Confined Space Entry and Monitor

PARTICIPANT MANUAL
VERSION 20.2

ENERGY SAFETY CANADA

Safety Doesn't Clock In and It Doesn't Punch Out. It's 24/7.

ESC lives and breathes safety so Canada's energy industry can live and work safely.

With roots dating back to 1949, ESC was created by industry for industry with a single purpose to improve safety throughout Canada's energy industry. ESC is a not-for-profit and registered charity and this status allows the organization to reinvest any revenues back into health and safety programs and resources dedicated to advance safety in Canada's energy industry.

For workers, we:

- Make safety training easier to get
- Reduce redundancy of duplicate training
- Have easily accessible training certifications
- Standardize safety measures across multiple sites

For companies, we:

- Produce ready-made resources to help keep the workforce safe
- Provide leading-edge data and customized support
- Enhance access to safety data analyses
- Save time and money and increase efficiency with shared solutions and common safety standards

We're Located Where You Need Us:

Our Network of Authorized Training Providers (ATPs):

Energy Safety Canada works with hundreds of partners nationwide to deliver safety training and services. From BC to the Atlantic provinces, you can find ATPs near you.

Energy Safety Canada has locations in:

Calgary
T 403 516 8000
F 403 516 8166
150 - 2 Smed Lane SE
Calgary, AB T2C 4T5

Fort St. John
T 250 794 0100
F 250 785 6013
2060 - 9600 93 Avenue
Fort St. John, BC V1J 5Z2

Weyburn
T 306 824 9822
F 306 337 9610
208 - 117 3 Street
Weyburn, SK S4H 0W3

Nisku
T 780 955 7770
F 780 955 2454
1803 11 Street
Nisku, AB T9E 1A8

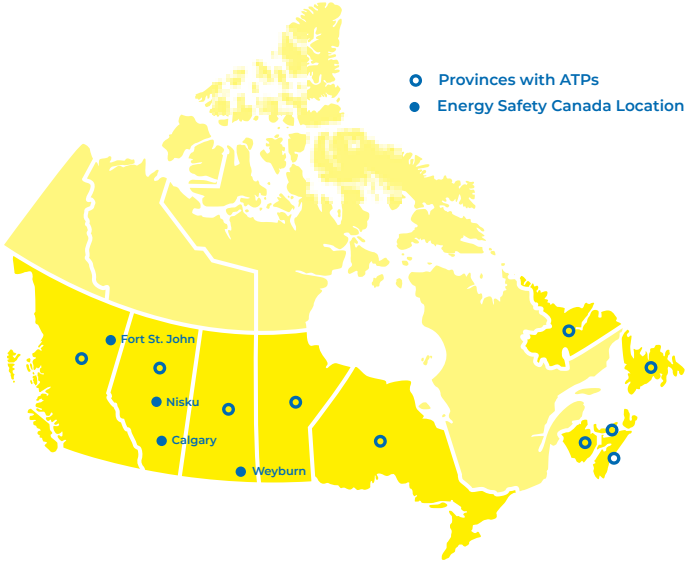


TABLE OF CONTENTS

1.0

CHAPTER 1:
Importance of Confined Space Training..... 4

2.0

CHAPTER 2:
Restricted vs. Confined Spaces and Operational Roles 14

3.0

CHAPTER 3:
Hazard Assessment and Controls 24

4.0

CHAPTER 4:
Atmospheric Testing and Hazards..... 36

5.0

CHAPTER 5:
Confined Space Classifications 52

6.0

CHAPTER 6:
Emergency Response and Entry Planning 64

APPENDICES

Appendices 74

CHAPTER 1:

Importance of Confined Space Training

OUTCOME

Describe confined space legislation, the Code of Practice, and best practices.

OBJECTIVES

At the end of this chapter, you should be able to:

1. List some of the main reasons that incidents occur.
2. Explain the obligations of each role with respect to confined spaces in the workplace.
3. Explain the Code of Practice.
4. Describe the Canadian Association of Petroleum Producers (CAPP) and how they have moved towards standardizing the development of codes of practice.

INTRODUCTION

Confined space entry involves high hazard work in high hazard environments. Risk is always present, and it is important to recognize the space and understand its potential hazards. You must understand why incidents occur and how to mitigate the risk. Knowing the legislative requirements for confined spaces, and who is responsible in your workplace and at worksites, will help you and your coworkers stay safe during confined space entry.

Figure 1-1: Confined Space Work

ACTIVITY 1.1: WHAT WOULD YOU DO?

How comfortable are you in entering a confined space? How much do you know about confined space entry? Your facilitator will play a 3D simulation to help gauge your comfort and knowledge with confined spaces. At certain points you will be asked questions. Write your answers in the table below.

What Would You Do?

Are you ready to enter the confined space?	☐ Yes ☐ No	» Why or why not?
Should you enter the confined space?	☐ Yes ☐ No	» Why or why not?
What else do you need?		

What is missing? What areas are not quite right?		
What should you do, enter or send a message to your entry monitor / tending worker?		
You should be safe, correct?	☐ I am safe ☐ I am unsafe	» Why or why not?
What areas have changed that may put you in immediate danger?		
Should you immediately exit the confined space?	☐ Yes ☐ No	» Why or why not?
Should you complete your work and then exit safely?	☐ Yes ☐ No	» Why or why not?

WHY DO INCIDENTS OCCUR?

A poor understanding of hazards and associated risk and changing conditions can be extremely dangerous and even deadly. Most fatalities in confined spaces occur because of procedural omissions or substandard acts by managers, supervisors, workers, and others.

Figure 1-2: Confined Space Incident

Confined Space Not Recognized

Workers do not recognize a confined space when they see one. Therefore, they do not know the space is dangerous.

Unaware of Hazards

Workers are not aware of the potential hazards. They think that if a confined space looks safe, it is safe. However, the hazards present in most atmospheres are invisible; most toxic or deadly atmospheres cannot be seen, tasted, or smelled.

Underestimate The Danger

Workers underestimate the danger. They think they can get in and out before a hazard affects them. They do not realize how quickly a deadly atmosphere can overcome them.

Unaware of Surroundings

Workers do not stay on guard. They forget that a hazard may develop after they have entered a space.

Rescuing Others

Trying to help a person in trouble is human nature. Unfortunately, untrained rescuers usually die along with the victim they try to save.

Administrative Factors

Administrative and human factors that contribute to serious injuries and fatalities include:

- Lack of a written confined space management program
- Inadequate emergency equipment and personnel
- Insufficiently trained employees
- Mental fitness (claustrophobia, etc.)
- Medical fitness (physical fitness and size of entry worker)

LEGISLATIVE REQUIREMENTS

Working in or around a confined space is a high-risk activity. Across Canada, a significant number of people are killed or seriously injured in confined spaces each year. This happens in a wide range of industries, from those involving complex process operations to simple storage vessels. Those affected include people working in the confined space and those who try to rescue them, often without appropriate training and equipment.

The regulations governing confined space activities vary significantly from one jurisdiction to the next.

Note
Do you know the regulations for your jurisdiction? Do you know where to find them? Ask your supervisor if you are unsure.

OBLIGATIONS

Employers, supervisors, and workers share the responsibility for health and safety in Canada's workplaces. This responsibility is a legal and moral obligation that cannot be delegated or assigned to other parties.

Employer: Plan Ahead

- Ensure all reasonable precautions have been taken to protect the health and safety of employees and others in the workplace
- Ensure workers have appropriate and adequate training
- Ensure all workers are **competent** to perform duties assigned
- Establish and maintain an effective health and safety program
- Support supervisors and employees in their safety activities

CLASS DISCUSSION

- What do you think constitutes a **competent** worker?

Supervisor: Prepare and Comply

- Ensure only authorized, adequately trained workers operate machinery and equipment
- Ensure equipment and facilities are maintained properly
- Consistently enforce safety rules and legislation
- Correct substandard acts and conditions
- Provide personal protective equipment (PPE) and ensure workers use and maintain it correctly
- Undertake inspections of work sites to ensure that work activities are carried out in a safe manner
- Follow safe work permitting, as required
- Conduct a Hazard Assessment prior to starting work

Workers: Anticipate and Participate

Know and comply with safe work permits, safety rules and legislation affecting your work. Follow the safe work practices/job procedures and Codes of Practice developed from the hazard assessment for the work.

- Report any substandard acts or conditions immediately
- Report any injuries to your supervisor immediately
- Make suggestions for improving safety conditions
- Refuse to do work that would create a danger to the health or safety of any person
- Ensure you have received training to perform tasks or duties assigned

ACTIVITY 1.2: WHAT COULD GO WRONG?

Let's look at a real scenario from 2016. Although the worker was adequately trained and it seemed like all proper precautions were taken, a fatality still occurred.

In your group, choose a spokesperson and a recorder. Read the scenario below and then discuss what may have caused the fatality. Be prepared to share your answers with the class.

Some items to consider include equipment, the confined space, Jane's actions, and training.

Introducing Jane

Jane worked seasonally at ABC Company for over four years. During this time, she completed over 100 confined space entries to perform maintenance work. Jane received training including confined space entry and monitor, fall protection, H_2S Alive, and standard first aid.

Figure 1-3: Jane

Figure 1-4: The Incident

The Incident

For two days, Jane performed maintenance in a confined space. The manway entrance was the only means of entry and exit, and the interior of the vessel was under nitrogen purge. Before each entry, Jane and other members of her crew completed and signed off on a hazard assessment. Among other hazards, the IDLH (immediately dangerous to life and health) environment was identified on the assessment.

During her work, Jane wore respiratory protective equipment including a full-face breathing apparatus, intended to function as an emergency escape unit. She also had supplied breathing air from an air trailer which was located on the ground, adjacent to her workspace. Additionally, Jane was fit tested for the mask to ensure a tight seal to her face, and completed a negative and positive pre-use fit test.

On the day of the incident, Jane entered the space as usual via the manway entrance. Jane was followed by another employee of ABC Company who was her spotter. The spotter was responsible for maintaining visual contact with Jane while she performed the maintenance work. A confined space entry monitor/tending worker was positioned at the manway entrance.

What Could Go Wrong?

It seems all precautions were taken—adequate training, a clearly identified IDLH space, an experienced worker, proper breathing equipment, a properly fitted mask, supplied breathing air, and a confined space entry monitor/ tending worker. What could possibly go wrong?

Shortly after Jane entered the workspace, the spotter observed that Jane was not moving. The spotter initiated the company's emergency response procedure by raising alarm to the confined space entry monitor/tending worker standing outside the manway entrance. Jane was extracted from the workspace in accordance with the company's emergency response procedure, but died due to inert gas asphyxia.

CODE OF PRACTICE

A Code of Practice sets out industry standards of conduct and provides guidance to employers, supervisors, contractors and workers that can be used to meet the requirements of OHS legislation. All employers must have a written Code of Practice and must complete the training requirements before undertaking any confined space work.

Table 1.1 Code of Practice Requirements

CODE OF PRACTICE	All employers must have a written Code of Practice and must complete the training requirements before undertaking any confined space work.
PROCEDURES	A Code of Practice describes the procedures to follow that allow workers to perform work in a confined space safely.
FAMILIARITY	It also requires that workers affected by its procedures be familiar with those procedures before working in the confined space.
MAINTAIN ▸ REVIEW	The Code of Practice must be maintained and periodically reviewed to ensure that its procedures are up-to-date and that it continues to reflect the company's work activities.

There are three basic steps in preparing a Code of Practice for confined space entry:

1. Identify confined spaces at the work site.
2. Identify hazards in the confined spaces.
3. Develop the Code of Practice.

Caution
You must have a current copy of the Code of Practice on site. Do you know where it is at your worksite? When you return to work, ask your supervisor where it is.

BEST PRACTICE – CAPP

The Canadian Association of Petroleum Producers (CAPP) represents companies, large and small, that explore for, develop, and produce natural gas and crude oil throughout Canada. Because confined space regulations vary from province to province, CAPP developed a guideline of recommendations to assist companies in the development of a code of practice, where required. This code of practice provides a practical guide to achieving the standards of worker health and safety required under Canadian Federal and Provincial Occupational Health and Safety (OHS) Regulations.

Figure 1-5: CAPP Code of Practice

EXERCISES

1. What are the health and safety responsibilities of employers, supervisors, and workers?

» Employers

» Supervisors

» Workers

2. What are four reasons that incidents occur when working in a confined space?

3. What is a Code of Practice? What are the three basic steps in preparing a Code of Practice for confined space entry?

4. What did CAPP develop?

CLASS DISCUSSION

» Do you know the regulations for your jurisdiction? Do you know where to find them?

» How does your company share the responsibility for health and safety?

» What can you do to help ensure the health and safety of both you and your coworkers regarding restricted and confined spaces?

CHAPTER 2:

Restricted vs. Confined Spaces and Operational Roles

OUTCOME

Summarize confined spaces and the roles and responsibilities of those accountable for confined space entry.

OBJECTIVES

At the end of this chapter, you should be able to:

1. Determine if a space is restricted or confined.
2. Define the types of confined spaces.
3. Explain the responsibilities of managers, supervisors and confined or restricted space entry workers and their training requirements.
4. Explain the essential duties of a competent Confined Space Monitor/Tending Worker.

INTRODUCTION

Restricted and confined spaces share certain characteristics. However, they differ in key areas that may help employers and workers operate more safely and efficiently. Both spaces are often entered for workers to complete repairs and tasks. Being aware of such spaces and taking proper precautions is essential to ensuring your safety and the safety of those around you.

All parties involved with confined or restricted spaces have specific roles and responsibilities.

