



OSHAcademyTM
Occupational Safety & Health Training

Confined Space Program

Employees who work in confined spaces face increased risk of serious physical injury. Hazards involving a confined space include entrapment, engulfment, and dangerous atmospheric conditions. As a result, employees who conduct work within confined spaces must be properly trained. This course presents information on the definition of a confined space, hazards of a permit-required confined space, and alternative procedures to control atmospheric hazards. The written program and entry permit system, rescue and emergency services, and importance of training are also discussed.

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OSHAcademy Course 713 Study Guide

Confined Space Program

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Contact OSHAcademy to arrange for use as a training document.

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 713.

We hope you enjoy the course and if you have any questions, feel free to email or call:

OSHAcademy

15220 NW Greenbrier Parkway, Suite 230

Beaverton, Oregon 97006

www.oshatrain.org

instructor@oshatrain.org

+1.888.668.9079

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Course Introduction

Many workplaces contain spaces that are considered to be "confined" because their configurations hinder the activities of employees who must enter into, work in or exit from them. In many instances, employees who work in confined spaces also face increased risk of exposure to serious physical injury from hazards such as entrapment, engulfment and hazardous atmospheric conditions. Confinement itself may pose entrapment hazards and work in confined spaces may keep employees closer to hazards such as machinery components than they would be otherwise. For example, confinement, limited access and restricted airflow can result in hazardous conditions that would not normally arise in an open workplace.

Keep in mind: Most permit-space accidents happen for the following reasons:

- Workers have not been properly trained to recognize permit-space hazards.
- Hazards are not eliminated or controlled before workers enter the space.
- Rescuers are inexperienced or improperly trained.

Course Goals

This course has been developed to explain basic requirements detailed within OSHA General Industry Standard 29 CFR 1910.146, Permit-required Confined Spaces, which will assist employers in establishing and maintaining an effective confined space program. For information on Confined Space Entry in Construction, see [OSHAcademy Course 816](#).

By implementing such a program, our employees will be able to:

- Recognize, evaluate, and control confined space hazards.
- Save lives and protect employees from job-related injuries and illnesses.
- Promote safe and effective work practices.
- Reduce preventable workers' compensation costs.
- Comply with company procedures and practices.

The course does not alter or determine employer compliance responsibilities in OSHA standards or the Occupational Safety and Health Act of 1970. Because interpretations and enforcement policy may change over time, you should consult current OSHA administrative interpretations and decisions by the Occupational Safety and Health Review Commission and the Courts for additional guidance on OSHA compliance requirements.

Module 1: Confined Space Basic Concepts

Introduction

In order to fully understand the information offered in this course, you must first understand the terms used. So, let's take a look at some important definitions for common confined space terms used by most industries and regulatory agencies.

What is a confined space?

That depends on where you're working.

In the United States, a confined space is defined by OSHA as a space that meets all of the following three criteria:

1. The space is large enough and configured such that an employee can bodily enter and perform work;
2. The space has limited means of entry (access) and exit (egress), which means you need to use your hands or contort your body to enter the space; and
3. The space is not designed for continuous employee occupancy.

In Canada, each province may have their own definition of a "confined space," and each of these definitions may be slightly different from OSHA's definition in the U.S. Generally, regulatory agencies in Canada define a confine as having the following three characteristics:

1. It is a fully or partially enclosed space, and
2. It is not both designed and constructed for continuous human occupancy, and
3. It is a space in which atmospheric hazards may occur because of its construction, location or contents or because of work that is done in it.

Quiz Instructions

After each section, there is a quiz question. Make sure to read the material in each section to discover the correct answer to these questions. Circle the correct answer. When you are finished go online to take the final exam. This exam is open book, so you can use this study guide.

1. A confined space must have limited means of entry (access) and exit (egress). How is "limited means of entry" defined?

- a. You must use your hands or contort your body to enter/exit
- b. You can only enter at a certain time
- c. You must use stairs to enter or exit
- d. You do not use a door for entry/exit

What is the difference between these two definitions?

- In the United States, a confined space must be large enough for bodily entry. In Canada, the size of the space doesn't matter. Therefore, we may assume it must be large enough for part of the body, like the head, to enter. Actually, workers have been killed in confined space after only sticking their heads through a hatch or lid. Workers have also been killed in rather shallow trenches. To have a fatal confined space accident, all it takes is a trench or ditch a couple of feet (or a meter) in depth, and a heavier-than-air hazardous atmosphere.
- To be considered a confined space in the United States, the space must have limited access or egress. There is no such requirement in Canada. Examples of limited access are hatches or covers.
- In both the U.S. and Canada, a confined space must not be designed for human/employee occupancy.
- And finally, in Canada the space must have the potential for developing a hazardous atmosphere. In the United States, this requirement is not included in the definition.

