

Confined Space

Trainee Handout

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# Introduction

This manual was developed to aid workers in understanding the regulations and requirements with regards to their responsibilities with working in and around confined spaces.

**This manual should never be used to replace regulatory rules or requirements which will change periodically.**

“Confined Spaces” have a significant potential to become deadly work areas that result in numerous industrial injuries and fatalities every year. It is rare to read about a confined space accident that results in only one injury or fatality and more often than not a confined space emergency results in multiple injured persons or worse fatalities.

Workers are killed every year in confined spaces having never heard the term “Confined Space”.

Confined spaces are not always deadly spaces, in some instances workers routinely work within confined spaces, they become complacent over time and eventually something changes that is no longer assessed and that one time change leads to a fatality.

A good confined space program should aim for providing a safe working area 100% of the time. With a proper confined space safety program which includes a hazard assessment process, permit system, energy isolation program, atmospheric monitoring requirements, ventilation requirements, proper PPE requirements and rescue planning we can reduce the risk to the worker and keep everyone safe.

## Training Requirements

An employer must ensure that a person takes and successfully completes training on confined space entry before participating as part of the entry team.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Nova Scotia** | **Newfoundland** | | **Federal/Maritime** | **Offshore Petroleum Board** |
| Training | Recertification requirement | | | | |
| Entrant | 2 years | 3 Years | Not regulated | | 3 years |
| Safety Attendant | 2 years | 3 Years | Not regulated | | 3 years |
| Rescue Team | 1 Year | Not regulated | Not regulated | | Not regulated |

# Regulatory Awareness

## Canadian Occupational Health and Safety Jurisdictions

There are many jurisdictions for OHS within Canada. It is one of the most complex and confusing systems in the world when we look at OHS regulatory requirements. We have 17 different jurisdictions within Canada and depending on where you work or who you are working for will determine the jurisdiction you must follow.

Canadian Occupational Health and Safety – COSH

Maritime Occupational Health and Safety – MOSH

Petroleum Board Occupational Health and Safety – POSH (x2 – C-NLOPB and C-NSOPB)

Provincial/Territory Occupational Health and Safety (13 provinces and territories)

The COSH is applicable to less than 10% of Canadians. Federal government employees, civilian employees of DND and anyone else required to work in or on a federal designated work site must follow the COSH requirements.

The MOSH is applicable to Canadian flagged vessels operating in Canadian waters and is applied as a component of the Canadian Shipping Act. It is enforced by Transport Canada.

The POSH is controlled by the two offshore petroleum boards located in Nova Scotia and Newfoundland and is required to be followed by any one working within the oil and gas industry on an offshore platform or vessel.

## Company Safe Work Practices

Within Canada there seems to be a lot of grey area with regards to which regulation or requirement we are legally responsible for implementing in our workplace. Ideally if you have to work inter-jurisdictionally it would be advisable to take the most stringent regulations and implement them into your company’s safe work procedure, thus allowing you to work in all jurisdictions using one safe work procedure and avoiding confusion and errors amongst your work team.

## Canadian Occupational Health and Safety Standards / Guidelines

Within Canada most (if not all) jurisdictions require us to follow some or all of the standards and guidelines listed below:

Canadian Standards Association (CSA);

* Guidance for manufactures on construction and testing of equipment used within the work place;
* CSA Z1006 – Voluntary Standard for managing confined space entry;

Manufacture usage guidelines;

* Regulations require us to use all equipment in accordance to the manufacture recommendations;
  + - When was the last time you inspected your CSA work boots?

National Institute for Occupational Safety and Health (NIOSH);

* Respiratory protection for industrial respirators and SCBAs follow NIOSH guidelines;

American Conference of Governmental Industrial Hygienists (ACGIH);

* Toxic exposure levels follow ACGIH limitations;

National Fire Protection Agency (NFPA);

* Regulate firefighting and rescue equipment ; and
* Standardize training requirements for rescue.

## Confined Space Provincial Regulations

Each province and territory within Canada has their own unique version of regulations and requirements with regards to occupational health and safety including confined space entry.

## CSA Z1006-16 Management of Work in Confined Spaces

This Standard is intended for voluntary application in Canadian workplaces.

It is designed to assist employers who are looking at developing their own confined space program;

It provides an overview of the required components for creating and maintaining an effective confined space program;

It is to be used with related occupational or technical standards as required by jurisdictional regulations;

Is intended to be referenced by other standards as the primary set of requirements for health and safety management of work in confined spaces; and

Guidelines within the standard are based on industry best practices and may be applied to almost any workplace.

**Although the standard is based on industry best practices several discrepancies exist between it and the regulatory requirements for most jurisdictions in Atlantic Canada. If using the CSA standard ensure you compare it to your jurisdictional requirements to confirm regulatory compliance.**

# Confined Space - Introduction

## What is a confined space?

Generally speaking, a confined space is an enclosed or partially enclosed space that:

Is not designed or intended for human occupancy;

Has a restricted access or egress;

Has known or potential hazards due to one or more of the following factors:

* Its design, construction, location or atmosphere;
* The materials or substances in it;
* Work activities being carried out in it, or the; and
* Mechanical, process and safety hazards present.

To classify a space as a “confined space” all four parts of the definition must exist, if you remove a component of the definition the space should no longer be classified as a confined space and should instead be considered a hazardous work space that requires some hazard mitigation but less than that required by a 100% confined space.



Confined spaces exist all around us. All most every workspace and job site has potential for confined spaces. Examples of confined spaces include silos, vats, hoppers, utility vaults, tanks, sewers, pipes, access shafts, truck or rail tank cars, aircraft wings, boilers, manholes, manure pits and storage bins. Ditches and trenches may also be a confined space when access or egress is limited.

Confined spaces are not always small and some are larger than the average normal work site (oil storage tanks). Confined spaces are not only below ground but may in fact be over head depending on the location and access points.

“Blue sky” confined spaces exist where the top is open to the sky. Take a cistern pit on a farm for example: It is open to the sky (partially enclosed), has restricted access and egress (ladder is required for access), not intended for us to live within the cistern (not intended for human occupancy), and is used for storage of animal waste (known or potential hazards due to the decomposing organic matter – low O2, methane, H2S may exist). Every year we hear about a worker or child on a farm fatally injured while working in a cistern or other waste pit.

# Confined Space Safety Program

To manage the risks associated with working in confined spaces, a confined space safety program shall be developed and implemented by employers.

The confined space safety program provides workers and supervisors with necessary information require to safely enter and work in confined spaces. A comprehensive safety program including all the necessary components can aid workers and supervisors in identifying hazards associated within confined spaces and provide them with guidance on how to safely mitigate the hazards.

#### A confined space program should include the following items:

Description of responsibilities of each worker or supervisor;

Advice on how to identify confined spaces;

Identification and assessment processes for potential hazards;

Mitigation control methods:

* Atmospheric monitoring program;
* Ventilation program;
* Cleaning and purging requirements;
* PPE requirements;
* Energy Isolation program (lock out-Tag out)

Training program for all the workers:

* Entrants;
* Safety Attendants;
* Supervisors;
* Emergency Team members (if required);
* Recertification program for all workers;

Entry permit system;

Emergency plan and response system;

Program review; and

Record and documentation control program.

# Entry Permit System

An Entry Permit is an administrative tool used to document the completion of a hazard assessment for each confined space entry. The entry permit is a mandatory requirement before entering a confined space.

Completion of the entry permit should normally be assigned to someone fully trained and experienced in the confined space work that is required. Supervisors should review the permit prior to the job commencement to ensure it is completed correctly.

There is no cookie cutter solution to designing a confined space permit. Each employer is responsible for developing their own permit system. As guidance for what is required within their operations jurisdiction OHS regulations should be consulted. As a general rule the permit should contain the following information:

The length of time the permit is valid for

* Normally this is the length of the normal work shift;
  + - 8 to 12 hours is the normal length of a work shift;
* Some jurisdictions allow the permit to be opened for a maximum of 24 hours after atmospheric testing (COSH/MOSH);
  + - Some companies allow a permit to extend for up to 7 days, these companies normally have more stringent atmospheric monitoring requirements and re-test the space at regular intervals to meet legal regulatory requirements;

The name(s) of the worker(s) that are authorized to enter the confined space;

The name(s) of the attendant(s) (safety watch) and/or supervisor;

The location and description of the confined space;

The work that is to be done in the confined space;

* Some jurisdictions require you to list the work which cannot be done during the entry, i.e. hot work;

Known and potential hazards;

The date and time of entry into the confined space;

Atmospheric testing results;

Date monitoring equipment was last calibrated;

Hazard control measures

Means of communication between the entrant and the attendant;

Emergency plan; and

Authorization signature by the supervisor certifying that the space has been properly evaluated, prepared, and it is safe for entry and work

The entry permit is normally laid out following the company’s safe work practice, ideally it should be a checklist of the requirements as identified in the safe work practice.