RESTRICTED VERSUS CONFINED SPACES

One of the first things you need to know when dealing with confined space entry is the difference between a restricted space and a confined space and how to determine those differences.

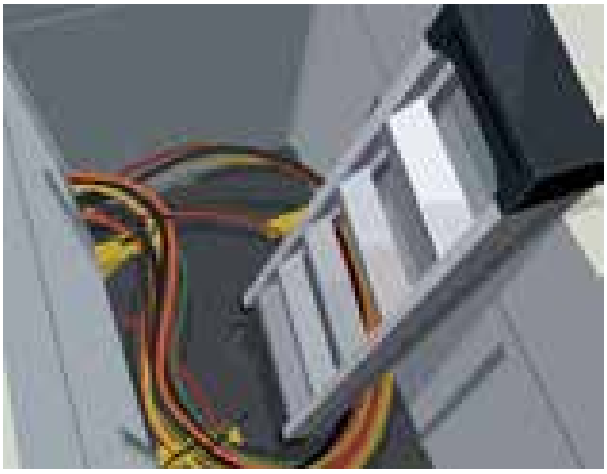


Figure 2-1: Restricted Space

Restricted Space

A **restricted space** is an enclosed or partially enclosed space that is not intended for continuous human occupancy. Restricted spaces have limited means of entry and exit which can make escape or rescue difficult. These limitations can include ladders or stairways that provide poor access because of steep slopes, narrow widths or extreme lengths, and physical obstructions such as bulkheads, collapsed materials, or machinery.

A restricted space can be thought of as a work area in which the only hazard is getting into or out of the space. All other hazards are either non-existent or have been eliminated or controlled.

To enter a restricted space, there must be:

» A hazard assessment
» Properly trained workers
» Proper communication during entry and exit
» Prevention of unauthorized entry
» A safe means of entry and exit.

Confined Space

A **confined space** is similar to a restricted space, but unlike a restricted space, confined spaces may become hazardous.

A confined space is an enclosed or partially enclosed space, not designated or intended for continuous human occupancy, that has a restricted or impeded means of entry or exit because of its construction and may become hazardous to a worker entering it because of atmospheric hazards, potential hazards in the space or hazards associated with the task.

Confined spaces are usually entered only for such purposes as cleaning, inspecting, maintaining, repairing, or construction. Most confined spaces are designed to hold substances such as liquids, gases and loose materials, or to house equipment. Some conditions or activities that can make a confined space hazardous include painting, welding, running gasoline or diesel engines, lack of oxygen due to purging or handling chemicals.

Though confined spaces come in many sizes and shapes, they are classified in two ways:

1. Open-topped with depth (e.g. pits, wells, tanks, vats, hoppers, bins, degreasers, vessels, and kettles)
2. Narrow openings (e.g. pipes, tunnels, exchangers, silos, casings, and sewers)

Figure 2-2: Confined Space

Remember
Employers and workers must be mindful that a restricted space can become a confined space if conditions or work practices change.

RESTRICTED, CONFINED OR NEITHER?

How do you know if the space is restricted, confined, or neither? The chart below helps you assess the space.

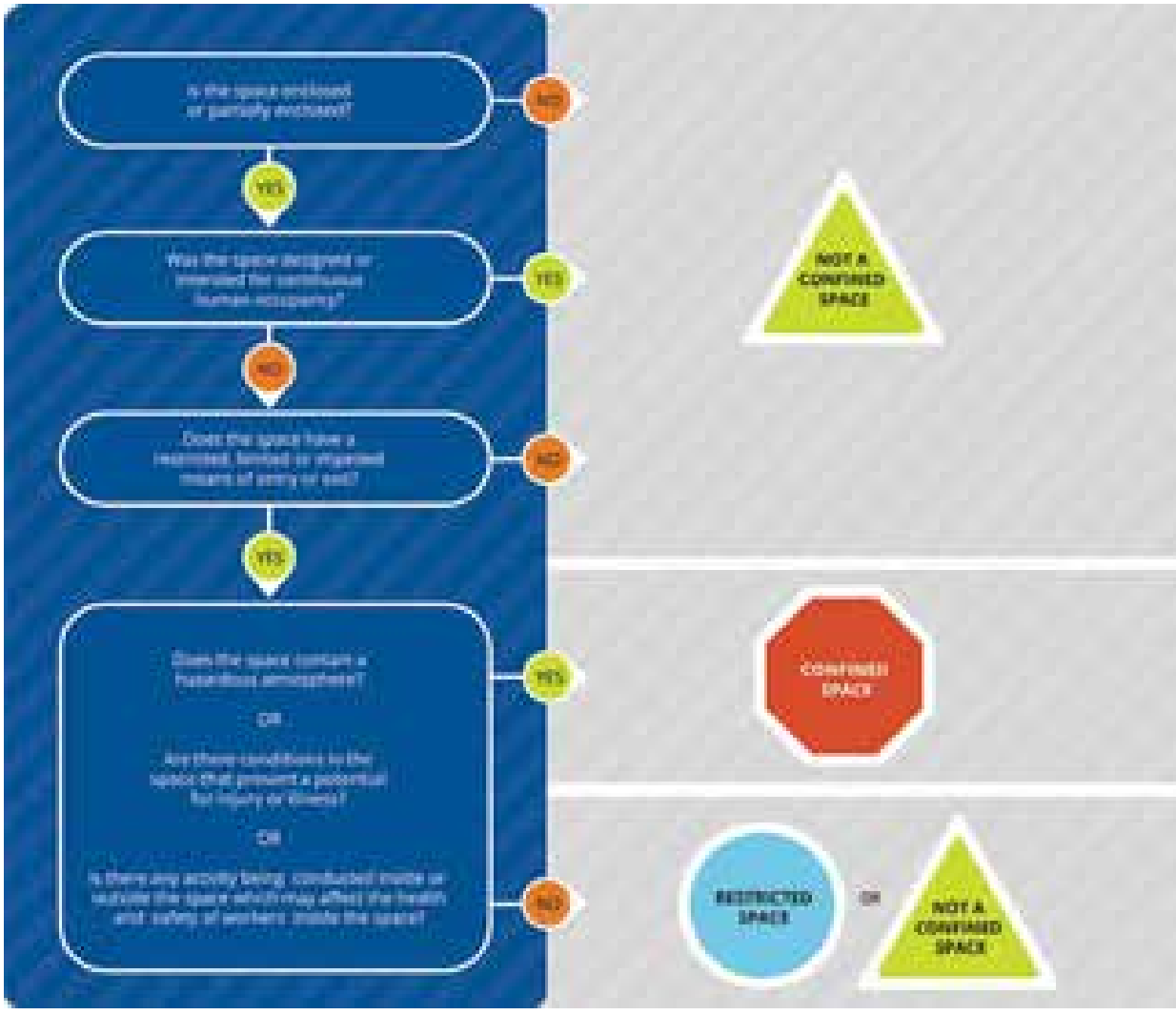


Figure 2-3: Restricted or Confined Space?

ACTIVITY 2.1 IS IT A RESTRICTED OR A CONFINED SPACE?

Now that you know the difference between a restricted space and a confined space, let's look at some scenarios. Using the above chart, in small groups determine if the described spaces are restricted or confined. Circle the appropriate type of space. Provide reasons for your selection.

Scenario 1:

Three workers are entering a trench box to weld a new gas line for the municipality. They have not tied into the existing system.

Restricted or confined? Why?

Scenario 2:

A newly constructed oil storage tank must be entered for final inspection before it is turned over to operations for commissioning.

Restricted or confined? Why?

Scenario 3:

The entire facility, including the cooling water system, is shut down for turnaround maintenance. The cold well for the cooling tower has been drained and must be entered to vacuum any residual mud.

Restricted or confined? Why?

ENTERING A CONFINED SPACE

If you have determined a space is confined, at what point do you enter it? You have entered a confined space when your breathing zone crosses the plane of the confined space access.

The breathing zone is a 60 centimetre, or two-foot, diameter half-sphere around your head and shoulders. It contains the atmosphere that you are most likely to inhale. If the confined space has positive pressure due to natural or forced ventilation, a confined space entry monitor/tending worker positioned directly in front of the opening could be in the air stream. In these conditions, the monitor/tending worker would be breathing the same atmosphere as the workers inside the space.

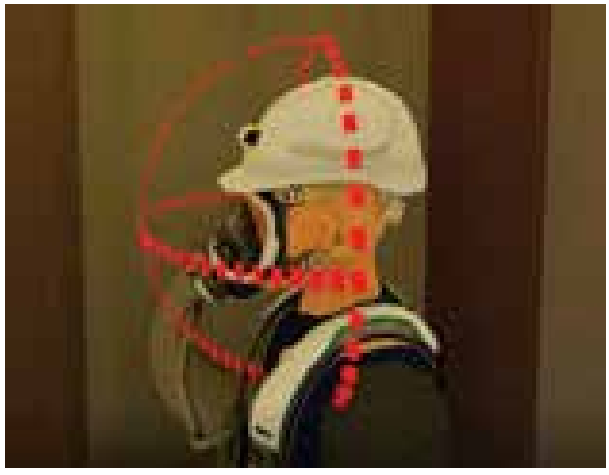


Figure 2-4: The Breathing Zone

Caution
When choosing the best location for a confined space entry monitor / tending worker to observe work activities, you must consider the atmospheric pressure of the space and whether the monitor/tending worker will be positioned in line with the air stream.

ROLES AND RESPONSIBILITIES

Earlier in this course, we reviewed the high-level roles of those that are responsible for confined or restricted space entry. Let's now delve into the operational responsibilities of these roles.

There are four main operational roles:

1. Management
2. Supervisors
3. Workers
4. Monitors/Tending Workers

Figure 2-5: Operational Roles

Management

Management teams have a critical responsibility for everyone's safety and are responsible for:

» Ensuring proper training for entry and exit
» Providing proper equipment for entry
» Ensuring all confined spaces are clearly identified
» Scheduling evaluations to ensure that workers maintain competency
» Ensuring appropriate access to the space for rescue operations
» Designating a worker to be in communication with a worker who is in a confined or restricted space
» Developing a hazard management system in which the hazards are assessed at the planning stage, at the task location, and during the task itself.

Supervisors

Supervisors are responsible for explaining the hazards of the work to all workers involved in the confined or restricted space entry. They must ensure that adequate hazard controls are in place and that all workers involved have the appropriate training, personal protective equipment, tools, and equipment to safely perform the work.

Supervisors must also understand their roles and obligations under OH&S legislation as well as the rights of the worker.

Figure 2-6: Supervisor Meeting

Life Saving Rule
Supervisors should always assess their workers to determine their physical and psychological ability to do the work, and the workers should inform their supervisors if there is something that inhibits their ability to perform the work.

Workers

Before workers are authorized to enter confined or restricted spaces, they must receive the required training, use the proper equipment, and comply with the site practices and procedures.

Some of the required duties of confined space workers which may require training include:

- Informing the employer of any limitations or competencies which may interfere with the ability to perform the functions of the position
- Understanding the hazards associated with confined or restricted space entry, including information on the types of hazards and the signs, symptoms and consequences of exposure to the hazard
- Knowing how to complete pre-use inspections and how to properly use the equipment required for safe entry
- Alerting the monitor or designated worker whenever they recognize any warning signs or symptoms of exposure to a dangerous situation or when any prohibited condition is detected
- Exiting the confined space as quickly as possible when required
- Following all applicable legislative requirements, codes of practice and any other facility specific standards, rules, procedures and practices
- Knowing and understanding the emergency response plan and procedures.

Monitors/Tending Workers

The essential duties of a competent Confined Space Monitor/Tending Worker are:

- Being in attendance outside the confined space at or near the entrance
- Tracking the number of persons inside the confined space at all times
- Maintaining constant communication with personnel inside the confined space
- Understanding and activating the emergency response plan
- Confirming all workers have vacated the confined space.

Confined Space Monitors/Tending Workers must also understand the legislative requirements associated with confined space entry and may require additional training for specific entry classifications or specific work situations as identified by the hazard assessment.

Caution
Confined Space Monitors/Tending Workers must ensure all entry requirements have been fulfilled and they have the authority to deny entry into a confined space if any of the requirements are not met. A confined space monitor/tending worker must be present and located at every active manway where confined space work is being completed.

Caution
Entry must be terminated if communication cannot be maintained.

ACTIVITY 2.2: WHOSE ROLE IS IT ANYWAY?

Working in small groups, determine which role is responsible for each duty or task. Circle the best answer for each question.

