contaminants. Keep bends in the exhaust duct to a minimum. Use a fan to provide adequate fresh make-up air into the confined space to compensate for air exhausted by the system. Where there are contaminants throughout the space, use a ventilation system that pushes fresh air into the space rather than one that pulls air out, or use a combined system that pushes air into the space and pulls air out. This helps with mixing. Blowing air into the space can result in air currents 30 times greater than the air currents created by a system that draws air out. This “blowing” helps to mix the air inside the space and provides outside air to workers deep inside the space. In addition, clean respirable air blown in creates a positive pressure and reduces the chance of outside air contaminants intruding into the space.
Workers outside the space are exposed to the discharged air.	Position the exhaust ventilation away from workers outside the space.

Confined space entry written procedure — not acceptable

Safe Work Ltd.
Confined Space Entry — Confined Space #5

Division/Department: Water Pumping

Location: Smith Street

Purpose of entry: Confined Space Entry

This work procedure written July 5, 2006 by Ed Sharp

Safety Guy (no previous education or experience in confined spaces), in consultation with Art Wolf, Confined Space Entry Program Administrator and the Joint Occupational Health and Safety Committee of Safe Work Ltd.

Atmosphere Hazard Level:

Personal Protective Equipment:

- X good work boots
- X hard hat
- X safety glasses
- X sufficient hearing protection
- X impervious gloves

Ventilation required:
Provide adequate ventilation to keep the air contaminants below the allowable limit.

Air monitor to use:
Pre-test the area with a monitor designed to test for all likely contaminants. Ensure testing is done on a regular basis.

Lockout:
Follow lockout procedure

Date completed:

Confined space entry written procedure (partial) — acceptable

PARTIAL work procedure

Safe Work Ltd.
Confined Space Entry — Confined Space #5

Division/Department: Pumping station

Location: Smith Street

Purpose of entry: Confined Space Entry for purposes of inspection only

This work procedure written July 5, 2006 by Ed Sharp, Contact #605-200-0000
No work other than routine inspection to be done without prior referral to Ed Sharp.

Confined Space entry specialist Ed Sharp (CIH, ROH, CSP, CRSP, or P.Eng. with sufficient experience in the recognition, evaluation, and control of confined space hazards), in consultation with Art Wolf, Confined Space Entry Program Administrator and the Joint Occupational Health and Safety Committee of Safe Work Ltd.

Atmosphere Hazard Level:

MODERATE

Personal Protective Equipment:

- [X] Green Triangle steel-toed ankle-high work boots
- [X] CSA approved hard hat
- [X] CSA approved safety glasses
- [ ] Hearing protection
- [X] Neoprene or Nitrile gloves

Air monitor:
The air monitor must be equipped with sensors to detect flammables, oxygen, and hydrogen sulphide. The GS-10 monitor available from the supply room should be fitted with the required sensors. Check with the technician prior to use to be sure the correct sensors are installed and the monitor is calibrated and bump tested. Prior to use in the space, use the monitor in a clean air environment to be sure the reading shows 20.9% oxygen and 0% flammables and 0 ppm hydrogen sulphide. Prior to entry and prior to ventilating ensure the monitor (using the 15' hose and pump mechanism) draws air from inside the space across the sensors on the monitor. Ensure enough time for the air to travel from the space, through the hose, and across the sensors. If readings are 20.9% oxygen, 0% flammables and 0 ppm hydrogen sulphide then entry can proceed. Ventilate if they are not. The first worker to enter should take the end of the air monitor hose into the area where work will be done.

Ventilation required:
Volume of space is 2000 cubic feet. Any ventilator used must provide no less than 50 cfm per person entering; however, it is recommended that 20 air changes per hour be provided, which is the same as 670 cfm. Bends in the air hose will reduce the amount of air getting into the space.
PRIOR TO ENTRY: If there is an indication that the air inside the space is not clean respirable air (less than or greater than 20.9% oxygen, or greater than 0% flammables, or greater than 0 ppm hydrogen sulphide), blow air into the space until levels are 20.9% oxygen, 0% flammables, and 0 ppm hydrogen sulphide.