The entry permit **shall** be posted at the entrance to the confined space and remain so until the work is completed.

The entry permit is a signed legal document and must be retained by the employer for at least 12 months.

See appendix A for an example of an entry permit.

# Hazards

Many workers are injured and killed each year while working in and around confined spaces. An estimated 60% of the fatalities/injuries have been would-be rescuers who rushed into a space to attempt a rescue and became a casualty as a result.

To effectively control the risks associated with working in a confined space, a Confined Space Hazard Assessment and Control Program should be implemented for your workplace. Before putting together this program, make sure to review the specific regulations that apply to your workplace. All jurisdictions within Canada have regulations dealing with confined space entry. The regulations can vary slightly from jurisdiction to jurisdiction.

A confined space can be more hazardous than regular workspaces for many reasons and can often be unpredictable, this unpredictability is why the hazard assessment is extremely important and should be completed for each and every entry.

Many factors need to be evaluated when looking for hazards in a confined space and there is smaller margin for error and potential hazards can have more serious consequences. The conditions in a confined space may be extremely hazardous and conditions may be life threatening under a combination of circumstances.

If the confined space cannot be made safe for the worker by taking precautions then workers should NOT enter the confined space until it is made safe to enter by additional means.

## Confined Space Hazards

All hazards found in a regular workspace can also be found in a confined space. However, they can be more hazardous within a confined space.

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### Some hazardous conditions include:

The entrance/exit might not allow the worker to get out in time should there be a flood or collapse of free-flowing solid;

Self-rescue by the worker is more difficult;

Rescue of the victim is more complicated;

The interior configuration of the confined space often does not allow easy movement of people or equipment within it;

Natural ventilation alone will often not be sufficient to maintain breathable quality air;

Conditions can change very quickly;

The space outside can impact the conditions inside; and

Work activities may introduce hazards not present initially.

## Hazard Classification

Hazards in confined spaces are normally categorized into two main can types of hazards:

Physical hazards; and

Atmospheric hazards.

# Physical Hazards

Any hazard that presents a physical danger to the worker should be considered, some examples include:

Chemical exposures;

* Burns resulting from physical contact with caustic chemicals;

Release of contents in a supply line (engulfment or drowning);

High noise;

Moving machinery;

Structural hazards;

* Size limitations for access;
* Crawl spaces;
* Internal equipment;
* Double bottom hulls on ships;
* Structural beams and bulkheads;

Reduced visibility;

Entanglement;

Slips / trips;

Radiation;

* Natural Occurring Radioactive Material (NORM);

Temperature

* Too hot or too cold;

Shifting or collapse of material;

Biological hazards;

* Mold;
* Human waste;
* Animals;

Uncontrolled energy;

* Lock-out, Tag-out requirements;

Fall from height;

* Fall protection requirements.

## Physical Hazard Control Methods

The traditional hazard control methods found in regular worksites can be effective in a confined space.

These include engineering controls, administrative controls and personal protective equipment. Engineering controls are designed to remove the hazard while administrative controls and personal protective equipment try to minimize the contact with the hazard.

Engineering

* Design considerations
  + - Redesigning the confined space to eliminate the requirement to enter
    - Providing improvements to access and egress routes allowing for safer entry
* Ventilation considerations
* Energy isolation

Administrative

* Permit to work
* Safe Work Practices (SWP)
* Energy isolation procedures

PPE

* Gloves
* Chemical Suits
* Splash shields
* Helmets, boots etc.

# Energy Isolation Program

All potentially hazardous energy sources such as electrical, mechanical, hydraulic, pneumatic, chemical, or thermal must be de-energized and locked out prior to entry to the confined space so that equipment cannot be turned on accidentally while work is being performed within the confined space.

An energy isolation program can help prevent:

Unintended or accidental release of hazardous stored energy; and

Unintended or accidental start-up or motion of machinery, equipment, or processes.

Energy isolation can include any or all of the following: mechanical; electrical; pressurized equipment; flushing / purging; and/or lock out / tag out.

A comprehensive program for lockout / tag-out must be established by the employer for all confined space work. This program should include: written procedures; LOTO certificate requirements; specific equipment for each component to be locked out; specific locks (only used for LOTO); and a tag system to identify who/what/where/when and why.

### Energy Isolation Plan

Every isolation requirement starts with a plan. The isolation plan (certificate) should contain the following information:

Equipment to be locked out;

Isolation control points

* Normal position and isolated position

Specific locks not used for any other purpose;

Verification of installation and removal; and

Name of person who performed the isolation.

See appendix B for an example of an Energy Isolation Certificate.

### Verification of the LOTO

Once the isolations are complete a “Verification” that the isolations were completed and that it is now safe to work on the equipment must be completed to ensure workers safety.

Often called “Verification of Zero Energy”, this test should be witnessed by all workers involved in the confined space work. There are various methods to confirm zero energy, the following are the most common:

Attempt to activate the system by turning it on (ensure to turn the switch to off after the test)

Use a volt meter to confirm zero energy on electrical systems;

Visually confirm all isolation control points are installed correctly;

* Show the work team each isolation point;

### Removal of Isolations

ONLY the individual who installed the lock and tag onto the control point is permitted to remove the locks and tags. This ensures that the system remains inoperable without the work team’s knowledge and that it is confirmed safe prior to reactivation of the system.

# Atmospheric Hazards

Atmospheric hazards come in many forms and any one of them can create potentially deadly work spaces. These hazards may not always be present at the commencement of work and some are created as a result of the entry into the confined space or the work that is being performed either within the space or nearby. It is important to remember that work outside the confined space can affect the atmosphere within the space and vice-versa.

With regards to hazardous atmospheres we must constantly be vigilant for changes within the space as the atmosphere may change rapidly, the hazard may not be visible or detectable by smell and depending on the concentration one breathe may kill you.

The three main Atmospheric Hazard classifications are:

O2 levels (enriched or deficient);

Flammable / Explosive; or

Toxic.

## Oxygen Levels

Normal air composition on earth is generally considered to be 78% nitrogen, 20.9% oxygen and 1.1% of water vapour, carbon dioxide, argon and various other components.

|  |  |  |
| --- | --- | --- |
| Oxygen Level Requirements | | |
|  | 23% | Maximum Safe O2 concentration (COHS / POHS / MOSH) |
|  | 22.5% | Maximum Safe O2 concentration (Nova Scotia) |
|  | 22% | Maximum Safe O2 concentration ( Newfoundland) |
|  | 20.9% | Normal Oxygen level in air |
|  | 20% | Minimum Safe level (Newfoundland) |
|  | 19.5% | Minimum Safe level (Nova Scotia) |
|  | 18% | Minimum Safe level (COHS / POHS / MOSH) |
|  | 17-12% | Mentally and Physically Impaired |
|  | 6-8% | Death |

Ideally when testing work spaces we want to find 20.9% oxygen, we consider an atmosphere that contains greater than (>) 20.9% oxygen to be an enriched atmosphere and if it contains less than (<) 20.9% oxygen it is considered deficient.

### Oxygen Deficient

An oxygen deficient atmosphere creates a potentially deadly work space. As the oxygen content decreases within the spaces it can and will affect human beings. Slightly reduced levels may cause us to become tired or sleepy, reducing our mental processing which can lead to poor decisions. As the levels continue to drop be will eventually be rendered unconscious and if the levels of oxygen continue to drop it will result in our eventual death.

Oxygen deficient atmospheres may be caused by: consumption; displacement; or absorption.

It is important to remember that a reduction in the oxygen content of as little as 0.1% may indicate the presence of a toxic substance that could be harmful to humans, this substance may be something that you are not already testing for.

#### Consumption

Consumption occurs when we use up the oxygen within the space. We do this by various methods. Breathing and oxidation (fire, rotting food and corrosion) consume oxygen and can quickly reduce the O2 content within a confined space to dangerous levels.