1. Ensuring proper training for entry and exit
   a. Management
   b. Supervisors
   c. Workers
   d. Monitors / Tending Worker

2. Confirming all workers have vacated the confined space
   a. Management
   b. Supervisors
   c. Workers
   d. Monitors / Tending Worker

3. Understanding and activating the emergency response plan
   a. Management
   b. Supervisors
   c. Workers
   d. Monitors / Tending Worker

4. Knowing how to complete pre-inspections and how to properly use the equipment required for safe entry
   a. Management
   b. Supervisors
   c. Workers
   d. Monitors / Tending Worker

5. Ensuring all confined spaces are clearly identified
   a. Management
   b. Supervisors
   c. Workers
   d. Monitors / Tending Worker

6. Alerting the monitor or designated worker whenever they recognize any warning signs or symptoms of exposure to a dangerous situation or when any prohibited condition is detected
   a. Management
   b. Supervisors
   c. Workers
   d. Monitors / Tending Worker

7. Explaining the hazards of the work to all workers involved in the confined or restricted space entry
   a. Management
   b. Supervisors
   c. Workers
   d. Monitors / Tending Worker

8. Informing the employer of any limitations or competencies which may interfere with the ability to perform the functions of the position
   a. Management
   b. Supervisors
   c. Workers
   d. Monitors / Tending Worker

9. Understanding the legislative requirements associated with confined space entry
   a. Management
   b. Supervisors
   c. Workers
   d. Monitors / Tending Worker

10. Ensuring appropriate access to the space for rescue operations
    a. Management
    b. Supervisors
    c. Workers
    d. Monitors / Tending Worker

EXERCISES

1. Adam needs to perform some work in a confined space. Before entering the space, John explains all the hazards associated with the space and checks to make sure that Adam has the proper Personal Protective Equipment (PPE). What is John's role?
   a. Manager
   b. Supervisor
   c. Worker
   d. Monitor / Tending Worker

2. Wayne is a confined space monitor/tending worker. He talks to the three confined space workers working during his shift, takes their attendance and learns they are entering the space in the next hour. Due to an emergency, Wayne is not at the entrance when the confined space workers enter the space. He returns 15 minutes later, and a co-worker advises that he saw all three workers enter the space. It is bitterly cold outside, so Wayne decides to stay in his truck with the motor running and the heat on. He is near the entrance and his communication radio is on. Shortly before the workers vacate the confined space, Wayne leaves his post for lunch. Prior to leaving, Wayne asks the same co-worker who saw the confined space workers enter the space to ensure all three workers exit safely. Is Wayne a competent confined space monitor/tending worker?
   a. No, he does not maintain constant contact with the workers inside the confined space.
   b. Yes, he stays near the entrance of the confined space for some of the time.
   c. Yes, he checks with a coworker to see if the three workers entered the confined space.
   d. Yes, he ensures that a co-worker watches for the exit of all three confined space workers.

3. What is a restricted space? How does a confined space differ from a restricted space?

4. Name two things that must be in place for restricted space entry? (There is a total of five.)

5. What are the two types of confined spaces? Provide an example of each type.

6. What activities could make a confined space hazardous?

7. What is a breathing zone?

CLASS DISCUSSION

» What must you consider when choosing the best location for a confined space entry monitor / tending worker to observe work activities?

» If you notice that there are gaps in training or responsibilities in your organizations, what should you do? For example, supervisors are not explaining the hazards of the work to all workers involved in the confined or restricted space entry, or workers do not know the emergency response plan procedures.

NOTES

CHAPTER 3:

Hazard Assessment and Controls

OUTCOME

Identify confined space hazards, risks, and controls.

OBJECTIVES

At the end of this chapter, you should be able to:

1. Describe the potential hazards with confined and restricted spaces.
2. Explain the four levels of the Hierarchy of Hazard Controls for confined space entry.
3. List the different types of energy sources that must be controlled.
4. Describe the three isolation strategies and approaches.

INTRODUCTION

The dangers of performing work in confined spaces can be controlled if all hazards are identified and measures are taken to control them. Hazards may be atmospheric or non-atmospheric and there are various ways to eliminate or minimize exposure to these hazards.

HAZARD ASSESSMENT

Before entering any confined space, a hazard assessment must be performed to identify and evaluate conditions that could lead to workers getting hurt or becoming ill.

Figure 3-1: Performing a Hazard Assessment

Hazard Assessment Steps

There are seven hazard assessment steps:

1. Identify and assess the hazards the worker is likely to be exposed to while in the confined or restricted space.
2. Review related documents that may assist the worker to better understand the task.
3. Specify the type and frequency of inspections and tests necessary to determine the likelihood of worker exposure to any of the identified hazards.
4. Perform the applicable inspections and tests specified.
5. Specify the safety and personal protective equipment (PPE) required to perform the work.
6. Identify the PPE and emergency equipment to be used by a worker who undertakes rescue operations in the event of an accident or other emergency.
7. Identify emergency evacuation and communication methods.

Caution
Confined space workers must be involved in the hazard assessment and control process. This process provides a consistent approach for employers and workers to identify and control hazards in the workplace.

HAZARD AND RISK ASSESSMENT

The other consideration that must be accounted for when doing a hazard assessment is the risk in relation to the hazard. This includes:

- The potential magnitude, frequency and duration of exposure to the hazard
- The number of persons potentially exposed
- The probability of occurrence
- The consequence of an occurrence (severity)
- The potential for changes in conditions in or near the confined space to occur
- Current and planned strategies for controlling the hazard
- The need for emergency response
- The impact the hazards, risks, and controls could have on emergency response.

HIERARCHY OF HAZARD CONTROLS

Hazard controls begin with management's understanding of hazards and a proactive approach to dealing with these hazards. When hazards need to be controlled, there are four levels—beginning with the most effective, and ending with the least effective:

This hierarchy of controls is a prioritization system used to eliminate or minimize exposure to hazards.

Figure 3-2: Hierarchy of Hazard Controls

Elimination or Substitution

The best way is to eliminate the hazard altogether by eliminating the need to enter the confined space. How can you eliminate the need to enter?

- Design the confined space that eliminates the need for entry
- Perform the task from outside the confined space
- Use a remote camera or a mirror attached to a probe for inspection
- Use a hook, long-handled clasp, or magnet on a string to retrieve an object from a confined space.

Substitution is replacing a hazard or work process with a less hazardous one. For example:

- Cleaning walls or surfaces without chemicals
- Using non-toxic substances instead of toxic ones
- Applying paints, solvents, or surface coatings with brushes instead of aerosols
- Replacing flammable substances with non-flammable ones
- Mechanically ventilating the vessel or space to produce a less dangerous environment for worker occupation.

Substitution can also involve introducing more complex machinery to perform a task. For example, using modern equipment with built-in safety features.

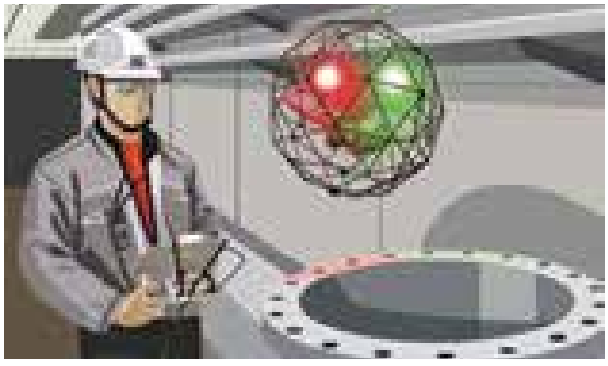


Figure 3-3: Elimination or Substitution Control

Engineering Controls

An engineering control requires a physical change to the workplace. This can be accomplished by enclosing or isolating the hazard, or it can be accomplished by careful design of processes, facilities, and the work environment.

The following are examples of engineering controls:

- Guards and barriers
- Process flow at the design stage
- Interlocks
- Automatic pressure relief valves
- HVAC

Administrative Controls

Administrative controls do not remove a hazard but limit workers exposure to the hazard and rely on human behaviour to be activated and effective. This includes rules, procedures, and training to ensure an activity is completed in as safe and efficient a manner as possible. It also includes signs and other devices that notify workers of hazards. Administrative controls are instrumental in guiding employers and employees in the proper care, use, and maintenance of engineering controls and PPE.

Figure 3-4: Administrative Control

Personal Protective Equipment

Personal Protective Equipment (PPE) is often used as a last resort to protect the worker from harm or last line of protection for workers against hazards. The PPE you use will depend on the work environment, the work conditions, and the process being performed.

It is important to remember that wearing the correct PPE is imperative. PPE does not reduce the workplace hazard nor does it guarantee permanent or total protection for the wearer. It is designed to lessen the potential for injury or illness should a worker be exposed to hazards. Examples of PPE are:

» CSA approved hard hats and work boots
» Fire-retardant coveralls
» Gloves specifically designed for the hazards of the task
» Earmuffs and plugs
» Welding masks and leather aprons
Common Non-Atmospheric Hazards

Table 3.1 Non-Atmospheric Hazards

NON-ATMOSPHERIC HAZARD	DESCRIPTION
Engulfment	» Loose material drawn from the bottoms of storage bins can suffocate or bury an entrant. Liquids or materials are suddenly released into space.
Mechanical or hydraulic energy	» Mechanical and hydraulic equipment start or move unexpectedly.
Noise	» Confined space can amplify sounds produced by tools and equipment.
Falling objects	» Objects fall into the space because topside openings are unguarded or improperly guarded.
Extreme temperatures	» The location of the space and the equipment it contains make its temperature extremely hot or cold.
Slippery surfaces	» Leaks, spills and condensation make walking surfaces slippery.
Corrosive chemicals	» Corrosive chemicals are stored in the space, or entrants use them to perform tasks.
Access problems	» Confined spaces are difficult to enter and exit.
Illumination problems	» Most confined spaces are dark places.

ACTIVITY 3.1: WHY SHOULD YOU BE CONCERNED?

We just described several non-atmospheric hazards. In small groups, discuss why you need to be concerned. Identify the associated Life Saving Rule, where applicable. Be prepared to share your answers.

Table 3.2 Why Should You Be Concerned

NON-ATMOSPHERIC HAZARD	WHY DO YOU NEED TO BE CONCERNED?	LIFE SAVING RULE
Engulfment		
Mechanical or hydraulic energy		
Noise		
Falling objects		
Extreme temperatures		
Slippery surfaces		
Corrosive chemicals		
Access problems		
Illumination problems		

ISOLATING ENERGY AND ENERGY SOURCES

Legislation states that the employer is responsible for ensuring the work activity is performed safely. Isolating energy is one way to provide a safe work environment and it ensures that NO harmful substances can be introduced into the work area.

The following types of energy must be controlled:

- Mechanical
- Electrical
- Flammable, chemical, combustible, corrosive
- Potential
- Thermal—steam, hot water, gases, liquefied gases (cold)
- Hydraulic and pneumatic

Life Saving Rule
Improper isolation can result in lifelong disabilities (including crushed limbs) and may even result in death.

ISOLATION STRATEGIES

Isolation strategies must ensure that the affected workers have control over the energy source for the time they will be working on, in or around the potentially hazardous energy.

Positive isolation can be accomplished by:

- Blanking or blinding
- Double block and bleed
- Disconnection and line separation
- Locking out electrical equipment

Figure 3-5: Isolation Strategy

BLANKING OR BLINDING

Blanking or blinding is the introduction of a solid plate at the flange connection of any piping system. The blank or blind material must be compatible with the product in the piping system, and it must be capable of withstanding any pressures.

The blank or blind must be installed as close as possible to the confined space, and the disconnected lines must be drained or vented. It must be clearly marked to show that it has been installed and is not to be removed.

Potential Hazards

There are various potential hazards during the blanking and blinding process:

- Explosive and flammable vapours
- Toxic gas
- High-pressure gas or liquids
- Kick from pipe due to improper alignment and pressure buildup
- Environmental damage due to spillage
- Auto drivers in an isolated system not being locked out.

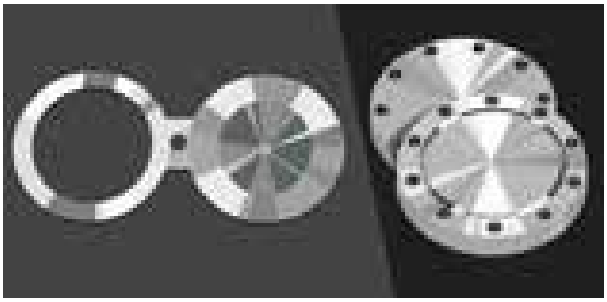


Figure 3-6: Blank or Blind

Figure 3-7: Blank or Blind

Caution
It is critical that all equipment must be isolated, locked, and tagged from all hazards prior to any work commencing.

DOUBLE BLOCK AND BLEED AND DISCONNECTING LINES

The double block and bleed is a method used to isolate a confined space from a line, duct, or pipe. This method provides a primary blocking seal and a second back-up seal with an operable bleed off between the two seals.

In some circumstances, lines leading to or from a confined space can be removed. When disconnecting and separating the lines, the open ends are either capped with a threaded cap where the piping is threaded, or blinded if the piping is not threaded. If a cap is used, it must be of the appropriate size and pressure rating. Always check both the cap and the pipe end to ensure that the threads are not stripped.

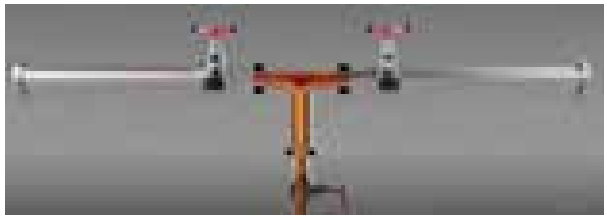


Figure 3-8: Double Block and Bleed

Life Saving Rule
After hazardous energy has been isolated, a "bump" test should be performed to verify the correct energy source has been isolated to the satisfaction of the affected workers. For example, when servicing an electrical pump, the equipment owner would attempt to activate the pump at the local switch after the breaker has been locked out. If isolation is proven, then the switch is secured in the off position.

Life Saving Rule
Remember: Isolation may have been someone else's job, but your safety is always yours. Check all isolation points at your location before entry.

LOCKOUT AND TAGOUT

Lockout devices and information tags can help ensure safety. Typically, lockout devices incorporate chains and/or cables with a keyed lock. Information tags are used with each lockout device and provide a warning to not start or operate the device, the tag installation date, the worker's name and signature, and any other pertinent information.

Figure 3-9: Lockout and Tagout

Caution
Tags alone do not ensure your safety!