1. Use positive pressure ventilator, available from the supply room and marked with a green lamicoid tag. Attach the 8" diameter 15 foot long yellow hose to the positive pressure side. This supplies 700 cfm.
2. Set up the air intake 10 feet away from the entranceway, use a hose on the inlet side if necessary, to prevent recirculation of the contaminated air.
3. Set up the air intake away from any internal combustion engines or other contaminant-generating equipment.
4. Place air hose to blow fresh air beside workers in the space.

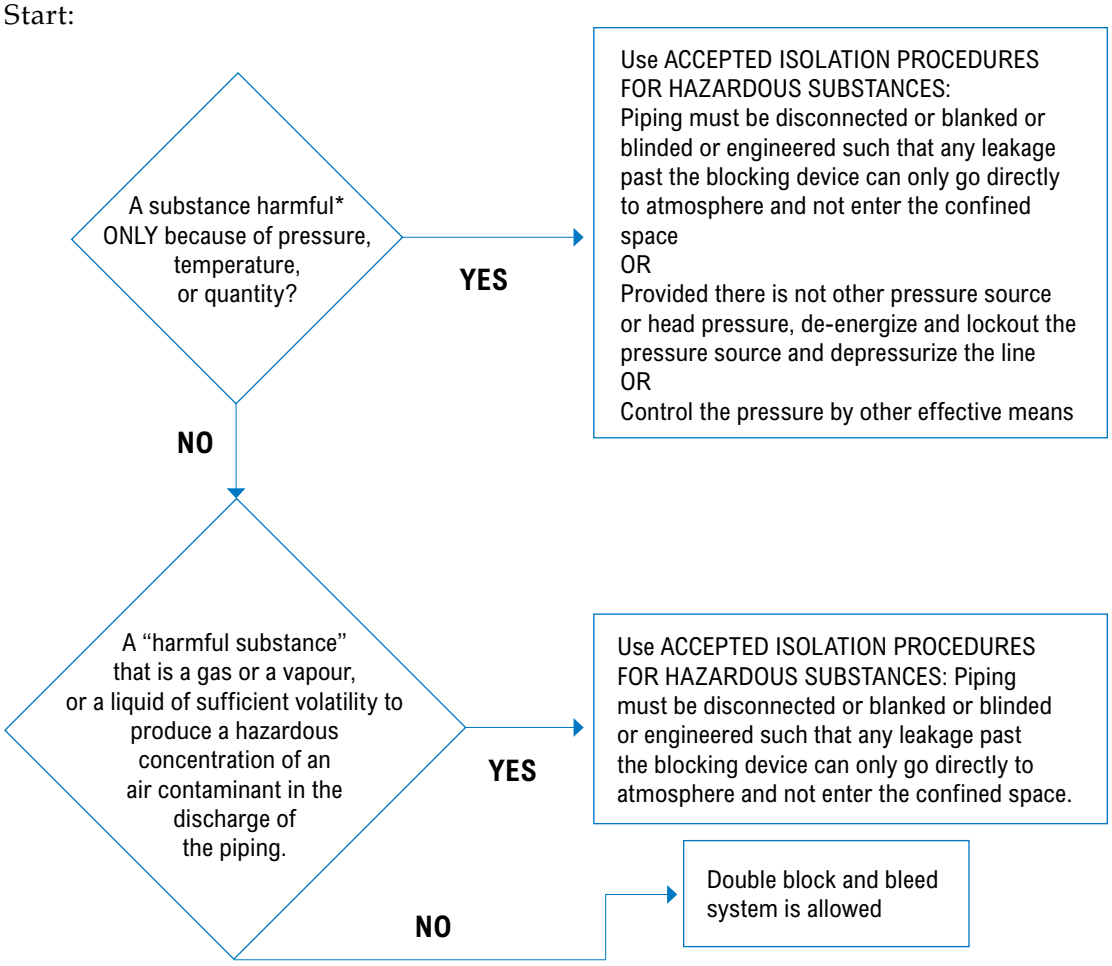
Lockout:
Apply personal locks to lockout point #5 on main control panel (use scissor clamp if more than one worker to enter space). Be sure switch is in the down (off) position before applying lock(s).