#### Displacement

When working in confined spaces we can accidentally or intentionally displace the O2 from the space. Accidental displacement occurs when we mistakenly introduce foreign airborne contaminates to the space, carbon monoxide from combustion engines is the most common cause. Intentional displacement is referred to as “purging”, this is done within a confined space to clean out or reduce explosive or toxic concentrations from a confined space.

#### Absorption

Some chemicals have the ability to absorb oxygen molecules when exposed to the atmosphere, damp activated carbon or charcoal is one such chemical.

### Oxygen enriched atmosphere:

An increase in the amount of oxygen within the atmosphere normally does not harm human beings but it does increase the flammable/explosive properties of everything contained within the affected area.

Enriched oxygen atmospheres do not happen naturally and are caused by human error. Leaking oxygen lines or cylinders within enclosed spaces or chemical reactions are the normal causes.

### Regulatory Oxygen level Requirements

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Nova Scotia** | **Newfoundland** | | **Federal/Maritime** | **Offshore Petroleum Board** |
| Enriched | 22.5% | 22% | 23% | | 22.5% |
| Deficient | 19.5% | 20% | 18% | | 19.5% |

## Fire and Explosive Atmospheres

Flammable or explosive atmospheres may already exist within the confined space prior to opening it or they may be created due to the work process within the space.

Sources of flammable or explosive atmospheres within the workplace normally fall within the following categories:

Flammable gas;

Flammable vapor; or

Dust.

We often detect and mitigate most flammable gases or vapours but often overlook the dust. Dust can be just as explosive as gases or vapours at the right concentration. We often hear of explosions in grain silos on farms, flour storage bins or even dust explosions at saw mills.

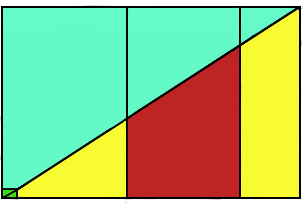
When testing for an explosive atmosphere we are primarily looking for the flammability or explosive limits which are conveyed as the “Lower Explosive Limit” or “LEL”. This is normally expressed in terms of percentage of LEL, i.e. 2% LEL. The LEL will vary based on increases or decreases of temperature and pressure. An increase in the temperature or pressure can cause a subsequent increase in the LEL.

Lower Explosive Limit (LEL)

Lowest concentration of a chemical mixed with air that will ignite

Upper Explosive Limit (UEL)

Highest concentration of a chemical mixed with air that will ignite



Temperature

Pressure

LEL

UEL



**10% LEL**

**Low Alarm**

As temperature or pressure increases it causes an increase in the level of flammable contaminates within the atmosphere. Fire or explosion may occur once the levels of contaminates achieve a concentration between the LEL and the UEL. Once we have the flammable concentration we need only add an ignition source to achieve combustion.

When we test the confined space for explosive concentrations most gas detectors will have the low alarm set to activate at 10% of the LEL which gives us a 90% safety margin before the atmosphere becomes explosive or flammable.

It is important to remember that a 1% indication of LEL may indicate the presence of contaminates that may be harmful to humans. Although we can legally work within a confined space up to 10% LEL we must consider respiratory protection measures to protect workers from the potential toxic atmosphere.

Example: Unleaded gasoline

LEL = 1.4%

PPM = 14,000 parts per million (1% = 10,000ppm)

10% LEL = 1,400 ppm (low alarm)

1% LEL = 140 ppm

TWA = 300ppm

By the time the gas detector indicates a low alarm at 10% we are already well above the time weighted average for our daily exposure to the vapours from unleaded gasoline.

### Explosive / Flammable Atmosphere Concentration Levels

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Nova Scotia** | **Newfoundland** | | **Federal/Maritime** | **Offshore Petroleum Board** |
| Work Requirements | Lower Explosive Limit (LEL) | | | | |
| Cold Work | <10% | <10% | 10% | | <10% |
| Inspection only | <50% | <25% | NA | | NA |
| Hot Work | <10% | <5% | 10% | | <5% |

### Hot Work

Hot work should not normally be performed in a confined space unless we can achieve and maintain a safe atmosphere. Ideally:

All flammable gases, liquids and vapours are removed;

Surfaces coated with combustible material should be cleaned or shielded to prevent ignition

Clean; purge or ventilate the space;

Mechanical ventilation is used to keep the concentration of any explosive or flammable hazardous substance less than the hot work regulatory limitations;

The oxygen content in the confined space can be maintained at normal levels;

Do not permit fuel or fuel containers to be taken into the space;

Ensure welding equipment is in good condition;

Use spark resistant tools;

Use intrinsically safe equipment;

Use explosion proof equipment; and

Ensure all equipment is bonded or grounded.

## Toxic Atmospheres

Within Atlantic Canada all provinces use the limitations prescribed by the American Conference of Governmental and Industrial Hygienists (ACGIH) as the standard for toxic contaminate limitations within the workplace. The Federal regulations, Maritime regulations and Offshore Petroleum board regulations also apply the limitations as identified by the ACGIH.

The ACGIH is a standalone body comprised of Industrial Hygienists from around the world and have no direct ties to industrial or governmental regulatory bodies.

Each year the ACGIH produce a user-friendly, pocket-sized publication of Threshold Limit Values (TLVs®) and Biological Exposure Indices (BEIs®) which is used world-wide as a guide for evaluation and control of workplace exposures to chemical substances and physical agents.

### Acronyms used by ACGIH for toxic levels:

Threshold Limit Value - TLV®

Time Weighted Average - TWA®

Short Term Exposure Limit - STEL®

Immediately Dangerous to Life and Health - IDLH

#### Threshold Limit Value - TLV®:

The airborne concentration of a contaminant to which it is believed a worker can be exposed day after day for a working lifetime without adverse health effects.

#### Time Weighted Average – TWA®:

An average value of exposure during an 8 hour work shift and a 40 hour week; and

May be adjusted by an Industrial Hygienist to account for a 12 hour work day.

#### Short Term Exposure Limit – STEL

A fifteen minute average exposure;

Maximum of 4 times per work day;

Minimum of 1 hour between each fifteen minute exposure; and

Should never be exceeded.

#### Immediately Dangerous to Life and Health - IDLH

A condition that presents an immediate or delayed threat to life that may cause irreversible adverse health effects and potentially interfere with your ability to escape unaided.

###### Common Atmospheric Toxins

#### Carbon Monoxide

Carbon Monoxide is a toxic chemical that is odourless, colourless, tasteless, non-irritating (initially) and difficult to detect by humans.

CO2, when inhaled, enters the lungs and more easily absorbed by the blood than oxygen (O2). This allows the CO2 to fill up the blood cells faster and prevents or blocks the O2 from being transferred to the body tissues and organs resulting in CO2 poisoning.

Signs and symptoms of CO2 poisoning may include:

Dull headache

Weakness

Dizziness

Nausea

Vomiting

Shortness of breath

Confusion

Blurred vision

|  |  |
| --- | --- |
| **Concentration** | **Symptoms** |
| 35 ppm (0.0035%) | Headache / dizziness - six to eight hours of exposure |
| 100 ppm (0.01%) | Slight headache - two to three hours |
| 200 ppm (0.02%) | Slight headache loss of judgment - two to three hours; |
| 400 ppm (0.04%) | Frontal headache - one to two hours |
| 800 ppm (0.08%) | Dizziness / nausea / convulsions - 45 min;  - Insensible within 2 hours |
| 1,600 ppm (0.16%) | Headache / dizziness / nausea -20 min;  - Death in less than 2 hours |
| 3,200 ppm (0.32%) | Headache, dizziness and nausea in five to ten minutes  - Death within 30 minutes. |
| 6,400 ppm (0.64%) | Headache and dizziness - one to two minutes. Convulsions, respiratory arrest, and death - less than 20 minutes. |
| 12,800 ppm (1.28%) | Unconsciousness after 2–3 breaths  - Death in less than three minutes. |

#### Hydrogen Sulphide (H2S)

H2S is a toxin that is produced by the decomposition of organic material in an environment that is deficient in oxygen. It can be naturally produced or a byproduct of industrial processes.

It is colorless, has a rotten egg odor (at low concentrations only), heavier than the atmosphere (in its pure form) and primarily enters the body through inhalation. Exposure to extremely low concentrations of H2S can be fatal (700ppm or 0.07% of the atmosphere).