Life Saving Rule
The only individuals who should remove a properly secured isolation lock and tag is the worker or workers who installed them—after first making sure no one is at risk when the device starts up. The removal of an abandoned isolation lock affects the health and safety of all workers and should only be considered as a last resort. Prior to removing abandoned locks, permission should be sought from Operations Management.

ISOLATION PROCEDURE

Your employer must have a properly secured isolation procedure to make sure everyone is performing it correctly. Employers must incorporate these tasks when designing the isolation procedure:

- List all required energy-isolating devices and their locations
- Identify the equipment, machine or process to which properly secured isolation is to be applied
- Write procedural steps for shutting down, isolating, blocking, securing and relieving stored or residual energy
- Identify the main isolating device for each energy source and isolate the equipment
- Apply properly secured isolation where required
- Fasten applicable lockout tags
- Ensure all personnel are clear of the equipment
- Write procedural steps for placing and removing lockout devices
- Maintain a properly secured isolation logbook at each isolation station.

ISOLATION APPROACHES

Employers can choose from three approaches to secure an energy-isolating device.

1. **Individual lockout:** Each worker involved must attach his or her own personal lockable securing device.
2. **Group lockout:** Multiple workers are involved, or multiple energy isolating devices must be secured.
3. **Complex group process:** A procedure-based "group lockout" process that is implemented when the individual or group processes are not reasonably practicable to secure energy-isolating devices. An example of a complex group process would be a plant turnaround or a pipeline system shutdown.

Caution
Controlling hazardous energy can be a complex process and additional training may be required. Please check with your supervisor.

EXERCISES

1. Match each non-atmospheric hazard to its description. Write the letter of the non-atmospheric hazard description next to its definition.

   a. Loose material drawn from the bottoms of storage bins can suffocate or bury an entrant. Liquids or materials are suddenly released into space.
   b. When equipment starts or moves unexpectedly.
   c. Confined space can amplify sounds produced by tools and equipment.
   d. The space's location and the equipment it contains can result in extremely hot or cold environments.
   e. Leaks, spills, and condensation can result in a fall.
   f. Confined spaces are difficult to enter and exit.
   g. Most confined spaces are dark places.

   ..... Extreme temperatures

   ..... Mechanical or hydraulic energy

   ..... Noise

   ..... Engulfment

   ..... Illumination problems

   ..... Slippery surfaces

   ..... Access problems

2. When controlling hazards, there is a hierarchy of controls you must follow. Write the type of control next to its description.

Perform the task outside its confined space:

_____

Process flow at the beginning of the design stage:

_____

Rules, procedures and training:

_____

Wearing appropriate safety gear:

_____

3. Match each non-atmospheric hazard with the applicable cause for concern. Write the letter of the cause for concern next to the corresponding type of non-atmospheric hazard.

   a. May cause serious injury or death if energy is not properly controlled
   b. Can interfere with essential communication between entrants and attendants
   c. May make it difficult for workers to enter, exit, and work in a confined space because of poor lighting
   d. May make tasks more difficult to perform due to excessive cold, hot environments may put workers at risk for heat stress
   e. Can trap or bury a worker in seconds

   ..... Engulfment

   ..... Mechanical or hydraulic energy

   ..... Noise

   ..... Extreme temperatures

   ..... Illumination

4. Which energy source **does not** need to be controlled in a confined space?
   a. Electrical
   b. Solar
   c. Combustible
   d. Thermal

5. Positive isolation is the use of control measures, such as blanking, blinding, or electrical lockout, to prevent hazardous energy from affecting the space.
   ☐ True ☐ False

6. Which statement is true concerning lockout and tagout?
   a. Lockout/tagout is a standard operating procedure to ensure hazards are properly indicated and secure.
   b. Typically, lockout devices incorporate chains and/or cables with a keyed lock.
   c. Information tags are to be used with each lockout device.
   d. All of the above.

CLASS DISCUSSION

» When doing a hazard assessment why must you consider the risk in relation to the hazard?

» Do you know if your employer has a properly secured isolation procedure? If you don't know, what should you do?

NOTES

CHAPTER 4:

Atmospheric Testing and Hazards

OUTCOME

Describe confined space atmospheric testing, hazards, and potential controls.

OBJECTIVES

At the end of this chapter, you should be able to:

1. Define the four atmospheric test terms and explain why they are important.
2. Recognize some common atmospheric, traffic, and other hazards in confined spaces.
3. Explain the concepts of vapour density, oxygen enrichment and oxygen deficiency.
4. Recognize how toxic substances and static charges are produced and controlled.
5. Explain ventilation, purging, and inerting.
6. Differentiate between the three shoring methods.

INTRODUCTION

Despite the performance of many levels of assessments and controls being put in place, it is not always possible to eliminate all hazards. Prior to workers entering a confined space, pre-entry atmospheric testing must be done to ensure that dangerous gases are not present.

A static charge can be created in a restricted or confined space. Techniques can be employed to prevent sparks.

Elimination of hazards related to loose and unstable materials may involve a few control tactics including cut back methods, trench shields and shoring methods.

ATMOSPHERIC TESTING TERMS

Prior to any entry or work in a confined space, the atmosphere must be tested for oxygen deficiency, flammability, and toxic substances. It is critical that air monitoring and gas detection equipment is used properly and calibrated so that these hazards are not underestimated and are within the legislative limits.

There are four main atmospheric test terms.

Table 4.1 Atmospheric Testing Terms

TERM	DEFINITION	WHY DOES THIS MATTER?
Lower Explosive Limit (LEL)	Minimum concentration of fuel in the air required to create an explosion if ignited.	» Ensuring the fuel and fuel mixtures in the air do not rise above the LEL is a key method of preventing fires and explosions. Gas monitoring with LEL-based warnings are safety critical. » It is not flammable and combustible materials that burn but the vapours emitted that form an ignitable mixture with air in turn creating a hazard.
Upper Explosive Limit (UEL)	The point at which fuel concentration is so high that there is not enough oxygen to create an explosion.	» In enclosed systems, fuel and fuel mixtures will not ignite. » However, if oxygen is introduced into the system, eventually a mixture below the UEL will occur and create the potential for an explosion.
Occupational Exposure Limit (OEL)	Maximum concentration of a substance to which a person can be exposed for specific lengths of time as defined by the OH&S Act, Regulation and Codes.	» Contaminants in confined spaces may be toxic, therefore understanding exposure limits, control measures, routes of entry, health impact, and first aid/emergency response for specific substances is critical to the development of safe work procedures, including measures to minimize, mitigate, and/or eliminate exposure.
% by Volume (or percent of volume)	The concentration of a component as a percentage of the total volume of an area.	» Safe, combustible gas atmospheres can still be toxic! This is not so much a factor when operating combustible gas monitors, as it is a consequence of misinterpreting the results of a gas measurement. » Combustible gas measurements are reported as **% by volume** while toxic gas measurements are reported in **PPM (parts per million) and 1% equals 10,000 PPM.**

Note

O_2, LEL, H_2S, and CO are typical gas sensors used in the oil and gas field. Gas monitors and detectors can be customized with sensors for a variety of substances that may be encountered. For example, specialized instruments that can detect benzene, silica and Naturally Occurring Radioactive Material (NORM) may also be employed.

Remember
Remember, human senses can be deceived. You should never assume that you can detect toxic gases by sight or smell. Some gases are odourless or colourless, and others can instantly destroy your sense of smell.

ATMOSPHERIC HAZARDS

There are four main atmospheric hazards

Table 4.2 Atmospheric Hazards

ATMOSPHERIC HAZARD	DESCRIPTION	EXAMPLES
Previous contents	Previous contents of the space	» A tank with a residual descaling solvent left inside 
Chemical reactions	Atmospheric hazards generated from chemical reactions of materials present in the space	» The decomposition of flammable gas, hydrogen sulphide, rusting or oxidation within a confined space that would consume oxygen and cause an oxygen deficiency. 

ATMOSPHERIC HAZARD	DESCRIPTION	EXAMPLES
Activities	Activities performed in or around the space	» Welding: generates welding fumes » Solvent cleaning: generates solvent vapours 
Adjacent spaces	Hazardous contaminants that may inadvertently enter the space from adjacent processes or locations.	» Carbon monoxide from vehicle exhaust entering street manholes or a trench. 

TESTING PROCEDURES

Testing should follow procedures as outlined in your entry plan as per your code of practice.

This is an example of a general gas detection process and is not the only component of a gas detection program. When workers are trained on the operation of instruments and procedures for confined space monitoring, the risks involved are greatly reduced. Additional training may be required.

1. Ensure you are competent to perform the atmospheric testing.
2. Check the test equipment for proper function and calibration.
3. Calibrate at 20.9% oxygen.
4. Know the products that you will be testing.
5. Run the atmospheric tester.
6. If you are doing atmospheric testing from inside the confined space, don the appropriate respiratory protection before atmospheric testing.
7. For accurate measurement, the gas tester should take several readings in various locations within the space.
8. Record the first readings in the confined space permit and/or logbook and on the entry tag.
9. Take appropriate action based on the test results: ventilate the space, wear respiratory protection, re-test as often as necessary and record test results and any additional hazards.

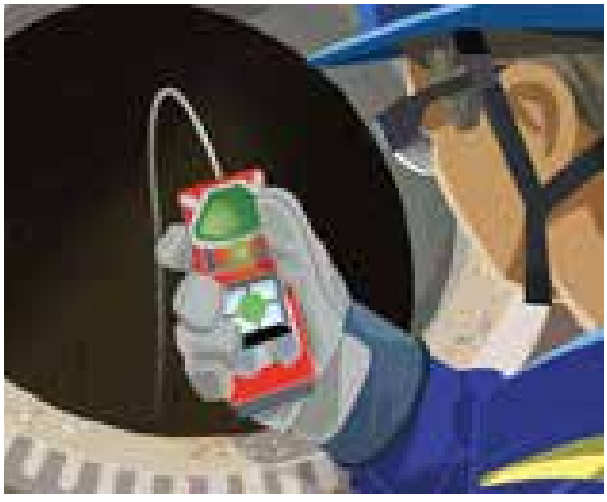


Figure 4-1: Atmospheric Testing

Life Saving Rule
The best practice to ensure a safe atmosphere in a confined space is continuous air monitoring.

VAPOUR DENSITY

Depending on their chemical weights, hazardous gases could be at the top, middle, or bottom of a confined space.

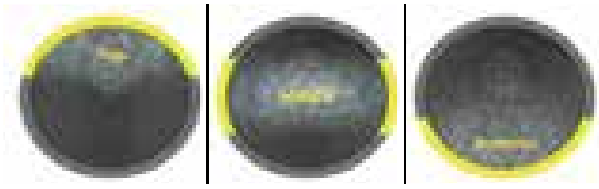


Figure 4-2 Vapour Density—Hazardous Gas Location

Some gases are heavier than air, others are lighter, and some are the same weight.

Figure 4-3 Vapour Density—Hazardous Gas Weight

Therefore, the only safe way to test the atmosphere of a confined space is to sample all levels. If toxic gases, combustible gases, or oxygen deficiency or enrichment are discovered, the confined space must be ventilated or purged and retested before any entry is permitted. When ventilation or purging cannot be accomplished, workers must use supplied air respiratory protection and complete a pre-use inspection if entry is required. In this case, the entry is considered a high hazard, and combustible levels must be below 20% of the LEL by legislative requirements— lower if set by site-specific requirements—for entry to proceed.

How often you retest depends on:

- The outcome of the hazard assessment
- The type of work being performed
- And the likelihood of the atmosphere changing substantially.

Note
Many sites in Alberta have a maximum limit of 10% LEL. The testing frequency may be specified in the company code of practice or site-specific procedures. Check your jurisdictional requirements for atmospheric testing limits.

OXYGEN

Because oxygen is colourless, odourless, and tasteless, you would not be able to detect an oxygen-enriched or oxygen-deficient environment, such as a nitrogen purged vessel.

The normal oxygen level is 21%, and the normal range is between 19.5% and 23%. There are also no psychological effects.

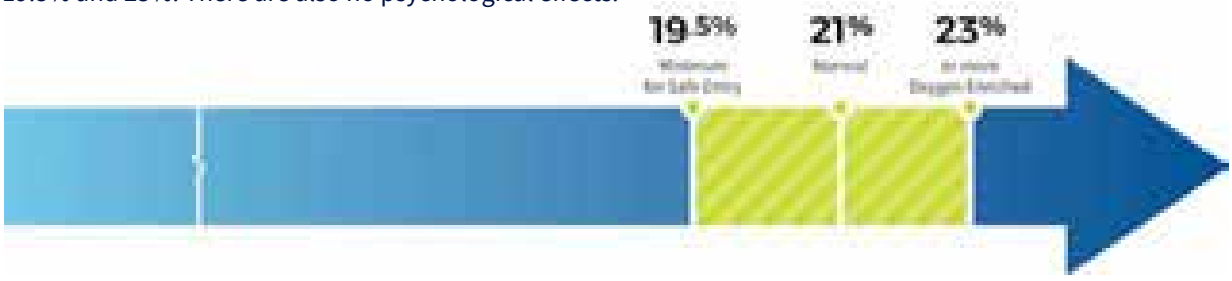


Figure 4-4 Normal Oxygen Range

Oxygen Deficiency

Oxygen deficiency occurs when a concentration of oxygen is less than 19.5% by volume. Oxygen levels at this concentration or less are insufficient to support life and have been the cause of many fatalities in confined space work.