Equipment:

Isolation of piping containing harmful substances

Adjacent piping with a HARMFUL* substance?

Start:



* A "**HARMFUL SUBSTANCE**" means a WHMIS controlled product, a substance referred to under section 5.48, or a substance that may have a harmful effect on a worker in a confined space.

Sample of a Confined Space Entry Permit

Confined Space Entry Permit — Page 1 of 4

Name of space ***(permit expires at end of shift)***
Smith Street Pump Station

Date of entry	Time entry begins	
November 5, 2006	*8:00 a.m.*	
Date expires	Time permit expires	
November 5, 2006	*2:00 p.m.*	
Name of standby person	Time start	Time stop
Paul Henry	*8:00 a.m.*	*11:30 a.m.*
Name of standby person	Time start	Time stop
Larry Stinson	*11:30 a.m.*	*2:00 p.m.*

ATMOSPHERE ❒ **High hazard** ☑ **Moderate hazard** ❒ **Low hazard**

Location/designation of space		
800 Smith Street		
Describe space		
Below ground pump station		
Describe work to be done		
Inspection and yearly maintenance of pumps (pumps will be removed from space for maintenance). Ensure lockout procedure is followed prior to entry.		
Signature of person supervising this confined space entry	Date	Time valid *(from/to)*
Marchand Loewen	*November 5, 2006*	*8:00 a.m. to 2:00 p.m.*
Signature of person supervising this confined space entry		

Confined Space Entry Permit must be completed, signed, and posted at the primary entrance when any of the following occurs:

- Lockout is required prior to entry
- Blanking or blinding is required to isolate the space prior to entry
- The space has piping coming into it that cannot be blanked or blinded
- There is risk of entrapment or of being buried/drowned
- Air quality would prevent self-rescue if ventilation or other equipment failed
- Mechanical ventilation is not provided
- Ventilation cannot keep contaminants below permissible concentrations

VENTILATION

CHOICE #1 (for any HIGH or MODERATE atmospheric hazard)	Ventilation required to maintain 20 air changes per hour *(show cfm and name of ventilator)* *Ventilator with green lamicoid tag from stores rated for 700 cfm with yellow 15' hose attached to outlet side, attach 10' hose on inlet side*
CHOICE #2* (used for LOW hazard atmospheres only)	Only natural ventilation used as means of providing ventilation? *(air flow achieved ..... cfm)*

* IF YES to CHOICE #2 THEN

- Space must be over 64 ft^3 per occupant AND
- Space must be a LOW Hazard AND
- Continuous monitoring must be in place AND
- Air flow in space must be continuously measured

NOTE: The minimum ventilation required for any space is 50 cfm per person. The ventilation must be adequate to provide good clean respirable air to workers inside the space. Providing 20 ac/hr will maximize mixing and will generally provide a good supply of air. Place ventilator hose close to the area where workers are working. Long ducts, ducts with interior roughness, tight bends and numerous bends all increase resistance and decrease air flow.

Confined Space Entry Permit — Page 2 of 4

Name of space ***(permit expires at end of shift)***
Smith Street Pump Station

GAS TESTING — MONITORING

Initials	Testing must be done for:	Contaminant — Reading from the Monitor				
		Oxygen (min 19.5% — max 23%)	**Flammables/ Explosive** (max 10% of LEL)	**Carbon monoxide** (max: 8-hr average 25 ppm)	**Hydrogen sulfide** (ceiling limit 10 ppm)	**Other** (i.e., Cl_2 max 8-hr average 0.5 ppm) Check hazard assessment
		☑ YES ☐ NO	☑ YES ☐ NO	☑ YES ☐ NO	☑ YES ☐ NO	*Not required*
	Pre-purge reading (ensure air travelling through hose has enough time to reach sensors)					
PH	Time 7:00 a.m.	18.5	3%	2	2	
	Post-purge reading					
PH	Time 7:40 a.m.	20.9	0	0	0	
PH	Time 8:00 a.m.	20.9	0	0	0	
PH	Time 9:46 a.m.	20.9	2%	0	0	
PH	Time 9:58 a.m.	20.9	0	0	0	
PH	Time 10:25 a.m.	20.9	0	0	0	
LS	Time 12:35 p.m.	20.9	0	0	0	
LS	Time 2:00 p.m.	20.9	0	0	0	

CONTINUOUS MONITOR TEST RESULTS are written accurately:

Date of calibration	Name of tester(s)
October 22, 2006	Paul Henry Larry Stinson

(Depending on use, the monitor may need calibration on a weekly or daily basis.)