#### 

|  |  |
| --- | --- |
| **Concentrations of note:** | PPM(Parts Per Million) |
| Odor threshold | 1 |
| Loss of smell | 20-200 |
| Disorientation and breathing problems | 200-500 |
| Unconscious | 500-700 |
| Death will occur in minutes | 700 + |
| \* 1% = 10,000 ppm | |

#### 

## Atmospheric Hazard Mitigation

Includes the following options:

Engineering controls

* Ventilation considerations
* Purging considerations
* Energy isolation
* Atmospheric Monitoring / Testing

Administrative controls

* Permit to work
* Work procedures
* Energy Isolation Procedures
* JSA/TBRA/THA

PPE

* Respiratory protection

# Atmospheric Monitoring:

The air within the confined space should be tested from outside of the confined space before entry into the confined space.

Care should be taken to ensure that air is tested throughout the confined space, side-to-side and top to bottom. A trained worker using the appropriate detection equipment should be tasked with completing and documenting the air quality testing.

Atmospheric monitoring may need to be continuous depending on the nature of the potential hazards and the nature of the work. Conditions can change while workers are inside the confined space and sometimes a hazardous atmosphere is created by the work activities in the confined space.

### Atmospheric Testing Types

In general there are three basic types of atmospheric testing they are: Initial, Repeat; and Continuous.

#### Initial Testing

These are the initial tests done prior to entry into the confined space. These initial test must be recorded on the permit.

#### Repeat Testing

Repeat testing of the confined space can be done for a number of reasons and all repeat tests should be recorded on the permit. Companies have different reasons for requiring repeat tests. The most common are:

Absence from the work site;

* Breaks or lunch times;
  + - On return a repeat test is conducted to ensure nothing has changed;

Hazardous nature of the task;

* Requires recording repeat tests at established intervals;
  + - Completed every 30 minutes, 15 minutes, every hour etc.

#### Continuous Testing

Depending on the hazardous nature of the job continuous monitoring may be required;

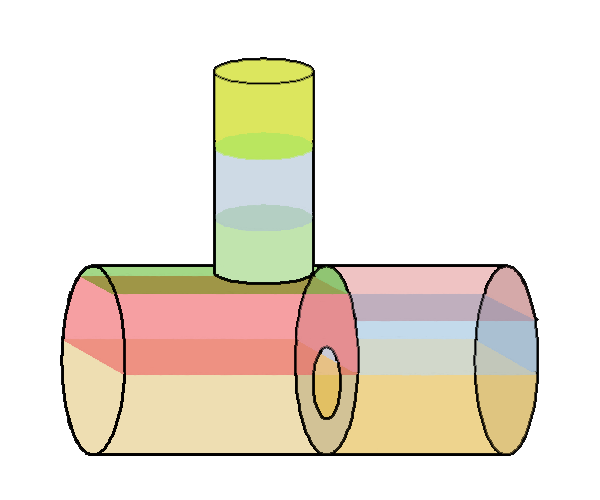
Continuous monitoring of a confined space is recommended anytime we have workers within the space.

### Testing Confined Spaces

At a minimum the legal regulations require a single gas test prior to the entry. Ideally an effective atmospheric monitoring program should require testing before opening the space and continue until the work is completed.

Atmospheric testing results must be entered on the permit with the device information used to collect the results (make, model, serial number, date of last calibration and last bump test).

When completing the atmospheric testing remember to test the whole space. Ideally we want to test all areas within the space: top; middle; bottom; side to side; and forward and aft. It is important to remember that it is not always possible to test the entire confined space from outside. A worker wearing PPE (a supplied air breathing apparatus) may have to enter the space to complete the testing prior to identifying it safe for entry.



**Methane**

**H2S**

**CO**

**Breathing Air**

Test the following areas:

* Top
* Middle
* Bottom
* Side to side
* Forward and aft

#### Gas Detection Clock Method

* Start about 10 meters away
* Slowly test all areas as you move closer to the job site
* Test the hatch or containment break area:
  + Before opening
  + During the opening process
  + After opening

### Atmospheric Monitoring considerations to consider:

Atmospheric monitor limitations;

* Correct monitor for the gasses present;
* Cross contamination issues;
* Maximum levels detectable by the monitor;

Wind strength and direction;

* Allows for emergency egress route planning;
* Contaminates may be created upwind of the work area;

Ambient temperature;

* Too hot or too cold may affect levels of contaminates;
* A change in ambient temperature may change contaminate levels;
* Some atmospheric monitors have temperature limitations which can affect the accuracy of the device;

Equipment or building configuration;

* Location of exhausts or potential contaminants;
* Low points / drains where contaminates could congregate;
* Bulkheads and internal equipment may affect ventilation;
* Interior configuration may prevent complete atmospheric testing from outside the space;

Areas of potential soil contamination;

* Monitors may detect contaminates originating from the contaminated soil;

Ventilation;

* Turn off the ventilation system prior to atmospheric testing to ensure you achieve an accurate reading of what is in the space otherwise you are only testing the air flow through the space;

Types and density of expected contaminates;

* Lighter toxins will tend to congregate higher within the space than heavier toxins.

# Atmospheric Monitoring Equipment

There are many different types of atmospheric monitoring devices commercially available. Generally they fall within one of the following types: fixed and portable.

### Fixed Monitors

These are installed within the workplace to continuously monitor the air for contaminates or explosive atmospheres and can be connected to workplace alarm systems to alert you to a potential problem.

### Portable Monitors

These are mobile testing devices that are taken by the employee to the job site. These can be of two main categories: Electronic or tubes.

#### Tubes 02Tubes

There are a variety of styles and brand names to choose from. Tubes require a device to draw the air through the tube. The tube will change colour depending on the level of contaminate detected. The tube has a graduated scale and depending on the level of colour change it will indicate the concentration of the chemical.

Although the style of testing often seems dated tubes are still relevant in the workplace due to the fact that we can get a tube for every known chemical and for higher levels of chemical contaminates we can get a selection of ranges with different tubes.

The downside of using tubes is that we can only use a tube once. Each time we must re-test the atmosphere we need a new tube, so the cost can be a detrimental factor. With tubes we must select the correct tube for the chemical we must test for. Each tube is designed to test for only one chemical.

#### Gas DetectorElectronic

Electronic monitors are the most common type of device used for testing confined spaces. These can be single sensor units capable of detecting a single chemical or multi-sensor units capable of detecting up to eight different chemicals. The most common electronic devices will test for four potential hazardous atmospheres, O2, H2S, CO and LEL.

## Electronic Atmospheric Monitors

### Electronic Monitor Classification

Generally gas detectors are categorized as Diffusion (passive) or Active monitors.

#### Diffusion (passive)

Diffusion type devices have the sensors the exposed to the environment, they can sample the air within approximately 12-18 inches of exposed sensors. One of the issues with the exposed sensors is that they are easily affected or damaged by cross contamination or water. These types of devices are generally used as a personal monitor worn by employees in potentially harmful atmospheres and are used for constant monitoring.

#### Active

Active type devices have an integrated pump that allows the air sample to be drawn into the sensors which are protected from exposure. We can achieve an accurate reading from a specific location (normally from the end of a probe or tube). The downside of this device is that it takes time to draw the sample through the tube. On average it takes approximately three seconds per foot of tubing and if the pump fails we have inaccurate results.

### Types of Sensors

Within the electronic monitors we have four types of sensors; electro-chemical; catalytic diffusion; photo ionizing; and infrared. The type of sensors within your atmospheric monitor will depend on the chemicals that you are attempting to locate and or the type of atmosphere you are required to work in.

#### Electro Chemical Sensor

These are the most common type of sensor used.