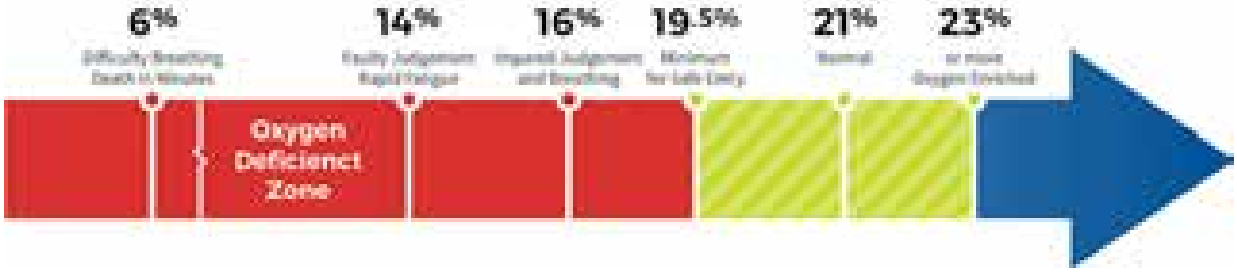


Figure 4-5 Oxygen Deficient Zone

Oxygen Enrichment

Oxygen enrichment occurs when a concentration of oxygen is more than 23% by volume. At these concentrations, the likelihood of explosions or fires increases.

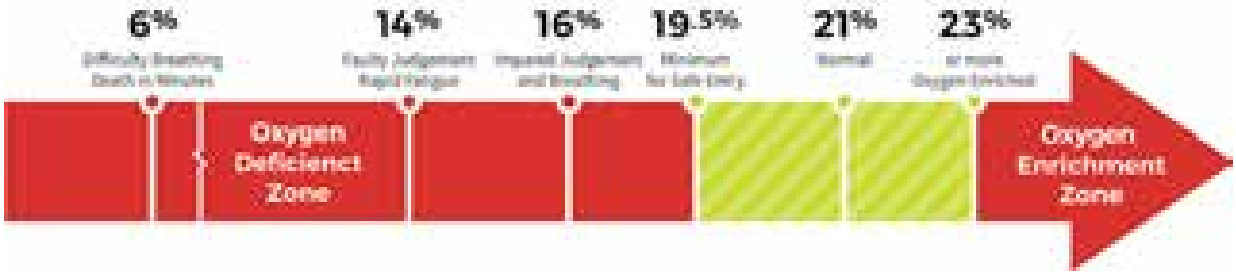


Figure 4-6 Oxygen Enrichment Zone

OXYGEN DEFICIENCY AND OXYGEN ENRICHMENT

What causes oxygen deficiency and oxygen enrichment?

Causes of Oxygen Deficiency

Oxygen deficiency can be caused by:

- Oxygen being displaced by gases such as nitrogen, carbon monoxide and argon, i.e., purging a space with nitrogen and then not ventilating the space
- Oxygen being used up by the combustion of flammable substances used in welding, scraping, and other hot work
- Absorption by grain, soils or biological agents (e.g. bacteria)
- Chemical reactions (such as rusting) that reduce oxygen content.

Causes of Oxygen Enrichment

Oxygen enrichment can be caused by:

- Leakage of equipment because of damage, poor connections or poor maintenance
- Failure to close cylinder valve or oxygen supply stop valve
- Opening valves deliberately or accidentally
- Poor ventilation where oxygen is used
- Excess oxygen in metallurgical processes such as gouging, cutting, scarfing, lancing, etc.
- Venting from cryogenic receptacles
- Venting of oxygen.

Figure 4-7: Cause of Oxygen Deficiency—Welding

Caution
NEVER use pure oxygen to ventilate a confined space.

FLAMMABILITY AND EXPLOSIVITY

For a fire or explosion to occur, the following elements must be present:

- Heat
- Oxygen
- Fuel
- Chemical reaction

Figure 4-8: Fire Tetrahedron

Figure 4-9: Explosion

All gases have an explosive range with an LEL and UEL. When the fuel and air mixture is below the LEL or above the UEL, ignition will not take place.

Figure 4 10 Explosive Range

Note
For example, in Alberta, work can only be performed if the atmosphere tests are below 20% of the LEL. Site-specific requirements may set the value lower, and employers and workers must understand what these requirements are when performing work activities that have the potential for creating an ignition source. Remember that you need to check your jurisdictional and site-specific policies.

TOXIC SUBSTANCES AND ELEMENTS

Toxic substances can be produced from the following sources:

- The process that normally occurs in the confined space
- Work activity in the confined space
- Waste materials in the confined space
- Sources outside of the confined space

Caution
Immediately Dangerous to Life and Health (IDLH) is a condition characterized by an oxygen-deficient atmosphere or an atmospheric concentration of any harmful substance that poses an immediate threat to life or health. Both conditions may cause irreversible immediate or delayed adverse health effects or may interfere with an individual's ability to escape from a dangerous atmosphere.

Figure 4-11: Work activity in the Confined Space

Remember
Gas detectors do not measure the concentration of particulates; this involves sending an air sample to a lab.

Properties of Some Gases and Vapours

Be aware of the toxic elements in this table:

Table 4.3 Toxic Elements

GAS OR VAPOUR	FLAMMABLE	PHYSICAL DESCRIPTION	VAPOUR DENSITY	MAIN DANGER
Argon	No	Colourless, Odourless	1.38	Displacement of oxygen
Carbon Dioxide (CO_2)	No	Colourless, Odourless	1.53	Displacement of oxygen. Toxic.
Carbon Monoxide (CO)	Yes	Colourless, Odourless	0.968	Displacement of oxygen. Toxic.
Chlorine	No	Greenish, yellowish colour, sharp, pungent odour	2.5	Toxic. Severe lung and eye irritant.
Gasoline Vapours	Yes	Colourless, sweet odour	3-4	Fire and explosion.
Acetylene	Yes	Colourless, ether/ garlic odour	0.906	Extremely flammable.
Hydrogen Sulfide (H_2S)	Yes	Colourless, rotten egg odour	1.19	Very toxic. Can cause lung failure.
Methane (CH_4)	Yes	Colourless, Odourless	0.584-0.610	Fire and explosion.
Nitrogen (N_2)	No	Colourless, Odourless	0.725	Displacement of oxygen.
Nitrogen Dioxide (NO_2)	No	Reddish brown colour, pungent odour	0.075	Toxic. Severe lung irritant.
Sulfur Dioxide (SO_2)	No	Colourless, suffocating odour	2.923	Toxic. Severe lung irritant.

Certain industry-related particulates are hazardous and can cause serious health concerns and even death if not controlled properly. Some are even explosive, such as coal or coke dust, if dense enough in the confined space. Some of the common particulates include:

- Asbestos
- Crystalline silica
- Respirable welding fumes and particulates
- Synthetic vitreous fibres
- Glass fibres
- Refractory ceramic fibres
- Rock wool

PURGING, VENTILATION AND INERTING

If atmospheric testing identifies a hazardous atmosphere or an atmosphere that is likely to become hazardous in a confined space, the employer must ensure that the space is purged, ventilated, or both before a worker enters the space.

Purging

Purging occurs by removing contaminants by displacement. Purging is always done first and may be followed with ventilation as per the hazard assessment.

Ventilation

Ventilation is a continuous supply of fresh air by mechanical means. If ventilation fails, there must be a method to alert workers, such as a piece of ribbon hung in the air flow.

Inerting

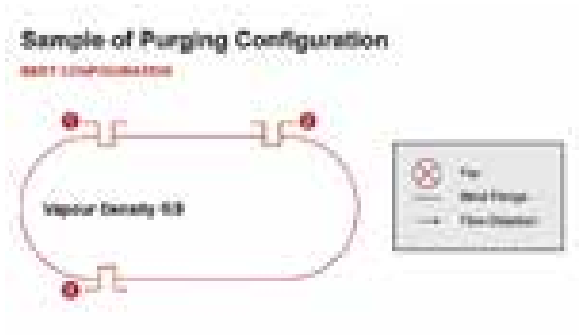
Inerting involves purging oxygen from a confined space using an inert gas, such as nitrogen, carbon dioxide or argon, to remove the hazard of fire or explosion. Nitrogen is most commonly used for inerting in the industrial sector.

Caution
To ensure an additional level of safety, all ignition sources must be controlled so that they cannot trigger a fire or explosion.

ACTIVITY 4.1
IDEAL PURGING SETUP

What is an ideal purging setup? In this purging example, gas that is lighter than air, for example methane, is encountered. How would you set up the purging to remove the residual gas from the lower reaches of the vessel?

In small groups, discuss and select the ideal placement for the fan, blind flange and flow direction. Indicate on the diagram below using the symbols provided. Answer the discussion questions below. Be prepared to discuss why you chose your setup.



DISCUSSION QUESTIONS

- With a vapour density of 0.5 where would the gas accumulate?
- If connection number 1 and 3 are the only ones accessible, where is the best location to install and electric purge fan?
- What is the potential problem by installing a purge fan to the wrong vessel connection?
- How would you correct for this problem?
- In purging this vessel what considerations must be given to the gas being purged?

Caution
In some circumstances, it is absolutely critical that you DO NOT purge with air due to increased explosion hazard. In this case, purging with inert gases is required. In this case, breathing apparatus is required for entry.

Caution
Workers must be trained in the evacuation procedures should the ventilation system or breathing equipment fail and there must be sufficient time to get out of the confined space.

STATIC

Static is an electric charge that cannot move. It is created when two objects or materials that are in contact with each other are separated. If static electricity is not quickly removed, the charge will build up and can produce a spark which can set off an explosion or fire. The danger is greatest when flammable liquids are being poured or transferred.

Static electricity can be produced by:

- Non-polar liquid flowing through a pipe or hose
- Spraying, blending, or mixing
- Transfer of fluids
- Movement and friction between materials
- Movement of dry powdered material through chutes or conveyors
- Movement of non-conductive conveyor belts or drive belts
- Appliances that are plugged into electrical outlets
- Flipping a light switch on or off.

BONDING, GROUNDING, AND HUMIDIFICATION

Bonding, grounding, and humidification are techniques used to prevent sparks.

Bonding

Bonding occurs when there is an electrical connection between two or more conductive containers, and it ensures that the containers have the same electrical charge. Without a difference in charge or 'electrical potential', a spark cannot be created that jumps from one container to another. Bonding may also occur when parts of equipment and containers that are electrically separated (for example, by gaskets or caulking compounds) are connected.

Grounding

A container is grounded when there is an electrical connection between the container and the earth. Grounding quickly drains away the static charge.

Humidification

Humidification can assist in the prevention of static. Keeping relative humidity between 60 and 70% at 21°C may stop paper or layers of cloth and fibres from sticking together. However, high humidity may not prevent the accumulation of static electricity and should not be solely relied upon where there are flammable liquids, gases, or dusts present.

Caution
Bonding does not eliminate the static charge, which is why it is used in combination with grounding—the only way to drain away the static charge.

SHORING

Great potential for worker injury exists at the bottom of an unprotected excavation or trench that has unsupported walls. To reduce the likelihood of being injured by a trench wall collapse, supervisors and workers should use one or more of the following control methods.

Cut Back Method

Depending on the soil consistency, the excavation may have a 1.5m (5ft) vertical wall from the bottom of the trench, with the remaining portion cut back either at 30° or 45°.

Figure 4-12 Cut Back Method

Trench Shields

A trench shield is an engineered piece of equipment designed to withstand a collapse without buckling and used to protect workers performing their duties within a trench.

Figure 4-13 Trench Shield

Shoring Systems

Shoring systems can be either a metal or a wood configuration. Unlike a trench shield, its application is to prevent collapse by actually holding up the wall of a trench.

Figure 4-14 Shoring System

TRAFFIC

Workers in a confined or restricted space must be protected from traffic hazards. Traffic hazards can include idling vehicles parked outside the space that could contaminate it with exhaust (e.g. carbon monoxide), lift trucks that could damage rescue equipment, or moving vehicles around manhole areas. A safe means of entry and exit must be provided for all confined or restricted space workers and rescue personnel, and the space must be free from traffic hazards. For example, secured steps, temporary platforms, and handrails may be suitable in certain circumstances.

Figure 4-15 Traffic Hazard

EXERCISES

1. Pure oxygen is the most effective gas to ventilate a space.

   ☐ True ☐ False

2. Match each method of contaminant removal to its definition. Write the letter of the contaminant removal description next to its definition.

   a. Displacing the contaminated air
   b. Supplying a continuous flow of fresh air by mechanical means
   c. Purging using nitrogen, carbon dioxide, or argon

   ..... Ventilation

   ..... Inerting

   ..... Purging

3. Match each atmospheric test term with its correct definition. Write the corresponding letter next to its definition.

   a. % by volume
   b. OEL
   c. LEL
   d. UEL

   ..... The minimum concentration of fuel in the air required to create an explosion if ignited

   ..... The point at which fuel concentration is so high that there is not enough oxygen to create an explosion

   ..... The maximum concentration of a substance to which a person can be exposed for specific lengths of time

   ..... The concentration of a component as a percentage of the total volume of an area

4. Review the five statements about oxygen deficiency and oxygen enrichment. Select True or False for each statement.

   Oxygen deficiency occurs when a concentration of oxygen is less than 19.5% by volume.

   ☐ True ☐ False

   Oxygen deficiency can often cause explosions or fires.

   ☐ True ☐ False

   Oxygen enrichment occurs when a concentration of oxygen is more than 23% by volume.

   ☐ True ☐ False

   Oxygen deficiency can be caused when oxygen is displaced by gases.