NOTE:

- No entry allowed if: Flammables greater than 20% of lower explosive limit (LEL)
- No entry **without high hazard precautions** if: oxygen level is less than 19.5% or greater than 23 % — or — hydrogen sulphide greater than 5 ppm — or — carbon monoxide greater than 12.5 ppm — or — flammables greater than 10% of LEL — or — risk of entrapment — or — being buried/drowned — or — confined space is an extension of an excavation (with potential for offgassing of contaminated soil)
- Monitoring must be continuous. Standby person must enter gas test results once every four hours or any time the space has been vacated for more than 20 minutes
- If initial test results indicate contaminants or lack of oxygen, purging is required. If 20 ac/hour is provided with good mixing inside the space and no additional contaminates are being generated, then purge time is 15 minutes. If airflow is less than 20 air changes per hour into the space, purge time must be increased accordingly (example — only 10 ac/hr, then 30 minutes required for purge).

Confined Space Entry Permit — Page 3 of 4

Name of space ***(permit expires at end of shift)***
Smith Street Pump Station

Signature of standby person

I certify that my sole duty at this worksite in the time period specified on the front of this permit is standby person. I will be documenting the continuous monitor readings and ensuring the check-in/check-out sheet is completed as well as the duties required of me as standby person.

Standby person's signature	Standby person's signature
Paul Henry	*Larry Stinson*

ENTRY/EXIT CHECKLIST

Legend: Standby person to write an " / " each time the named worker enters the confined space (/) and write a "\" each time the named worker exits (\) forming an "X" for a completed entry/exit (X).

Name of worker	Status															
Luigi Commazetto	X	X	X													
Deborah Langden	X	X														
Marchand Loewen	X															
Paul Henry	X	X														

Personal protective equipment that must be worn

☑ Hardhats	☑ Eye protection	☑ Footwear
☑ Gloves	❒ Respiratory protection	☑ Full body harness

Consider the following:

1. Small access point (restricts access)
2. Sloped floor (risk of slipping)
3. Material placement (restricts access)
4. Equipment placement (restricts access)
5. Equipment in space (requires lockout)
6. Internal baffles (restricts access)
7. Heights or depths (risk of falling)
8. Near power lines (risk of electrocution)
9. Stacking or bridging of materials (risk of engulfment or being buried)
10. Presence of pinch points (risk of being caught between)
11. Upstream fluids (risk of drowning)

11a. Upstream solids (risk of engulfment)

12. Slippery flooring (risk of slipping)
13. Laser measurement devices are present (risk of eye injury)
14. Dust in space (irritation or restricted vision)
15. Power tools (risk of electrocution — ground fault interrupter required)
16. Hot work being done (risk of fire)
17. Use of irritant or corrosive chemicals
18. Rusting substances using up oxygen
19. Internal baffles restricting ventilation
20. Equipment placement restricting ventilation
21. Below grade potential for gases to sink into space
22. Near contaminant sources that may affect atmosphere

22a. Risk of upstream gases (risk of being overcome)

23. Near spill sources that may require coordination with other agencies
24. Radiation — isotope measuring devices
25. Flammable dust — non-flammable dust
26. Temperature extremes — too hot, too cold

26a. Use of steam to clean (risk of inhalation of mists)

27. Compressed gas
28. Excessive noise
29. Hot work or use of chemicals causing exposure above WorkSafeBC limit
30. Materials being used to clean the space are toxic (risk of being overcome or becoming ill)
31. Contaminants existing inside the space that cannot be cleaned or purged prior to entry.