Within this sensor the gas is diffused into the sensor where we have an electrochemical reaction, this produces an electric current proportional to the gas concentration found. This current is sent to the instrument which detects and amplifies the current and scales the output according to the calibration. The results are displayed in:

* + Parts per million (PPM) for toxic gas sensors; and
  + Percent volume for oxygen sensors.

|  |  |
| --- | --- |
| **Common Electrochemical sensors** | |
| **Carbon Monoxide** | **CO** |
| **Chlorine** | **Cl2** |
| **Chlorine Dioxide** | **ClO2** |
| **Hydrogen** | **H2** |
| **Hydrogen Chloride** | **HCl** |
| **Hydrogen Cyanide** | **HCN** |
| **Hydrogen Sulfide** | **H2S** |
| **Nitrogen Dioxide** | **NO2** |
| **Nitric Oxide** | **NO** |
| **Oxygen** | **O2** |
| **Phosphine** | **PH3** |
| **Sulphur Dioxide** | **SO2** |

#### Catalytic Diffusion Sensor

These sensors are used for the detection of explosive or flammable atmospheres. They utilize temperature sensing units within the sensor as part of a balanced electric circuit (Wheatstone bridge). Within the sensor one unit detects ambient temperature whilst the over senses the temperature within the internal combustion chamber (the sensor burns the atmosphere within the chamber) the difference in temperature (measured in resistance) will disrupt the balanced circuit of the Wheatstone bridge causing current to flow to the instrument, the amount of current flow determines the results displayed on the screen.

The downside of this type of sensor is that we need oxygen to obtain accurate results. The amount of oxygen required be determined by the manufacturer, i.e. if we are operating in an oxygen enriched atmosphere it will potentially cause higher than normal results.

Correlation / Correction Factors

These factors are required to obtain accurate results for catalytic sensors. The factors are based on the calibration gas used for the instrument and the gas that you are detecting. The factor is multiplied to the LEL result on the screen to obtain an accurate result. Refer to the owner’s manual for the correlation/correction factor for your device.

#### Photo Ionizing Detector (PID) Sensor

These are normally used for the detection of volatile organic compounds (VOC).

Within the instrument there is an ionization process that will produce an electric current based on the level of gas detected.

Some atmospheric monitors use a PID sensor with a tube to detect specific chemicals, i.e. benzene or butylene.

#### Infrared Sensor (IR)

The Infrared (IR) detection method is based upon the absorption of infrared radiation as it passes through a volume of gas. Generally an infrared light source and an infrared light detector measures the intensity of the concentration. If a gas intervenes between the source and the detector, the level of radiation falling on the detector is reduced. Gas concentration is determined by comparing the relative values between the wavelengths.

These are normally used to detect explosive or flammable atmospheres and are not affected by oxygen levels as commonly found with the catalytic diffusion sensor.

### Calibration

Every atmospheric monitor requires calibration on a regular schedule, refer to the owner’s manual to determine the frequency of calibration. Calibration should be carried out by qualified personnel and all manufacturers provide instructions on how to calibrate their atmospheric monitor.

In some cases the manufacturer requires the device to be sent back to the manufacturer or to a certified agent for calibration.

### Functional (Bump) test

A functional test (commonly referred to as a bump test is also required prior to using a monitor. This test is used to verify the sensor and alarm operation and must be completed daily prior to the confined space entry.

In some jurisdictions (most Atlantic Provinces) you are required to maintain a record of the bump test. Some companies maintain a registry of detectors and bump tests, while others include the information on the atmospheric test results section of the permit. Within Nova Scotia and Newfoundland you must include the bump test results on the permit.

Please refer to the owner’s manual for the correct sequence of the bump test.

The follow bump test is an example:

* Turn on unit;
* Allow the self-test to complete;
* Zero the oxygen sensor;
* Apply test gas;
* Allow sensors to respond;
* Verify proper alarm function;
* Remove gas and allow monitor to clear; and
* Record the results.

## Emergency Actions as a result of gas alarm

Upon activation of any alarm on the atmospheric monitor we recommend that you evacuate the confined space. If the alarm continues once out of the space evacuate the area immediately outside the confined space, we normally recommend moving cross wind to get out of the immediate area then move up wind to a safe area.

Once clear of the hazard contact your control/command center (supervisor, control room, bridge etc).

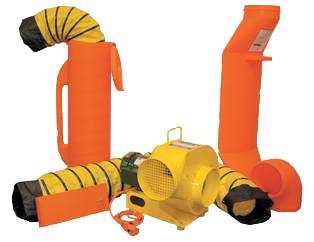
If the alarm continues you may have to consider alternative hazard control measures i.e. additional ventilation options, or higher levels of PPE.

# Purging

Purging is often confused with ventilation. Purging is the introduction of a compound into the confined space to clear the space of a hazard such as toxins or flammable atmospheres. Normally an inert gas such as nitrogen, argon, CO2 is used, but these can be substituted with water or steam.

In all cases purging creates a hazardous atmosphere as it normally removes all the oxygen from the space during the process. In some cases nitrogen is introduced into the space effectively reducing the O2 levels to below 10%, workers properly trained and equipment then enter the space to perform work.

# Ventilation



Ventilation is the process where we move air throughout the confined space. There are two main classifications of ventilation:

Natural; and

Mechanical (3 types)

* Exhaust
* Supply
* Combination

Natural ventilation (natural air currents through the open access hatches) is never reliable and should not be considered sufficient to maintain the safe air quality within a confined space.

Mechanical ventilation is usually necessary to maintain air quality and this type of ventilation requires powered blowers or fans to move the air. These systems may utilize electric or pneumatic ventilation fans and come in a variety of sizes and capacities. When considering the ventilation requirements you must also consider how much air you must move and how far you must move it when developing the ventilation plan.

Considerations with regards to mechanical ventilation:

Requirements should be noted on the entry permit;

Verify intake air is free from contaminates;

Exhaust air outlet should be positioned away from workers and identified;

Consider air movement throughout the space;

* Length of ducts required;
* Number of bends or elbows required;

Pockets of toxins may remain;

Do not ventilate with oxygen;

Shut off ventilation system prior to atmospheric testing; and

Warning system or constant monitoring in the event of a failure.

## Ventilator limitations:

Each ventilator has limitations, how much air can it move (Cubic feet per minute - CFM), length of ducting permitted, number of elbows and bends permitted. These will be found within the owner’s manual and should be referenced while developing the plan.

## Mechanical Ventilation

### Supply

Supply ventilation is when we supply fresh air into the confined space. With supply ventilation you must ensure that the intake of air into the fan is positioned so that we get clean fresh air and that it is free from contaminates.

Supply ventilation is best used for maintaining normal oxygen levels within the confined space.

Care must be taken when supplying fresh air into a confined space that contains a toxic or flammable atmosphere as the fresh air will push contaminates out any access points into the work space.

### Exhaust

Exhaust ventilation is used to remove toxins or flammable atmospheres from the confined space. When using exhaust ventilation it is important to ensure that the exhaust outflow is positioned at a location that is safe for all workers in the area. Depending on the hazardous nature of contaminates, this area may require signage and barriers to prevent workers from being exposed.

When using exhaust ventilation fresh air is allowed to enter the space through open access points.

### Combination

A combination system uses both supply and exhaust ventilation working together to exhaust contaminates and supply clean fresh air. This system can be very effective in ventilating a space and depending on the interior configuration allows for the best air flow through the space.

This type of ventilation is dependent on the number and location of the access points within the confined space.

### Short Circuiting of Ventilation

Short circuiting of the ventilation happens when the exhaust or supply air is recirculated back through the other system. To avoid short circuiting we can use additional ducts to position the intake and exhaust flow away from one another.

## Required ventilation time

The required time it takes to ventilate a space will depend on the size of the space, the interior configuration, the type of ventilation available, the capacity of the ventilation fans, the length of dust work required and the number of bends or elbows required.

To completely ventilate a space we are required to exchange the air inside a minimum of 7 full air exchanges.

To work out the required time to ventilate a space we can use a simple formula:

Ventilation time = (area X 7) / airflow rate

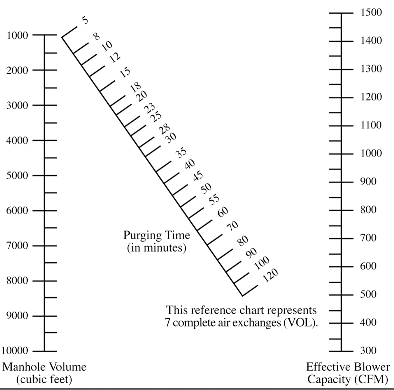
Example: A 5000 cubic foot confined space ventilated with a ventilator with a maximum capacity of 1000 cubic feet per minute (CPM) –

Time = (5000 X 7) / 1000

Time = 35,000 / 1000

Time = 35 minutes

The chart below is affixed on some ventilation models, by laying a straight edge marking the confined space volume and fan capacity you can plot the required time to exchange the air 7 full times.