   ☐ True ☐ False

   Oxygen enrichment can be caused by chemical reactions, such as rusting.

   ☐ True ☐ False

5. Depending on their chemical weights, hazardous gases could be at the bottom, middle, or top of a confined space.

   ☐ True ☐ False

1. What element is not required for a fire or explosion to occur?

   a. Heat
   b. Oxygen
   c. Fuel
   d. Nitrogen

7. Match each term with its correct definition. Write the letter of the term next to its definition.

   a. Grounding
   b. Static
   c. Bonding

   ..... An electrical connection between a container and the earth; drains away a static charge

   ..... Ensures an electrical connection between two or more conductive containers have the same electrical charge

   ..... An electrical charge that cannot move; created when two objects or materials in contact with each other are separated

8. Which of the following actions would not produce static electricity in a confined or restricted space?
   a. Spraying, blending, or mixing
   b. Transfer of fluids
   c. Purging a space
   d. Movement of dry powdered material through chutes or conveyors

9. Workers in a confined or restricted space must be protected from traffic hazards. Which of the following are potential traffic hazards for confined spaces?
   a. Idling vehicles placed outside the space
   b. Lift trucks that could damage rescue equipment
   c. Moving vehicles around manhole areas
   d. All of the above

CLASS DISCUSSION

» How often should you retest the atmosphere and why?

» Do you know your testing procedures as outlined in your entry plan? If no, where can you get this information?

NOTES

CHAPTER 5:

Confined Space Classifications

OUTCOME

Describe the three confined space classification levels.

OBJECTIVES

At the end of this chapter, you should be able to:

1. Define the three confined space classification levels.
2. Describe the criteria, controls, and training required for each level.
3. Define the purpose of the permit.
4. Recognize the different entry tags and signs.

INTRODUCTION

Confined spaces have specific requirements that must be met before entry is allowed. These requirements reflect both the relative hazards and the classification level assigned.

CLASSIFICATION LEVELS OVERVIEW

To reflect relative hazards and to ensure a consistent approach, confined space entries have been classified into three levels, each with specific entry requirements or controls. Depending on your workplace and/or work-site, there are various labels that may be used to classify these levels for example:

Table 5.1 Classification Levels

LABEL SAMPLE 1	LABEL SAMPLE 2
Level 1	High hazard
Level 2	Moderate hazard
Level 3	Low hazard

For the purpose of this course, we will label the three levels using Level 1, Level 2 and Level 3.

Figure 5-1 Classification Levels

The classification of entry is based on the conditions present at the time of entry with consideration for potential changes of conditions as identified in the hazard assessment.

Figure 5-2 Confined Space Entrance

Figure 5-3 Level 1 (High Hazard)

Table 5.2 Level 1 (High Hazard)

DEFINITION	A confined space that is Immediately Dangerous to Life or Health (IDLH). This includes, but is not limited to, a confined space characterized by at least one of the following: » Oxygen deficiency » Flammable (explosive) atmosphere » Concentrations of toxic substances
EXAMPLE	A sludge tank with a surrounding dike that has 18.8% oxygen by volume inside the tank and 19.0% LEL of flammable liquid inside the tank. The surrounding area atmosphere inside the dike exceeds the protective limits of air-purifying respiratory equipment.
CRITERIA	A confined space will be considered Level 1 if the entry is either the first or initial entry or any of the following apply: » The hazards in the confined space or in its proximity are either not known or have not been determined. » The hazards in the confined space include one or all of the following: » Oxygen concentration is less than 19.5% or more than 23.0% by volume » Explosive or flammable atmosphere between 10% and 20% of the LEL » The area atmosphere exceeds the protective limits of air-purifier respiratory equipment
CONTROLS	The following controls MUST be put in place for a Level 1 classified area: » An approved hazard assessment » An effective means of communication between the monitor / tending worker and entry workers and the emergency response representative » Supplied breathing air available and worn » Continuous atmospheric testing » All entrants/monitors must be trained to use supplied breathing air equipment » PPE as per the approved hazard assessment » A qualified Confined Space Monitor in attendance at all times » A specific, documented Rescue Plan which has been developed, reviewed and approved by the equipment owner and the Emergency Response Representative » A valid Confined Space Entry Permit » A valid Level One Entry Tag at each entrance » A documented Evacuation Plan » Confined Space signage as per the Level of Entry classification
TRAINING	For Level 1 Confined Space Entry, additional training may be required depending on hazard assessments and/or work specific requirements, such as gas detection, supplied air breathing apparatus (SABA), air purifying respirator, and fall protection.

Caution
Any time a Level 1 entrance is left unattended, it MUST be barricaded physically and a 'DANGER DO NOT ENTER' sign must be hung at the entrance.

Figure 5-4 Level 2 (Moderate Hazard)

Table 5.3 Level 2 (Moderate Hazard)

DEFINITION	A confined space that is not Immediately Dangerous to Life or Health but has the potential for causing injury and illness if preventive measures are not used.
EXAMPLE	A vessel with 21.6% oxygen by volume inside the vessel with 4.5% of the LEL of explosive gas and a concentration of the toxic substance H_2S exceeding 50% of the OEL.
CRITERIA	A confined space will be considered Level 2 if all identified hazards are controlled and one of the following applies: » Oxygen concentration is between 19.5% and 23.0% by volume » Explosive (flammable) atmosphere greater than 1% and less than 10% LEL » Concentration of toxic substances exceeds 50% of the OEL
CONTROLS	The following controls MUST be put in place for a Level 2 classified area: » Approved hazard assessment » Effective means of communication between the monitor / tending worker and entry workers and the emergency response representative » A qualified Confined Space Monitor in attendance at all times » A valid Confined Space Entry Permit » A valid Safe Entry Tag hung at each entrance » A documented Evacuation Plan » A valid Rescue Plan » PPE as per the approved hazard assessment » Continuous atmospheric testing if there is a potential for the atmosphere to change unpredictably » Confined Space signage as per the Level of Entry Classification
TRAINING	For Level 2 Confined Space Entry, additional training may be required depending on hazard assessments and/or work specific requirements, such as gas detection, supplied air breathing apparatus (SABA), air purifying respirator, and fall protection.

Figure 5-5 Level 3 (Low Hazard)

Table 5.4 Level 3 (Low Hazard)

DEFINITION	A confined space in which the potential danger to life or health would not require any special modifications of the work procedure.
EXAMPLE	An excavation for deep services that has a concentration of 21.4% oxygen by volume. The concentration of explosive gases is 0.0% of LEL and unlikely to change, and the airborne concentration of toxic substances is zero as no toxic substances are involved with the scope of work.
CRITERIA	A confined space will be considered Level 3 if all identified hazards are controlled, the potential for change is unlikely, and ALL of the following apply: » Oxygen concentration is between 19.5% and 23.0% by volume » Concentration of explosive gases is less than 1% of the LEL » Airborne concentration of toxic substances is less than 50% of the OEL
CONTROLS	The following controls MUST be put in place for a Level 3 classified area: » Approved hazard assessment » Effective means of communication between a competent worker (if a monitor / tending worker is not required) and entry workers and the emergency response representative » A qualified Confined Space Monitor / tending worker may (based on the hazard assessment) be required » A valid Confined Space Entry Permit » A valid Safe Entry Tag at each entrance » A documented Evacuation Plan » A valid Rescue Plan » PPE as per the approved hazard assessment » Confined Space signage as per the Level of Entry classification
TRAINING	For a Level 3 Confined Space Entry, additional training may be required depending on hazard assessments and/or work specific requirements, such as gas detection, air purifying respirator, and fall protection.

Note
If the hazard assessment determines that a confined space monitor / tending worker is NOT required at the point of entry, a competent worker must be designated to maintain communication with the other workers in a confined space (e.g. co-worker, buddy system). The entry log MUST still be maintained.

CLASSIFICATION SUMMARY

Let's review the main differences between the three classifications. Remember to check your own site-specific code of practice for the classifications determined by your company. Two different classification categories are provided.

Table 5.5 Level Assessment Summary

LEVEL 1 (HIGH HAZARD)	LEVEL 2 (MODERATE HAZARD)	LEVEL 3 (LOW HAZARD)
Approved hazard assessment	Approved hazard assessment	Approved hazard assessment
Effective means of communication (between monitor / tending worker, entry workers, emergency response team, operations)	Effective means of communication (between monitor / tending worker, entry workers, emergency response team, operations)	Effective means of communication between: » A competent worker or monitor / tending worker as determined by the hazard assessment » Entry workers » Emergency response team » Operations
Monitor in attendance at all times	Monitor in attendance at all times	
Level 1 entry tag hung at each entry point	Level 2 entry tag hung at each entry point	Level 3 entry tag hung at each entry point
Documented valid approved rescue/evacuation plan (copy at location)	Documented valid approved rescue/evacuation plan (copy at location)	Documented valid approved rescue/evacuation plan (copy at location)
PPE as per the hazard assessment/site specific requirements	PPE as per the hazard assessment/site specific requirements	PPE as per the hazard assessment/site specific requirements

LEVEL 1 (HIGH HAZARD)	LEVEL 2 (MODERATE HAZARD)	LEVEL 3 (LOW HAZARD)
Documented log of entry operations	Documented log of entry operations	Documented log of entry operations
Continuous atmospheric testing	Continuous atmospheric testing if there is a potential for changes	
Supplied breathing air available and worn (all entrants and monitors must be trained on supplied breathing equipment)		
Level 1 signage "Danger Do Not Enter"	Level 2 signage "Confined Space Monitor / tending worker and Permit Required for Entry"	Level 3 signage "Confined Space Permit Required for Entry"
Note: Any time a Level 1 entrance is left unattended, the entrance must be physically barricaded and a "Danger Do Not Enter" sign displayed across the entrance.	Note: Any time a Level 2 entrance is left unattended, the entrance must be physically barricaded and a "Confined Space Monitor / tending worker and Permit Required for Entry" sign displayed across the entrance.	Note: Any time a Level 3 entrance is left unattended, the entrance must be physically barricaded and a "Confined Space Permit Required for Entry" sign displayed across the entrance.

Table 5.6 Assessment of Hazardous Atmospheres

HIGH-HAZARD ATMOSPHERE	MODERATE-HAZARD ATMOSPHERE	LOW-HAZARD ATMOSPHERE
A high-hazard atmosphere is one where a hazardous atmosphere does exist i.e., a confined space which cannot be ventilated to provide and maintain a safe atmosphere, and in which there now exists or is likely to exist: » A hazardous gas, vapour, dust or fumes, or » Any oxygen content of less than 19.5% or more than 23% This is a type of space that, due to the unique circumstances of the particular space, the atmosphere cannot be purged and/or ventilated adequately to provide a safe breathable atmosphere. It could also be a situation where the atmosphere is completely unknown, or the space compromised by the ambient working environment. Therefore, it is considered to be a High-Hazard atmosphere working space.	A moderate-hazard atmosphere is one where there is the potential for a hazardous atmosphere to exist i.e., a Confined Space which has been purged and ventilated and steps have been taken to provide and maintain a safe atmosphere and there has existed or was likely to have existed: » A hazardous gas, vapour, dust or fumes; or » An unsafe oxygen content less than 19.5% or more than 23% by volume could develop if circumstances change. These types of spaces have been known to have potentially hazardous atmospheres either before or during the work. An example could be a vessel containing a product. After isolation, cleaning, purging or ventilation, the fact it had something hazardous in there to begin with leads to a potential that a hazardous atmosphere could exist if something was done incorrectly or if other equipment fails (example: ventilation fan). Hence, a Moderate-Hazard Atmosphere confined space.	A low-hazard atmosphere is one where a hazardous atmosphere is not likely to exist i.e., a Confined Space in which there does not exist and there is not likely to exist either: » A hazardous gas, vapour, dust or fumes could develop in extreme circumstances but is not anticipated; or » An unsafe oxygen content less than 19.5% or more than 23% by volume could develop if circumstances change. Typically, the risks are more associated with aspects such as the physical configuration of the space, access/egress, etc. An example could be a trench or excavation whereby the largest risk may be related to the structural integrity of the space - therefore a Low-Hazard Atmosphere confined space. Please note this does not mean that all trenches/excavations always have safe atmospheres.

ACTIVITY 5.1

Working in your small groups, read the following 4 scenarios. For each scenario, determine the classification level and what control measures must be used. Be prepared to share with the class. Hint: One of the scenarios is not a confined space.

Scenario 1

You are climbing down a ladder to enter a communication vault to complete an inspection.

Oxygen 20.9%, LEL 0%, OEL 0%

Classification Level: .....

Control measures: .....

Scenario 2

You are installing a sump pump in a chemical warehouse that does customized blending.

Oxygen 20.9%, LEL 7.5%, OEL 25%

Classification Level: .....

Control measures: .....

Scenario 3

You are installing a refrigerant coil in a commercial walk-in fridge. The cooling system has been de-pressurized. The odour of ammonia is still present.

Oxygen 20.9%, LEL 0%, OEL 10%

Classification Level: .....

Control measures: .....

Scenario 4

You are inside a trench 3m deep and trying to locate a leak on a gas main (natural gas). You can hear the leak but can't find it.

Oxygen 19.5%, LEL 12%, OEL 0%

Classification Level: .....

Control measures: .....

PERMIT SYSTEM

The purpose of the permit is to protect the workers and to act as a guideline for the work being completed. A person or persons must not enter a confined space without a valid confined space entry permit.