Confined Space Entry Permit — Page 4 of 4

Name of space ***(permit expires at end of shift)***
Smith Street Pump Station

Control measures

1. *Use tripod, lifeline, and harness. When descending ladder, use three-point contact.*
4. *Do not service the pump while inside the space. Remove pump using lifting device . Make sure pump is not on the edge of the hole when servicing, and use a barricade or cover the hole to prevent a fall hazard.*
7. *2 metre ladder. Use caution. Allow no slack in lifeline when ascending or descending.*
12. *Floor may be slippery. Use caution.*
18. *Possibility of lack of oxygen. Pre-test and purge prior to entry. Ventilate and use a continuous monitor during entry. Standby person must be stationed at entranceway during entry. Place outlet hose from ventilator close to workers during entry.*
21. *Ensure any internal combustion engines are not close to the air intake or are not upwind of intake.*
22. *Chlorination station is located nearby. If alarm sounds in station, ensure all workers exit space immediately. Evacuate by moving upwind of the station.*
23. *Local hazmat team can provide the necessary emergency response equipment and expertise, and have agreed in writing to attend if a chlorine leak develops. (Call 911)*
28. *Unless noisy equipment will be used in the space during the inspection, there is no requirement to use hearing protection.*
29. *This permit does not provide information about the requirements during hot work or when cleaning materials are being used.*

TO GET HELP in an EMERGENCY

Cell phone call — 604 111-4444 Radio — Use Code Red

Be prepared to give exact location and circumstances to dispatch.

DO NOT ENTER SPACE TO RENDER ASSISTANCE (unless you are trained to do so, and another qualified standby person is stationed at the entranceway). Your job is to get help, not to provide any rescue service unless you have been specifically trained as a rescue provider.

Where a term is defined in the Occupational Health and Safety Regulation, the section number containing the definition is included in parentheses. Other definitions give the meaning of the term as used in this manual.

Adjacent piping

A device such as a pipe, line, duct, or conduit which is connected to a confined space or is so located as to allow a substance from within the device to enter the confined space (section 9.1).

Asphyxiant

A vapour or gas that can cause unconsciousness or death by suffocation (lack of oxygen). There are two classes of asphyxiants: simple asphyxiants such as nitrogen or methane that act by replacing oxygen in the air, and chemical asphyxiants such as carbon monoxide that cause asphyxiation by preventing the body cells from using the oxygen in the blood.

Auto-ignition temperature

Temperature at which a flammable gas or vapour can catch fire without a source of ignition.

Blank

A solid plate installed through the cross-section of a pipe, usually at a flanged connection (section 9.1).

Blanking or blinding

The absolute closure of adjacent piping, by fastening across its bore a solid plate or cap that completely covers the bore and is capable of withstanding the maximum pressure of the adjacent piping.

Blind

A solid plate installed at the end of a pipe that has at that point been physically disconnected from a piping system.

Breathable air

See *Clean respirable air*.

Clean respirable air

When used to describe the atmosphere inside a confined space, means an atmosphere that is equivalent to clean, outdoor air and that contains:

(a) about 20.9 percent oxygen by volume,

(b) no measurable flammable gas or vapour as determined using a combustible gas measuring instrument, and

(c) no air contaminant in concentrations exceeding either 10 percent of its applicable exposure limit in Part 5 of the Occupational Health and Safety Regulation or an acceptable ambient air quality standard established by an authority having jurisdiction over environmental air standards, whichever is greater (section 9.1).

Confined space

Except as otherwise determined by the Board*, means an area, other than an underground working, that:

(a) is enclosed or partially enclosed,

(b) is not designed or intended for continuous human occupancy,

(c) has limited or restricted means for entry or exit that may complicate the provision of first aid, evacuation, rescue, or other emergency response service, and

(d) is large enough and so configured that a worker could enter to perform assigned work (section 9.1, effective January 1, 2005).

***** *"Otherwise determined by the Board"*
Refer to the Guidelines for Part 9 of the OHS Regulation available at WorkSafeBC.com.

Contaminant

A harmful or irritant material, or nuisance dust, foreign to the normal composition of a substance, or a material that varies the normal proportions of components in a mixture such as air (section 1.1).