**Even after using the formula or chart and ventilating for the appropriate time it is important to always perform atmospheric testing to confirm the ventilation was successful and that the space is safe for entry.**

# PPE requirements

Depending on your jurisdiction and the hazard assessment of the confined space you may require specific items of PPE for safe entry.

As with any work place the minimum PPE requirements exist within the confined space:

CSA footwear

CSA eye protection

CSA helmet

CSA hearing protection (as required)

Chemical handling protection

* Splash shield
* Gloves

The following items may be required based on the hazard assessment or legal regulatory requirements:

Respiratory protection

* Self-Contained Breathing Apparatus (SCBA)
* Supplied Air Breathing Apparatus (SABA)
* Half face or full face respirator with appropriate cartridges.

Fall arrest harness

Lifeline

Flame proof clothing

## Full Body Harness

Within Canada different regulatory jurisdictions have different requirements with regards to the full body harness. Some jurisdictions require the harness to be a constant wear item while others allow you to determine the need based on the risk assessment.

It is our recommendation that a full body harness should always be worn while in a confined space unless it is a safety hazard in which case the justification for not wearing it should be documented on the entry permit.

The harness provides a couple of options when it comes to rescue that make it beneficial to wear:

If you are using the lifeline attached to the harness it may allow us to perform a “non-entry rescue” if the entrant is rendered unconscious;

The lifeline and harness can allow a rescue team to quickly locate you within a confined space; and

The harness provides a rescue team with a quick and easy way to move you through the space and extract you.

In Nova Scotia the regulations require an entrant to always wear a full body harness when in a confined space.

The following quote was taken from the Nova Scotia Occupational Health and Safety General Regulations Section 134, subsection (3)

*(3) An employer shall:*

1. *where reasonably practicable, provide a person entering into and occupying a confined space with a full body harness;*
2. *ensure that a full body harness provided under clause (a) is worn; and*
3. *where it does not present a hazard, ensure that an attached life line is*
4. *securely fastened to an anchor point, and*
5. *controlled by the competent person referred to in subsection (2).*
6. *An employer shall ensure that the full body harness referred to in subsection (3) complies with the requirements for Group E harnesses in the latest version of CSA standard CSA 259.10, “Full Body Harnesses”.*

The Newfoundland & Labrador, COSH, MOSH and POSH regulatory requirements all use a quote similar to the following:

The following quote was taken from the Newfoundland and Labrador Regulation 5/12

Occupational Health and Safety Regulations

* Part XXVII – Confined Space Entry
* Sections 513

***513.****(1) An employer shall ensure that a worker who is required or permitted to enter a confined space in which a harmful atmosphere exists or may develop or where he or she may become entrapped by material*

*(a)  wears appropriate retrieval equipment which would keep the worker in a position to be rescued; and*

*(b)  has a life-line attached to the retrieval equipment which is tended at all times by a person, stationed outside the entrance to the confined space who shall be equipped for and capable of effecting rescue*

*(c) and the employer shall prevent entanglement of life-lines and other equipment where one or more workers enter the confined space*

At no time in the above quote does it require an entrant to always wear the full body harness, it is only required when we cannot maintain a safe atmosphere or there is a danger of becoming entangled or trapped.

**The inherent danger within confined spaces is that things can and do change rapidly. One minute everything is safe and controlled and the next minute something changes, normally unforeseen or unpredicted, and we instantly have a dangerous atmosphere or situation requiring rescue. We recommend that the entrant always wears a harness unless it is a safety hazard**

## Respiratory Protection

### Air Purifying Respirator (APR)

Air purifying respirators can be used to filter out contaminates and protect the worker from exposure to harmful toxins or dust. In Canada the CSA standard for Selection and Care of Respirators refers to the NIOSH standard requirements.

The APRs utilize disposable cartridges designed to filter out a specific dust or vapour contaminate so you must ensure the following:

Ensure you have the right cartridge for the hazard;

Ensure the cartridge is within its date of expiry; and

Complete a pre-use visual inspection of the cartridge.

They come in two styles:

Half face

Full face

APRs only filter out dust and vapours and do not supply oxygen. They must never be used when working in an oxygen deficient atmosphere.

### airpakNXG7-pg-prdshotSelf-Contained Breathing Apparatus (SCBA)

An SCBA is designed to supply the user with clean, dry compressed air. These units provide air via a re-fillable cylinder traditionally carried on the back of the user. The system supplies breathable air to the user at a pressure slightly higher than the surrounding ambient air, this is delivered to the user via a positive pressure mask.

The positive pressure mask provides an additional level of safety to the user, if a leak in the mask occurs the positive pressure pushes air out through the leak and prevents contaminated air from entering.

Like the APRs, the CSA standard for Selection and Care of Respirators refers to the NIOSH standard requirements for all industrial SCBAs and for firefighting SCBAs we refer to the National Fire Protection Agency (NFPA)

The SCBA allows for greater freedom of movement within the working area but the addition of the cylinder on your back makes you larger and therefore may restrict your movement during access and egress. At no time should you ever consider removing the tank and passing it into the space ahead of you to allow for access into the space. The system is designed to remain on your back and if you cannot access the space while wearing it then you should consider other options.

### Supplied Air Breathing Apparatus (SABA)



The SABA system operates similar to the SCBA in that it is designed to supply the user with clean, dry compressed air. These units provide air via an airline that is attached to an external air supply. The system supplies breathable air to the user at a pressure slightly higher than the surrounding ambient air, this is delivered to the user via a positive pressure mask as per the SCBA.

Like the APRs, the CSA standard for Selection and Care of Respirators refers to the NIOSH standard requirements for all industrial SABAs and for firefighting and rescue SABAs we refer to the National Fire Protection Agency (NFPA)

The SABA allows for improved access, egress and movement through the confined space. As we do not have to carry the large cylinder of air on our back.

With any airline system we are required to always wear an escape pack that would supply the user with 5 to 15 minutes of compressed air in an emergency.

# Preparation to Enter

When preparing to enter a confined space we should always ask ourselves the question: Is it absolutely necessary that the work be carried out inside the confined space? In many cases where there have been deaths in confined spaces where there was no reason to enter and the work could have been done from outside the space.

## Pre-Entry

When preparing to enter a confined space the following guidelines should be followed:

Ensure the confined space hazard assessment and control program has been followed;

Hazard assessment is completed and review by trained and experienced persons;

* It should identify and evaluate all the existing and potential hazards;
* It should identify appropriate hazard mitigation controls;
* Evaluate activities both inside and outside the confined space;
  + - Simultaneous operations outside the confined space can negatively affect conditions within the confined space;

Entry Permit initiated;

Atmospheric monitoring program initiated;

Energy isolation program initiated;

* If required;

Ventilation program initiated;

Required PPE identified and present and the worksite;

Personnel competences verified;

* Confirm training of all personnel is current and up to date;
* Pay particular attention to new personal and 3rd part contractors;

Rescue plan completed;

Rescue equipment is onsite;

* Confirm equipment inspection has been completed;

Toolbox talk (pre-job briefing) completed

Once all the required components are in place we can open the permit and start the task.

## During Entry

The Safety Attendant (also knowns as the Safety Watch or Standby person), shall be posted outside the access point to the confined space anytime a worker is inside the confined space.

The Safety attendant must not be assigned any other duties that would take them away from the access point to the confined space. They must continuously monitor the area inside and outside for any condition that could negatively affect the work team.

The entrant, working in a confined space, must be constantly alert for any changing conditions within the confined space. In the event of an alarm from monitoring equipment or any other indication of danger, workers should immediately leave the confined space.

Additional considerations during confined space work:

Should a worker leave a confined space unattended for a short time the space should be re-tested before the worker re-enters;

No confined space should be closed off until it has been verified that no person has been left inside; and

After exiting a confined space, the time of exit should be noted on the entry permit.