The employer must establish an entry permit system that includes information such as:

- Date, location, and scope of work
- Verification of emergency plan
- List of workers entering the space and the reason
- Time-frame for work to be completed
- Specifics of work being done in the space
- Safety precautions
- Code of practice requirements

Entry Tags

Before any permit is issued for entry to a Confined Space, an Entry Tag must be fully completed and hung at the entrance to the Confined Space by the equipment owner.

Figure 5-6 Confined Space Entry Tags

Entrance Signs

Whenever an entrance to a confined space is left unattended, three types of signs are used to indicate the status of the space and the requirements for entry.

Table 5.7 Entrance Signs Descriptions

SIGN TYPE	DESCRIPTION/INDICATIONS
	For **Level 1** entries, the "DANGER DO NOT ENTER" sign must be hung at the entrances every time the space is left unattended. This sign overrides all other signs at entrances to confined spaces. When it is in place, no one may enter the space under any circumstances. Note that for **Level 2 and 3** entries, this sign must be hung at the entrance! This is in case the space needs to be evacuated due to an emergency.
	A sign similar to this is used on a **Level 2** space to signify that the space is safe to enter provided that the people authorized to enter have a valid permit to work and there is a Confined Space Monitor/ Tending Worker present at the entrance.
	This sign is used on a **Level 3** entry where a Confined Space Monitor / Tending Worker may not be required and indicates that although there is a Safe Entry Tag, the space can only be entered with a valid permit.

EXERCISES

1. Which of the following characteristics best describe a Level 3-Low Hazard confined space entry?
   a. The concentration of oxygen, toxic substances, and gases is outside the acceptable limits.
   b. The concentration of an explosive gas is above the legal limit; however, there are no toxic substances in the space.
   c. The concentration of oxygen, toxic substances, and explosive gases is within legal limits and all identified hazards are controlled.
   d. All hazards are identified, but conditions are likely to change without notice.

2. A Level 1-High Hazard confined space atmosphere:
   - Has an oxygen level greater than 23.0% or less than 19.5%
   - Has an atmosphere between 10% and 20% of the lower explosive limit
   - Exceeds protective limits of respiratory equipment

   ☐ True ☐ False

3. Match each definition with the applicable confined space entry level. Write the description of the level next to the level classification.
   a. A confined space that is Immediately Dangerous to Life or Health. Confined space characterized by at least one of the following: oxygen deficiency, flammable (explosive) atmosphere, concentrations of toxic substances.
   b. A confined space in which the potential danger to life or health would not require any special modifications of the work procedure.
   c. A confined space that is not Immediately Dangerous to Life or Health but has the potential for causing injury and illness if preventive measures are not used.

   ..... Level 1-High Hazard

   ..... Level 2-Moderate Hazard

   ..... Level 3-Low Hazard

CLASS DISCUSSION

» What type of Classification system is used at your work for confined space entry?

» Is the permit system at your work clearly identified? If not, where can you find this information?

CHAPTER 6:

Emergency Response and Entry Planning

OUTCOME

Explain emergency response requirements, options, and entry planning for confined or restricted space entry.

OBJECTIVES

At the end of this chapter, you should be able to:

1. Describe the two types of emergency response plans (ERPs) and list their requirements.
2. Select the appropriate rescue option for removal of entrants from a confined space.
3. Describe the elements of an entry program to ensure a safe and efficient confined or restricted space entry.
4. Explain the importance of retaining records associated with confined or restricted space entry.

INTRODUCTION

Employers must have an effective emergency response plan in place, including the emergency procedures to be followed in case of an incident or other emergency. Planning is an effective method of organizing activities at a confined or restricted space worksite, ensuring everyone is following the same guidelines.

THE EMERGENCY RESPONSE PLAN

Have you ever been involved in an emergency? Did you know what to do? If the emergency was at work, was there an effective plan in place to ensure your safety?

Before entering a confined or restricted space, planning must take place to ensure safe entry, and to establish procedures in the event of an emergency or rescue.

As you learned in the video, just relying on calling 911 is not sufficient. Employers must ensure that an emergency response plan, or ERP, is developed specifically for any confined space work. The ERP must reflect legislative and site-specific requirements and workers and monitors/tending workers must be capable of initiating and activating the ERP.

Types of Emergency Response Plans

There are two types of emergency response plans.

Specific Rescue

A specific, documented rescue plan that has been developed, reviewed, and approved by the equipment owner and the Emergency Response representative. This type of plan is specifically for Level 1(High Hazard) confined space entries.

Valid Rescue

A plan developed specific to site conditions that is general in nature and can be applicable anywhere on site. This type of plan is specifically for Levels 2 (Moderate Hazard) and 3 (Low Hazard) confined space entries, and for restricted space applications.

ERP Five Points

An emergency response plan must address the following points:

1. Type of rescue equipment
2. Location of rescue equipment
3. Rescue personnel requirements
4. Means of communication
5. Execution of rescue

ERP Considerations

An effective ERP must answer these questions:

- What are the potential emergencies?
- How and who are you to contact in an event of an emergency?
- What are the procedures for dealing with potential emergencies and evacuations?
- Do emergency workers have the appropriate training?
- What first aid services might be required?
- Who are the designated rescue and evacuation workers?
- What are the locations and operational procedures for emergency equipment?
- What types of circumstances would require the confined space to be evacuated?

If any of the above questions reveal deficiencies, the employer must re-evaluate the plan and make corrections as needed before entry can proceed.

RESCUE OPTIONS

Should an emergency occur, there are four rescue options:

1. Self
2. External (Non-Entry)
3. Entry
4. Immediate Danger to Life or Health (IDLH)

Table 6.1 Rescue Options

RESCUE TYPE	DEFINITION	WHEN TO USE
SELF	The entrant is physically and mentally capable of exiting the confined space without assistance.	Use when there is early notification that a control system that is in place for the safety of entrants has been compromised, such as a gas detector alarm or ventilation alarm activates, signs or symptoms of exposure to a hazard are recognized, or an evacuation of the confined space has been ordered.
EXTERNAL (NON-ENTRY)	Rescuers do not enter the confined space, but instead use a retrieval system to extract the entrant.	Use when the entrant is unable to self-rescue. The path out of the space is large enough to accommodate the entrant and is straight up or straight out horizontally (i.e. there are no pathway or exit doorway obstructions). » The retrieval system is set up prior to entry. » The entrant is either tethered to the retrieval line or there is a system to attach the entrant to the line from the outside.
ENTRY	Rescuers enter the confined space to retrieve the entrant.	Necessary if the entrant is unable to self-rescue and one or more of the following conditions exist: » There is an uneven floor surface. » The entrant is injured and moving the entrant without stabilizing his or her injuries could produce complications. » The entrant is injured and will have to be extricated more than 3 meters or 9.8 ft horizontally. » The pathway is obstructed (e.g. by physical barriers, pipes, cables, liquids, sludge). » The entrant is untethered.
IDLH ENTRY RESCUE	The emergency response team has to enter a space to rescue an entrant exposed to an IDLH or unknown atmosphere, or to another immediately dangerous condition.	Time is of the essence in this situation. This is the only rescue scenario where the principle of “life over limb” is allowed.

Figure 6-1 External (Non-entry) Rescue

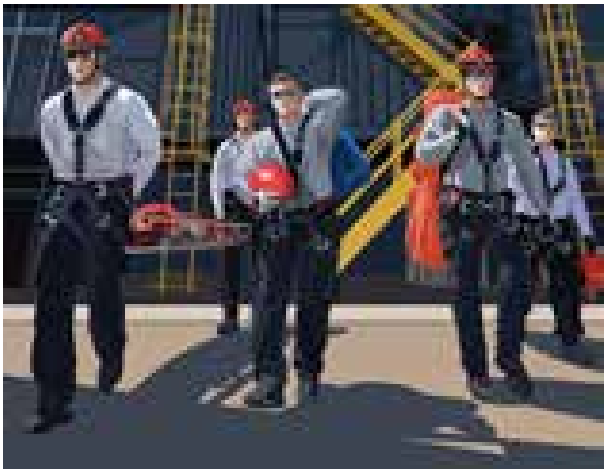


Figure 6-2 Entry Rescue

Figure 6-3 IDLH Rescue

Remember
The method to use should be discussed at the pre-job meeting. Employers should consider completing rescue drills to ensure ERP can be activated appropriately.

911

In the case of rescue involving workers in confined spaces and workers suspended in the air after a fall, calling 911 alone and waiting for the arrival of emergency response personnel is an insufficient emergency response process. The employer must have some basic level of on-site rescue capability if emergency response personnel are delayed or unable to attend the scene.

Caution
It's important to note the emergency contact number may not be 911. For example, while working at some Oilsands sites do not dial 911 from your cell phone, it will misdirect your call to the Wood Buffalo Regional Municipality Emergency Services, not the site's Emergency Response.

EQUIPMENT REQUIREMENTS

Equipment requirements will depend on the hazards in the confined space and the relevant plan.

Examples of safety equipment include harnesses and lifelines, hoist/retrieval systems, self-contained breathing apparatuses, airline respirators, and other personal protective equipment.

RESCUE PERSONNEL

Rescue personnel must be available on site and ready to immediately implement the written on-site rescue procedures should a rescue be required.

The physical location of the team depends on the level of hazard identified through the hazard assessment, and on site-specific procedures. For entries identified as IDLH, the emergency response team should be present and ready to respond immediately.

Caution

Should the scope of work change prior to or during a confined space entry operation, all work must stop until the emergency response plan is reviewed with the emergency response team leader to verify if the scope change will affect the plan.

ENTRY PLANNING

Before entering a confined or restricted space, planning must take place to ensure a safe entry, and to establish procedures in the event of an emergency or rescue. A confined space entry program provides a guideline for pre-entry planning and post-entry inspection.

An effective entry program consists of four main steps:

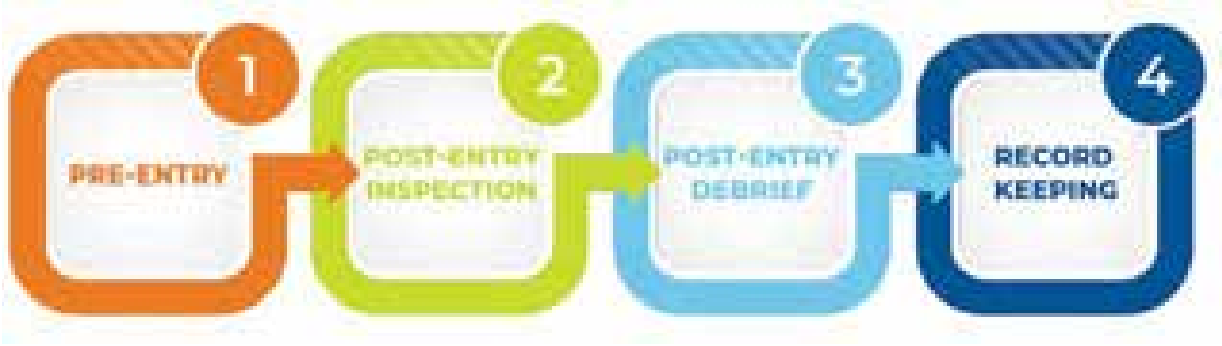


Figure 6-4 Entry Planning

Pre-entry

To ensure a safe and efficient confined or restricted space entry, pre-entry planning is vital. The amount of time that should be spent on this task is proportional to the complexity of the confined or restricted space and the work to be done inside of it.

The use of a checklist is strongly recommended to ensure all areas of risk are addressed. Pre-entry checklists are typically site specific as each site has unique considerations. Employers are encouraged to develop their own checklists while reviewing site specific requirements.

Every worker involved with the confined or restricted space entry, including a representative of the rescue team, must attend a pre-job meeting.

Post-entry Inspection

Upon completion of the job, an inspection must be performed to ensure that all work was done as planned.

The following checks must be performed when restoring a confined or restricted space to its operational mode:

» Are all personnel out of the confined space and accounted for?
» Have isolation devices been removed, and pipes been restored to their original positions?
» Have all lockouts been removed?
» Have all safe entry tags and signs been removed?
» Has all equipment and waste been removed from the work area?
» Has all specialized PPE and rescue equipment been cleaned, post-inspected and stored?
» Have all entry permits been signed out and filed properly?
» Have other applicable areas of the facility been notified that the work in the confined space is complete and operations are ready to be resumed?

Post-entry Debrief

The final step of each confined space entry is a post-entry meeting that should be attended by everyone involved in the entry and work. The purpose of the meeting is to review the confined space entry plan.

During the post-entry debrief, the following questions should be answered:

» Did the plan include enough detail?
» Were any unexpected hazards encountered?
» Are revisions needed in the Code of Practice, Work Methods or Safe Work Practices that would assist in the next confined space entry?
» Is additional training of workers needed?
» Is additional equipment needed?

Record Keeping

After the post-entry debrief, the proper documentation must be retained as per legislation and site-specific policies. Records must be retained for not less than:

» One year if no incident or unplanned event occurred during the entry; or
» Two years if an incident or unplanned event occurred during the entry.
» Some of the records that must be retained include:
  - Checklists
  - Job safety analyses
  - FLHAs
  - Entry permits
  - Safe entry tags
  - Entry/exit logs
  - Pre-job meeting (scope of work)
  - Isolation procedure
  - Hazardous energy isolation list
  - Copy of personal training records
  - PPE requirements
  - Communication system used
  - Emergency Response Plan
  - Hazard assessments
  - Testing procedures and records

ACTIVITY 6.1
IDENTIFY THE TYPE OF RESCUE

For each scenario, determine the type of rescue required.

Darlene is working in a confined space. An alarm is activated, and she must evacuate.