Continuous monitoring

Continuous atmospheric testing of a confined space, while workers are in the space, to identify concentrations of gas, oxygen, and explosives.

CSA

Canadian Standards Association.

Disconnecting

Physically disconnecting (and misaligning) adjacent piping from a confined space to prevent its contents from entering the space in the event of discharge (section 9.1).

Double block and bleed

The closure of adjacent piping by locking out a drain or vent in the open position in the line between two locked out valves in the closed position (section 9.1).

Due diligence

Due diligence means taking all reasonable care to protect the well-being of employees or co-workers. To meet the standard of due diligence, you must take all precautions that are reasonable in the circumstances so that you can carry out your work and your health and safety responsibilities. This is the standard of care required to comply with the Occupational Health and Safety Regulation.

Entering a confined space

A worker has entered a confined space when the worker's breathing zone breaks the plane of an opening into the confined space.

Engineering controls

The physical arrangement, design, or alteration of workstations, equipment, materials, production facilities, or other aspects of the physical work environment, for the purpose of controlling risk (section 1.1).

Flammable gas

A substance which meets the criteria for WHMIS Class B Division 1 flammable gas (a compressed gas with an upper flammable limit of 13% or less or with an explosive range of 12% or more) (section 5.1).

Flammable liquid

A substance that meets the criterion for WHMIS Class B Division 2 flammable liquid (a flash point less than 37.8°C (100°F)) (section 1.1).

Flange

A protruding rim, edge, or collar, usually on a pipe, used to strengthen an object, hold it in place, or attach it to another object.

Harmful substance

A WHMIS controlled product, a substance referred to under section 5.48, or a substance that may have a harmful effect on a worker in a confined space (section 9.1).

Hazard

A thing or condition that may expose a person to the risk of injury or occupational disease (section 1.1).

Hazard assessment

Hazard identification and risk assessment of a confined space conducted by the qualified person.

Hazardous substance

See *Harmful substance*.

High-hazard atmosphere

An atmosphere that may expose a worker to risk of death, incapacitation, injury, acute illness or otherwise impair the ability of the worker to escape unaided from a confined space, in the event of a failure of the ventilation system or respirator (section 9.1).

IDLH atmosphere

Means an atmosphere containing a substance at a concentration that is immediately dangerous to life or health (IDLH) because the concentration is greater than that from which one could escape without any escape-impairing symptoms or irreversible health effects, and includes an atmosphere with an unknown concentration with the potential to be immediately dangerous to life or health (section 1.1).

Inerting

Intentionally flooding the inside of a confined space with an inert gas such as nitrogen to eliminate the hazard of ignition of flammable vapours inside the confined space but thereby creating an oxygen-deficient atmosphere (section 9.1).

Intrinsically safe

To ensure something is intrinsically safe refers to ensuring an electrical apparatus is designed so that it is unable to release sufficient energy, by either thermal or electrical means, to cause an ignition of a flammable gas.

Lockout

Means the use of a lock or locks to render machinery or equipment inoperable or to isolate an energy source in accordance with a written procedure (section 10.1).

Low-hazard atmosphere

An atmosphere that is shown by pre-entry testing or otherwise known to contain clean respirable air immediately prior to entry to a confined space and which is not likely to change during the work activity, as determined by the qualified person after consideration of the design, construction, and use of the confined space, the work activities to be performed, and all engineering controls required by the Occupational Health and Safety Regulation (section 9.1).

Lower explosive limit (LEL)

The minimum concentration of combustible gas or vapour in air, expressed as a percentage by volume, that will ignite if a source of ignition is present (section 23.1). Also known as lower flammable limit (LFL).

Material safety data sheet or MSDS

A document disclosing the information referred to in section 13(a)(i) to (v) of the *Hazardous Products Act* (Canada) and section 12(1) to (3) of the Controlled Products Regulations (Canada) (section 1.1).

Mechanical ventilation

Ventilation of a space with mechanical air movers (such as fans) or local exhaust systems and a means of directing the air, such as ductwork.

Moderate-hazard atmosphere

An atmosphere that is not clean respirable air but is not likely to impair the ability of the worker to escape unaided from a confined space, in the event of a failure of the ventilation system or respirator (section 9.1).