# Duties of Personnel

## Attendant / Safety Watch Duties

Must be trained and competent in confined space entry procedures;

Must know the hazards & mitigation controls;

* Understands the nature of the hazards that may be found inside the particular confined space and can recognize signs, symptoms and behavioral effects that workers in the confined space could experience;

Monitors the confined space and surrounding area and is on the lookout for dangerous conditions;

Remains outside the confined space and does no other work which may interfere with their primary duty of monitoring the workers inside the confined space;

Maintains constant two-way communication with the workers in the confined space;

Orders the immediate evacuation if a potential hazard, not already managed by the hazard assessment is detected;

Calls for emergency assistance immediately if an emergency develops;

Know the rescue procedure

* Is immediately available to provide non-entry emergency assistance when needed;
* Have all required non-entry rescue equipment immediately available and be trained in its use

Signs the entry permit

Posts the permit at the entrance to the space

Verifies entrant PPE is worn properly

Restrict access to the confined space to trained and authorized persons

Maintain a record of entrants

Performs atmospheric monitoring

## Entrant Duties

Must be trained and competent in confined space entry procedures;

Must know the hazards & mitigation controls;

* Understands the nature of the hazards that may be found inside the particular confined space and can recognize signs, symptoms and behavioral effects that workers in the confined space could experience;

Maintains communication with the attendant

Performs continuous atmospheric monitoring

Signs the entry permit

Evacuates the space if a potential hazard, not already managed by the hazard assessment is detected;

Evacuates the space if directed to do so by the safety attendant;

Completes the job

Return the space to normal

* Removes all tools
* Housekeeping

## Supervisor Duties

Must know the hazards & mitigation controls;

* Understands the nature of the hazards that may be found inside the particular confined space and can recognize signs, symptoms and behavioral effects that workers in the confined space could experience;

Verifies the permit is completed;

Verifies the permit is posted at the entrance;

Verifies attendant and entrant are trained in confined space entry;

Periodically monitors the work site;

Ensures PPE is being used properly; and

Knows the rescue procedure.

# Confined Space Rescue

If a situation arises where there is a hazardous condition and the worker does not leave or is unable to leave the confined space, rescue procedures should begin immediately.

The old standard rescue plan of calling 911 is no longer acceptable within industry as a viable rescue plan. Some jurisdictions do not have emergency teams properly trained or equipment for confined space rescue. Other areas may have the equipment and training but may not be available to respond due to other emergency calls they are responding to, in fact you may end up in a queue waiting for your turn.

By having an effective rescue plan, equipment and trained personnel onsite you are better able to ensure the safety of the work team.

## Emergency Response Planning

Rescue planning involves identifying all the required components for the rescue including personnel; equipment; and procedures.

The employer shall ensure that:

An effective rescue plan is on site and can meet the needs of the specific hazards that may be associated with the assigned job tasks;

Responders on site must know the emergency procedures and the capabilities of personnel on site;

* Knowing the off-site responders and their response time is a valuable tool to aid in your planning;

Workers must know their role and responsibilities during the emergency;

Emergency procedures should be in writing, communicated to all workers and posted in the work place. This must include:

* How to report the emergency;
* Rescue options; and
* How to provide first aid;

Rescue workers should be trained to operate equipment that will be identified in the rescue plan;

Rescue personnel should be trained in first aid; emergency scene management as well as to be able to give ongoing medical treatment for the causality after extraction for the space.

**For an example of an Emergency Response Plan see Appendix C**

Emergency planning should include detailed plans for all personnel working with the confined space, including but not limited to:

Entrant

Attendant

Supervisor

External Service Provider

## Emergency Response Plans (ERPs)

Emergency planning should include detailed plans for all personnel working with the confined space, including but not limited to:

Entrant

Attendant

Supervisor

External Service Provider

## Basic Rescue Plan

The basic rescue plan should be kept as simple as possible and should be described in detail on the permit or on a separate document that is attached to the permit pack.

For a safety attendant the rescue procedure can be quite simple:

Raise the alarm;

* How? What is the phone number or radio frequency;

Verify / start ventilation;

* An effective way to move clean fresh air into the space

Attempt non-entry rescue

* If possible;

Standby and await rescue team; and

* Assist the rescue team as required.

For a supervisor the plan becomes more complicated. Now we get in to more emergency management, notification etc.

For a rescue team their plan is also as uncomplicated as possible but must include options for rescue as well as keeping the rescue team safe.

## Rescue Options

When discussing rescue from a confined space we normally always come back to three options:

Self-rescue;

Non-entry rescue; and

Entry rescue.

### Self-Rescue

Self-rescue is when the entrant egresses the confined space without assistance.

### Non-Entry Rescue

This is performed from outside the confined space by the safety attendant or rescue team. It involves using the entrant’s lifeline to extract them or attaching a retrieval device to the entrant whilst remaining outside the space.

When possible the entry rescue can be executed extremely fast and can be very effective at extracting an injured person.

The down side of the non-entry rescue is that it is not always possible due to the interior configuration of the space. Once the entrant has to move away from the access point, pass under or over internal equipment or move around a corner this type of rescue is impossible.

### Entry Rescue

This is the most complicated and dangerous of the rescue options. When an entry rescue is the only available choice the rescue team must perform the task while ensuring the safety of the team members. This type of rescue involves higher levels of training, more equipment and normally more time to complete.

If an offsite rescue team (such as 911) has to perform the rescue it is not as simple as arriving on scene and jumping into the hole for the rescue. They must gather the necessary information, assess the hazards, develop a plan for the site, and set up their equipment which takes time.

Many companies and some regulatory jurisdictions require entry rescue teams to be available onsite for every confined space entry.

## Rescue Considerations

When developing your rescue plan consider the following:

Non-entry rescue options should be considered first;

* If possible, rescue the injured person from outside the space;

Pre-position rescue equipment at the entrance to the confined space;

Consult with onsite rescue teams prior to any entry;

* Some companies will have the onsite rescue supervisor sign on the entry permit prior to any confined space work; and

Never attempt an entry rescue unless you are trained and properly equipped.

# Appendix A – Confined Space Entry Permit

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Confined Space Entry Permit** | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| **Date:** |  | | | **Start Time:** | | |  | | | **End Time:** |  |  | |
|  |  | | |  | | |  | | |  |  |  | |
| **Location:** | |  | | | | | | | | | | |  |
|  | |  | | | | | | | | | | |
| **Description of space:** | | | |  | | | | | | | | |
|  | | | |  | | | | | | | | |
| **Work Description:** | | | | |  | | | | | | | |
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| **Hot Work:** | | |  | |  | **Cold Work:** | |  |  | | | | |
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| **Pre-Entry Operations** | | | | | | | | | | | | | | | | |
| **Item** | | | | | | | | | | **🗹** | | | **Comments** | | | |
| **General area secured:** | | | | | | | | | |  | | |  | | | |
| **Task Hazard Assessment completed and attached:** | | | | | | | | | |  | | |  | | | |
| **Entry team preparation completed:** | | | | | | | | | |  | | |  | | | |
| **Equipment / rigging preparation:** | | | | | | | | | |  | | |  | | | |
| **Breathing air supply set-up:** | | | | | | | | | |  | | |  | | | |
| **Atmospheric monitoring program commenced:** | | | | | | | | | |  | | |  | | | |
| **Ventilation equipment set-up** | | | | | | | | | |  | | |  | | | |
| **Rescue plan completed and attached:** | | | | | | | | | |  | | |  | | | |
| **Rescue equipment inspected:** | | | | | | | | | |  | | |  | | | |
| **Pre-entry briefing completed:** | | | | | | | | | |  | | |  | | | |
|  | | | | | | | | | | | | | | | | |
| **Permit Open** | | | | | | | | | | | | | | | | |
| **Date:** |  | **Time:** |  | | **Authorizer:** | |  | | | | | | | **Signature:** | |  |
| **Permit Validity Period** | | | | | | | | | | | | | | | | |
| **This permit is valid until:** | | | | **Date:** | |  | | **Time:** | | |  | | | |  | |
|  | | | | | | | | | | | | | | | | |
| **Termination** | | | | | | | | | | | | | | | | |
| **Item** | | | | | | | | | **🗹** | | | **Comments** | | | | |
| **Personnel accounted for:** | | | | | | | | |  | | |  | | | | |
| **Equipment removed:** | | | | | | | | |  | | |  | | | | |
| **Record all relevant information:** | | | | | | | | |  | | |  | | | | |
| **Equipment inspection / maintenance:** | | | | | | | | |  | | |  | | | | |
|  | | | | | | | | | | | | | | | | |
| **Permit Closed** | | | | | | | | | | | | | | | | |
| **Date:** |  | **Time:** |  | | **Authorizer:** | |  | | | | | | | **Signature:** | |  |