Rescue type:

Wayne has twisted his ankle while working in a confined space and he needs help to exit. His team uses a pulley to lift him out.

Rescue type:

Sue goes into the confined space to help Wayne.

Rescue type:

Bruce is working in a confined space and has a malfunction with his PPE and loses consciousness. The team doesn't know why he is not responding to their communication.

Rescue type:

EXERCISES

1. What are the five key points that an ERP must address?

---

2. During a confined space entry, the workers had to be evacuated due to an unsafe environment. Jill and Sam have conducted a post-entry debrief and are responsible for the proper documentation. How long do the documents need to be kept?
   a. 1 year
   b. 2 years
   c. 3 years
   d. 5 years

3. Every worker involved with the confined or restricted space entry, including a representative of the rescue team, must attend a pre-job meeting.
   ☐ True ☐ False

CLASS DISCUSSION

» What are some things to consider when assessing a situation prior to commencing a rescue?

» How can you practice and maintain your rescue and other skills required to respond to an emergency safely?

ACTIVITY 6.2

Working in small groups, read the case study below. Using your manual as a guide and the questions below, identify the type of space, entry classification, hazards present, and requirements for testing, controls, entry planning and emergency response. Be prepared to contribute to a class discussion.

This is an 800,000-litre heated water storage tank for a small hamlet in central Alberta. The tank is constructed of carbon steel, with external insulation, and has been in continuous service for 17 years. The building to the right of the tank houses a diesel engine-drive fire pump that will automatically start if a fire hydrant is opened. The tank is being opened for cleaning, application of an epoxy coating, inspection and repairs. When the tank was being drained, the 150mm (6") drain pipe became clogged, leaving 1.5 metres (5 feet) of water in the tank. The 500 mm (24") man-way on the side of the tank cannot be used due to the water level. The only other access point is a 500 mm (24") roof hatch used for routine visual inspections. There is no internal ladder, so a worker must be lowered 10 metres (30 feet) into the tank by a hand-operated crank hanging off a tripod to clear the obstruction so the tank can be drained.

Questions

1. Is the storage tank a confined space? If yes, what level of entry best describes it?

2. What hazards or potential hazards exist in this situation?

3. What do you need to do to isolate this space?

4. Do you need to ventilate the space?

5. What information do you need about the atmosphere in the tank?

6. What atmospheric conditions would you consider acceptable for entry?

7. What type of Personal Protective Equipment would you use?

8. Do you need an emergency response plan? If so, what things would you consider for this water tank entry?

NOTES

APPENDICES

APPENDIX 1

% BY VOLUME (OR PERCENT OF VOLUME)	The concentration of a component as a percentage of the total volume of an area.
ADMINISTRATIVE CONTROLS	Administrative controls do not remove a hazard but limit workers exposure to the hazard and rely on human behaviour to be activated and effective. This includes rules, procedures, and training to ensure an activity is completed in as safe and efficient a manner as possible. It also includes signs and other devices that notify workers of hazards.
BLANKING OR BLINDING	Blanking or blinding is the introduction of a solid plate at the flange connection of any piping system. The blank or blind material must be compatible with the product in the piping system, and it must be capable of withstanding any pressures.
BONDING	Bonding occurs when there is an electrical connection between two or more conductive containers, and it ensures that the containers have the same electrical charge. Without a difference in charge or electrical potential, a spark cannot be created that jumps from one container to another. Bonding may also occur when parts of equipment and containers that are electrically separated (for example, by gaskets or caulking compounds) are connected.
BREATHING ZONE	The breathing zone is a 60 centimetre, or two-foot, diameter half-sphere around your head and shoulders. It contains the atmosphere that you are most likely to inhale.
CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS	The Canadian Association of Petroleum Producers (CAPP) represents companies, large and small, that explore for, develop, and produce natural gas and crude oil throughout Canada. CAPP developed a guideline of recommendations to assist companies in the development of a code of practice, where required. This code of practice provides a practical guide to achieving the standards of worker health and safety required under Canadian Federal and Provincial Occupational Health and Safety (OHS) Regulations.
CODE OF PRACTICE	A Code of Practice describes the procedures to follow that allow workers to perform work in a confined space safely. It also requires that workers affected by its procedures be familiar with those procedures before working in the confined space. The Code of Practice must be maintained and periodically reviewed to ensure that its procedures are up-to-date and that it continues to reflect the company's work activities.
COMPLEX GROUP PROCESS	A procedure-based group lockout process that is implemented when the individual or group processes are not reasonably practicable to secure energy-isolating devices. An example of a complex group process would be a plant turnaround or a pipeline system shutdown.

CONFINED SPACE	A confined space is an enclosed or partially enclosed space, not designated or intended for continuous human occupancy, that has a restricted or impeded means of entry or exit because of its construction and may become hazardous to a worker entering it because of atmospheric hazards, potential hazards in the space or hazards associated with the task.
CONFINED SPACE ENTRY MONITOR / TENDING WORKER	An individual who is stationed outside the confined space and monitors the entrants. The Confined Space Entry Monitor / Tending Worker's primary function is to protect the entrants in the confined space. To do this the they must have a good understanding of confined space entry hazards and procedures, and proficiently performing a variety of duties.
CUT BACK METHOD	Depending on the soil consistency, the excavation may have a 1.5m (5ft) vertical wall from the bottom of the trench, with the remaining portion cut back either at 30° or 45°.
DOUBLE BLOCK AND BLEED	Double block and bleed is a method used to isolate a confined space from a line, duct, or pipe. This method provides a primary blocking seal and a second back-up seal with an operable bleed off between the two seals.
ENGINEERING CONTROL	An engineering control requires a physical change to the workplace. This can be accomplished by enclosing or isolating the hazard, or it can be accomplished by careful design of processes, facilities, and the work environment.
ENTRY RESCUE TYPE	Rescuers enter the confined space to retrieve the entrant.
EXTERNAL (NON-ENTRY) RESCUE TYPE	Rescuers do not enter the confined space, but instead use a retrieval system to extract the entrant.
GROUNDING	A container is grounded when there is an electrical connection between the container and the earth. Grounding quickly drains away the static charge.
GROUP LOCKOUT	An isolation approach involving multiple workers, or when multiple energy isolating devices must be secured.
HUMIDIFICATION	Humidification can assist in the prevention of static. Keeping relative humidity between 60 and 70% at 21°C may stop paper or layers of cloth and fibres from sticking together. However, high humidity may not prevent the accumulation of static electricity and should not be solely relied upon where there are flammable liquids, gases, or dusts present.
IMMEDIATE DANGER TO LIFE OR HEALTH (IDLH) RESCUE	The emergency response team has to enter a space to rescue an entrant exposed to an IDLH or unknown atmosphere, or to another immediately dangerous condition.
IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH)	A condition characterized by an oxygen-deficient atmosphere or an atmospheric concentration of any harmful substance that poses an immediate threat to life or health. Both conditions may cause irreversible immediate or delayed adverse health effects or may interfere with an individual's ability to escape from a dangerous atmosphere.

INDIVIDUAL LOCKOUT	An isolation approach where each worker involved must attach his or her own personal lockable securing device.
INERTING	Inerting is a special form of purging and ventilating. It involves purging oxygen from a confined space using an inert gas, such as nitrogen, carbon dioxide or argon, to remove the hazard of fire or explosion. Nitrogen is most commonly used for inerting in the industrial sector.
LEVEL 1/HIGH-HAZARD CONFINED SPACE	"A confined space that is Immediately Dangerous to Life or Health (IDLH). This includes, but is not limited to, a confined space characterized by at least one of the following: ·oxygen deficiency ·flammable (explosive) atmosphere ·concentrations of toxic substances."
LEVEL 2/MODERATE-HAZARD CONFINED SPACE	A confined space that is not Immediately Dangerous to Life or Health but has the potential for causing injury and illness if preventive measures are not used.
LEVEL 3/LOW-HAZARD CONFINED SPACE	A confined space in which the potential danger to life or health would not require any special modifications of the work procedure.
LOWER EXPLOSIVE LIMIT (LEL)	The minimum concentration of fuel in the air required to create an explosion if ignited.
OCCUPATIONAL EXPOSURE LIMIT (OEL)	The maximum concentration of a substance to which a person can be exposed for specific lengths of time as defined by the OH&S Act, Regulation and Codes.
OXYGEN DEFICIENCY	Oxygen deficiency occurs when a concentration of oxygen is less than 19.5% by volume. Oxygen levels at this concentration or less are insufficient to support life and have been the cause of many fatalities in confined space work.
OXYGEN ENRICHMENT	Oxygen enrichment occurs when a concentration of oxygen is more than 23% by volume. At these concentrations, the likelihood of explosions or fires increases.
PERSONAL PROTECTIVE EQUIPMENT (PPE)	Equipment worn to protect workers against hazards. PPE includes items such as gloves, boots, helmets, and reflective clothing.
POST ENTRY DEBRIEF	The final step of each confined space entry is a post-entry meeting that should be attended by everyone involved in the entry and work. The purpose of the meeting is to review the confined space entry plan.
POST ENTRY INSPECTION	Upon completion of the job, an inspection must be performed to ensure that all work was done as planned.
PURGING	Purging occurs by removing contaminants by displacement. Purging is always done first and may be followed with ventilation as per the hazard assessment.
RESTRICTED SPACE	A restricted space is an enclosed or partially enclosed space that is not intended for continuous human occupancy. Restricted spaces have limited means of entry and exit which can make escape or rescue difficult.
SELF RESCUE	The entrant is physically and mentally capable of exiting the confined space without assistance.

SHORING SYSTEM	Shoring systems can be either a metal or a wood configuration. Unlike a trench shield, its application is to prevent collapse by actually holding up the wall of a trench.
SPECIFIC RESCUE PLAN	A specific, documented rescue plan that has been developed, reviewed, and approved by the equipment owner and the Emergency Response representative. This type of plan is specifically for Level 1/high-hazard confined space entries.
STATIC	Static is an electric charge that cannot move. It is created when two objects or materials that are in contact with each other are separated. If static electricity is not quickly removed, the charge will build up and can produce a spark which can set off an explosion or fire.
SUBSTITUTION	Substitution is replacing a hazard or work process with a less hazardous one.
TRENCH SHIELD	A trench shield is an engineered piece of equipment designed to withstand a collapse without buckling and used to protect workers performing their duties within a trench.
UPPER EXPLOSIVE LIMIT (UEL)	The point at which fuel concentration is so high that there is not enough oxygen to create an explosion.
VALID RESCUE PLAN	A plan developed specific to site conditions that is general in nature and can be applicable anywhere on site. This type of plan is specifically for Levels 2/Moderate-hazard and 3/Low-hazard confined space entries, and for restricted space applications.
VENTILATION	Ventilation is a continuous supply of fresh air by mechanical means. If ventilation fails, there must be a method to alert workers, such as a piece of ribbon hung in the air flow.

LIFE SAVING RULES

CONFINED SPACE

Obtain authorization before entering a confined space

- I confirm energy sources are isolated
- I confirm the atmosphere has been tested and is monitored
- I check and use my breathing apparatus when required
- I confirm there is an attendant standing by
- I confirm a rescue plan is in place
- I obtain authorization to enter

WORKING AT HEIGHT

Protect yourself against a fall when working at height

- I inspect my fall protection equipment before use
- I secure tools and work materials to prevent dropped objects
- I tie off 100% to approved anchor points while outside a protected area

WORK AUTHORIZATION

Work with a valid permit when required

- I have confirmed if a permit is required
- I am authorized to perform the work
- I understand the permit
- I have confirmed that hazards are controlled and it is safe to start
- I stop and reassess if conditions change

ENERGY ISOLATION

Verify isolation and zero energy before work begins

- I have identified all energy sources
- I confirm that hazardous energy sources have been isolated, locked, and tagged
- I have checked there is zero energy and tested for residual or stored energy

LINE OF FIRE

Keep yourself and others out of the line of fire

- I position myself to avoid:
  - Moving objects
  - Vehicles
  - Pressure releases
  - Dropped objects
- I establish and obey barriers and exclusion zones
- I take action to secure loose objects and report potential dropped objects

BYPASSING SAFETY CONTROLS

Obtain authorization before overriding or disabling safety controls

- I understand and use safety-critical equipment and procedures which apply to my task
- I obtain authorization before:
  - Disabling or overriding safety equipment
  - Deviating from procedures
  - Crossing a barrier

DRIVING

Follow safe driving rules

- I always wear a seatbelt
- I do not exceed the speed limit, and reduce my speed for road conditions
- I do not use phones or operate devices while driving
- I am fit, rested and fully alert while driving
- I follow journey management requirements

HOT WORK

Control flammables and ignition sources

- I identify and control ignition sources
- Before starting any hot work:
  - I confirm flammable material has been removed or isolated
  - I obtain authorization
- Before starting hot work in a hazardous area I confirm:
  - A gas test has been completed
  - Gas will be monitored continually

SAFE MECHANICAL LIFTING

Plan lifting operations and control the area

- I confirm that the equipment and load have been inspected and are fit for purpose
- I only operate equipment that I am qualified to use
- I establish and obey barriers and exclusion zones
- I never walk under a suspended load

FIT FOR DUTY

Be in a state to perform work safely

- I will be physically and mentally in a state to perform my assigned duties
- I commit to not being under the influence of alcohol or drugs
- I will inform a supervisor immediately if I or a co-worker may be unfit for work

ENERGY SAFETY CANADA

customerservice@energysafetycanada.com
1 800 667 5557

EnergySafetyCanada.com