Natural ventilation

Ventilation of a space by natural air movement resulting from wind or convection currents.

NIOSH

National Institute for Occupational Safety and Health (in the United States).

Oxygen deficient

In relation to air, a condition in which there is less than 19.5% oxygen by volume, or the partial pressure of oxygen is less than 16.3 kPa (122 mm Hg) (section 1.1).

Purging

The process of removing an unsafe atmosphere in a confined space and replacing it with clean respirable air.

Qualified

Being knowledgeable of the work, the hazards involved and the means to control the hazards, by reason of education, training, experience, or a combination thereof (definition in section 1.1). See page 10 for further information on what training and experience are acceptable for a person conducting a hazard assessment or preparing written procedures for a confined space.

Rescue person

A person who is properly equipped and adequately trained to perform rescue duties in confined spaces.

Risk

A chance of injury or disease (section 1.1).

Standby person

A person stationed outside a confined space whose responsibility is to check on the well-being of workers inside the space and initiate rescue in an emergency.

Supervisor of the entry

The person assigned responsibility for supervision of a confined space entry under section 9.7. Section 1.1 defines a supervisor as a person who instructs, directs, and controls workers in the performance of their duties.

Ventilation

See *Mechanical ventilation* and *Natural ventilation*.

Venting

Opening up a confined space to allow clean air to enter and circulate without the use of mechanical ventilation.

Venturi effect

Compressed air moving through a pipe that narrows causes a reduction of air pressure in the narrow part of the pipe. The reduction of air pressure results in air subsequently rushing in to fill the space. Air horns work on this principle. In a 16" model, input of 40 PSI @ 73 CFM might provide an output of 2,200 CFM.

WHMIS

Workplace Hazardous Materials Information System.

WorkSafeBC Offices

Visit our web site at WorkSafeBC.com.

Abbotsford
2774 Trethewey Street V2T 3R1
Phone 604 276-3100
1 800 292-2219
Fax 604 556-2077

Burnaby
450 – 6450 Roberts Street V5G 4E1
Phone 604 276-3100
1 888 621-7233
Fax 604 232-5950

Coquitlam
104 – 3020 Lincoln Avenue V3B 6B4
Phone 604 276-3100
1 888 967-5377
Fax 604 232-1946

Courtenay
801 30th Street V9N 8G6
Phone 250 334-8765
1 800 663-7921
Fax 250 334-8757

Kamloops
321 Battle Street V2C 6P1
Phone 250 371-6003
1 800 663-3935
Fax 250 371-6031

Kelowna
110 – 2045 Enterprise Way V1Y 9T5
Phone 250 717-4313
1 888 922-4466
Fax 250 717-4380

Nanaimo
4980 Wills Road V9T 6C6
Phone 250 751-8040
1 800 663-7382
Fax 250 751-8046

Nelson
524 Kootenay Street V1L 6B4
Phone 250 352-2824
1 800 663-4962
Fax 250 352-1816

North Vancouver
400 – 224 Esplanade W. V7M 1A4
Phone 604 276-3100
1 888 875-6999
Fax 604 232-1558

Prince George
1066 Vancouver Street V2L 5M4
Phone 250 561-3700
1 800 663-6623
Fax 250 561-3710

Surrey
100 – 5500 152 Street V3S 5J9
Phone 604 276-3100
1 888 621-7233
Fax 604 232-7077

Terrace
4450 Lakelse Avenue V8G 1P2
Phone 250 615-6605
1 800 663-3871
Fax 250 615-6633

Victoria
4514 Chatterton Way V8X 5H2
Phone 250 881-3418
1 800 663-7593
Fax 250 881-3482

Head Office / Richmond
Prevention Information Line:
Phone 604 276-3100
1 888 621-7233 (621-SAFE)

Administration:
6951 Westminster Highway
Phone 604 273-2266

Mailing Address:
PO Box 5350 Stn Terminal
Vancouver BC V6B 5L5

After Hours
Health & Safety Emergency
604 273-7711
1 866 922-4357 (WCB-HELP)

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