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| **Task Hazard Assessment (THA)**  (Identify all the known and potential hazards at or near the rescue area) | | | | | | |
| **Hazards** | | | **Mitigation Controls / Comments** | | | |
| **Slips trips and falls** | | |  | | | |
| **Obstructions Below Work Site** | | |  | | | |
| **Falling or Dropped Objects** | | |  | | | |
| **Poor lighting or visibility** | | |  | | | |
| **High noise** | | |  | | | |
| **Pinch points / struck by / struck against** | | |  | | | |
| **Traffic** | | |  | | | |
| **Pressurized equipment / lines** | | |  | | | |
| **High energy / high voltage** | | |  | | Isolation Certificate # |  |
| **Hot / Cold Equipment** | | |  | | | |
| **Engulfment Hazard** | | |  | | | |
| **Vibrating equipment** | | |  | | | |
| **Moving objects / equipment** | | |  | | | |
| **Trenching / Excavations** | | |  | | | |
| **Nearby simultaneous operations** | | |  | | | |
| **Hazardous substances** | | | **(Attach copy of MSDS)** |  | Isolation Certificate # |  |
| **Atmospheric hazards** | | | **Complete atmospheric monitoring record** | | | |
| **Weather** | | |  | | | |
| **Ignition Sources** | | |  | | | |
| **Additional Hazards:** |  |  |  | | | |
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| **All known hazards are to be reduced to the ALARP level prior to task commencement**  **(As Low as Reasonably Possible)** | | | | | | |

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| **Worker Acknowledgement** | | | | | | | |
| **Position** | **Name (print)** | | | | **Signature** | | **Date** |
| **Attendant** |  | | | |  | |  |
| **Entrant** |  | | | |  | |  |
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| **Entry Log** | | | | | | | |
| **Entrant Name** | | **Entry Time** | **Exit time** | **Attendants Initials** | | **Entrant Signature** | |
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| **Atmospheric Monitoring Results** | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| **Atmospheric Monitor:** | |  | | | | | | **Model:** | | |  | | **Serial Number:** | | | |  | |
|  | | | | | | | | | | | | | | | | | | |
| **Calibration Due (#days):** | | | |  | | | **Functional Test completed (Bump test):** | | | | | | | | Signature | | | |
|  | | | | | | | | | | | | | | | | | | |
| **Attendant (name):** | | | | | Print | | | | | **Attendant:** | | | | Signature | | | | |
|  | | | | | | | | | | | | | | | | | | |
|  | **Time** | | **O2 %** | | | **%LEL** | | | **CO** | | | **H2S** | | | | **VOC** | | **Other** |
| **Prior to**  **entry** |  | |  | | |  | | |  | | |  | | | |  | |  |
| **Every 30 minutes when “Entry Team” is in the**  **confined space** |  | |  | | |  | | |  | | |  | | | |  | |  |
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# Appendix B – Energy Isolation Permit

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| **Energy Isolation Certificate** | | | | | | | | |
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|  | | | | | | | | |
| **Date:** |  | | **Permit #** |  |  |  |  | |
|  | | | | | | | | |
| **Location:** | |  | | | | | |  |
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| --- | --- | --- | --- | --- | --- |
| **Isolation Point** | **Normal Position** | **Isolated Position** | **Lock/Tag number** | **Isolating Authority (Initials)** | |
| **Installed** | **Removed** |
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| **Isolation Installation Verified** | | | | | | | |
| **Date:** |  | **Time:** |  | **Authorizer:** |  | **Signature:** |  |
|  | | | | | | | |
| **Isolation Removal Verified** | | | | | | | |
| **Date:** |  | **Time:** |  | **Authorizer:** |  | **Signature:** |  |

# Appendix C – Emergency Response Plan (ERP) Confined Space Rescue

* Assess rescue situation
* Confirm Mitigation controls are still in place
* Perform atmospheric testing
* Set up rescue equipment
* Confirm rescue possible
* Attempt entry rescue

**RONC Rescue Team**

Tier 2: 911

**Rescue successful?**

**Yes**

**No**

**911 Rescue Team Arrives**

* Rescue team will complete the rescue
* Turn IP over to EHS for Transport

**Safety Attendant**

* Turn over IP to First Aider

Tier 0: Immediate response

Tier 0: Onsite Personnel

Tier 1: RONC Rescue Team

Tier 3:

Hospital

**INCIDENT OCCURS**

**Safety Attendant**

* Raise the Alarm
* Assess Scene
* Make Area Safe

**Safety Attendant**

* Confirm non-entry rescue is possible
* Attempt non-entry rescue

**First Aider**

**Safety Attendant trained in non-entry rescue?**

* Onsite Alarm contact: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Offsite Alarm contact: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Location of Confined Space: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Number of injured persons (IP) \_\_\_\_\_\_\_\_\_\_\_\_
* Nature of injury/illness if known \_\_\_\_\_\_\_\_\_\_\_

**Tier 3 Facility**

**Nearest hospital:**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**No**

**Yes**

* Provide First Aid for Trauma and Shock
* Hand over Injured Person to EHS
* Provide detailed debriefing to EHS
* Secure/inspect and repack equipment

**Tier 2 medical (EHS)**

* Stabilize & Assess IP
* Transport to nearest Tier 3 facility

**Technical Rescue Team Required**

* **Go to Tier 1 of this “ERP”**

**First Aider Information**

* Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Contact information: \_\_\_\_\_\_\_\_\_\_\_\_\_

**Rescue successful?**

**Yes**

**No**

**Safety Attendant**

* Inform supervisor
* Elevate ERP to Tier 1 status

**911 Emergency Call**

Hi my name is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

I am calling from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

We have a confined space incident and require a rescue team and EHS.

RESCUE PLAN

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Rescue Equipment Onsite | | | | |
| Check equipment to be used in the rescue plan | | | | |
| PPE for Rescue Team | | | | |
|  | Coveralls / Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
|  | Gloves / Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
|  | Helmet | | | |
|  |  | |  | Helmet (CSA Type 1 class E) |
|  |  | |  | Helmet (CSA Type 1 class D) |
|  |  | |  | Helmet (CSA Type 2 class E) |
|  | CSA Boots | | | |
|  | Full Body Harness CSA Class “E” | | | |
| Respiratory Protection | | | | |
|  | | Half Face respirator with cartridge | | |
|  | | Full Face respirator with cartridge | | |
|  | | SCBA | | |
|  | | SABA | | |
| Rescue Team Lifelines | | | | |
|  | Type 3 SRL | | | |
|  | NFPA rescue rope 12.5mm | | | |
|  | NFPA rescue rope 11 mm | | | |
| Anchor Point Systems | | | | |
|  | | DBI Sala Tripod | | |
|  | | Protecta Tripod | | |
|  | | SKED Tripod | | |
|  | | Arizona Vortex Tripod system | | |
|  | | Bean Clamp | | |
|  | | Anchor Strap | | |
| Lifting/Lowering Systems | | | | |
|  | | DBI SALA Man Winch | | |
|  | | Protecta Type 3 SRL | | |
|  | | 4:1 mechanical advantage system | | |
|  | | Rollgliss 550 | | |
|  | | Petzl JAG System | | |
|  | | Other system: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | |
| Patient Package Systems | | | | |
|  | | SKED Stretcher | | |
|  | | Half SKED | | |
|  | | Stokes litter | | |
|  | | Yates SPECPAC | | |
|  | | Casualties own harness system | | |
|  | | Victim harness | | |
|  | | Improvised harness | | |
| Medical Equipment | | | | |
|  | | First Aid Kit | | |
|  | | Trauma Kit | | |
|  | | AED | | |
|  | | O2 Kit | | |
| Ventilation Equipment | | | | |
|  | | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | |
|  | | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | |
| Other Equipment on site | | | | |
|  | | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | |
|  | | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | |
|  | | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | |

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| --- |
| SITE SPECIFIC RESCUE PROCEDURE |
| TO BE COMPLETED by the Rescue Team when onsite |
| Fill out the required steps for the anticipated rescue operation. |
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| **RESCUE TEAM PERSONNEL** | | | |
| **Print Name** | **Signature** | **Rescue Trained** | |
| **Yes** | **No** |
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**911 Emergency Call**

Hi my name is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

I am calling from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

We have a confined space incident and require a rescue team and EHS.