In this course, we will focus on confined space entry as defined by OSHA in the USA.

Reasons for Entering Confined Spaces

Entering a confined space may be done for various reasons. It is done usually to perform a necessary function, such as inspection, repair, maintenance (cleaning or painting), or similar operations which would be an infrequent or irregular function of the total industrial activity.

Entry may also be made during new construction. One of the most difficult confined space entries to control is that of unauthorized entry, especially when there are large numbers of workers and trades involved, such as welders, painters, electricians, and safety monitors.

A final and most important reason for entry would be emergency rescue. This, and all other reasons for entry, must be well planned before initial entry is made and the hazards must be thoroughly reviewed.

2. Which type of confined space entry is listed as the most difficult to control?

- a. Authorized entry
- b. Unauthorized entry
- c. Construction sites
- d. Road construction

Permit-required confined spaces (PRCS)

By definition, a permit-required confined space is a space that meets the criteria for a confined space and has one or more of these characteristics:

1. Contains or has the potential to contain a hazardous atmosphere; or
2. Contains a material with the potential to engulf someone who enters the space; or
3. Has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section; or
4. Contains any other recognized serious safety or health hazards.

See the Confined Space Entry Decision Flow Chart to help you determine if your confined spaces need a permit.

Examples of confined spaces that could become permit spaces

Most confined spaces are designed to hold substances such as liquids, gases, and loose materials, or to house equipment. They come in many sizes and shapes, though most can be classified in one of two ways: those with depth and open tops and those with narrow openings. These are examples of each:

- Open-topped areas with deep spaces and narrow openings
- Ship compartments
- Pits
- Wells

- Silos
- Pipes
- Tunnels
- Tanks
- Casings
- Sewers
- Vats
- Hoppers
- Bins
- Degreasers
- Kettles

3. Which of the following is one of the four additional criteria for a permit-required confined space (PRCS)?

- a. It contains a hazardous atmosphere
- b. It is large enough for human occupation
- c. It has limited access and egress
- d. It is not designed for human occupation

Where confined spaces are found

Confined spaces are found not only in industrial settings but also in public places such as shopping malls and large public swimming pools. Waterfalls and water fountain displays used in malls for beautification may have pump vaults or valve pits that are seldom entered. Some swimming pool pumps are placed in vaults below ground. There have been reports of maintenance employees entering these areas and losing consciousness.

Take a look at this discussion that includes examples of where [confined spaces are found in construction...](#)

The general industry confined space standard does not address the unique characteristics of confined spaces in construction; therefore, OSHA is creating a separate rule to protect employees from the hazards resulting from exposure to confined spaces in the construction industry.

4. Which of the following would NOT meet the criteria for a confined space in the USA?

- a. a 55-gallon drum
- b. a trench
- c. a utility vault
- d. a manhole

Why confined spaces are hazardous to entrants

By nature, confined spaces can be hazardous due to:

- Space configurations such as small openings and inwardly converging walls, which can trap an entrant, restrict easy entry and exit, or impede rescue.
- Atmospheric hazards such as gasoline tank vapors, combined with limited ventilation. Such conditions can cause asphyxiation or explosion.
- Physical hazards, such as unstable grain contained in silos, which can engulf a worker.
- All other serious hazards associated with general industry, such as electrical equipment, moving machinery, falling objects, and wet or slippery surfaces.

Below is a list of potential hazards.

- No ventilation (pits and vaults seldom opened).
- Leaking chlorine gas (which is heavier than air) can accumulate in low-lying spaces.
- Oxygen depletion can be caused by:
 - Rotting vegetation and decaying dead animals.
 - Corroding or rusting machinery.

Read these actual [confined space accident summaries](#) to learn more about the dangers of confined spaces.

5. Atmospheric hazards such as low oxygen levels and gasoline vapors in confined spaces

_____.

- a. need not generally be measured
- b. are uncommon hazards in confined spaces
- c. can cause asphyxiation or explosion
- d. are less dangerous than engulfment hazards

What is confined space "entry"?

A confined space entry is considered to have occurred when any part of a person's body crosses the plane of an opening into the space. Each employer should ask these two questions at the onset of each project:

1. Is confined space entry always necessary for this task?
2. Is it possible to complete the task from the outside?

If possible, avoid entering a confined space. Every consideration should be given to completing the task from the outside.

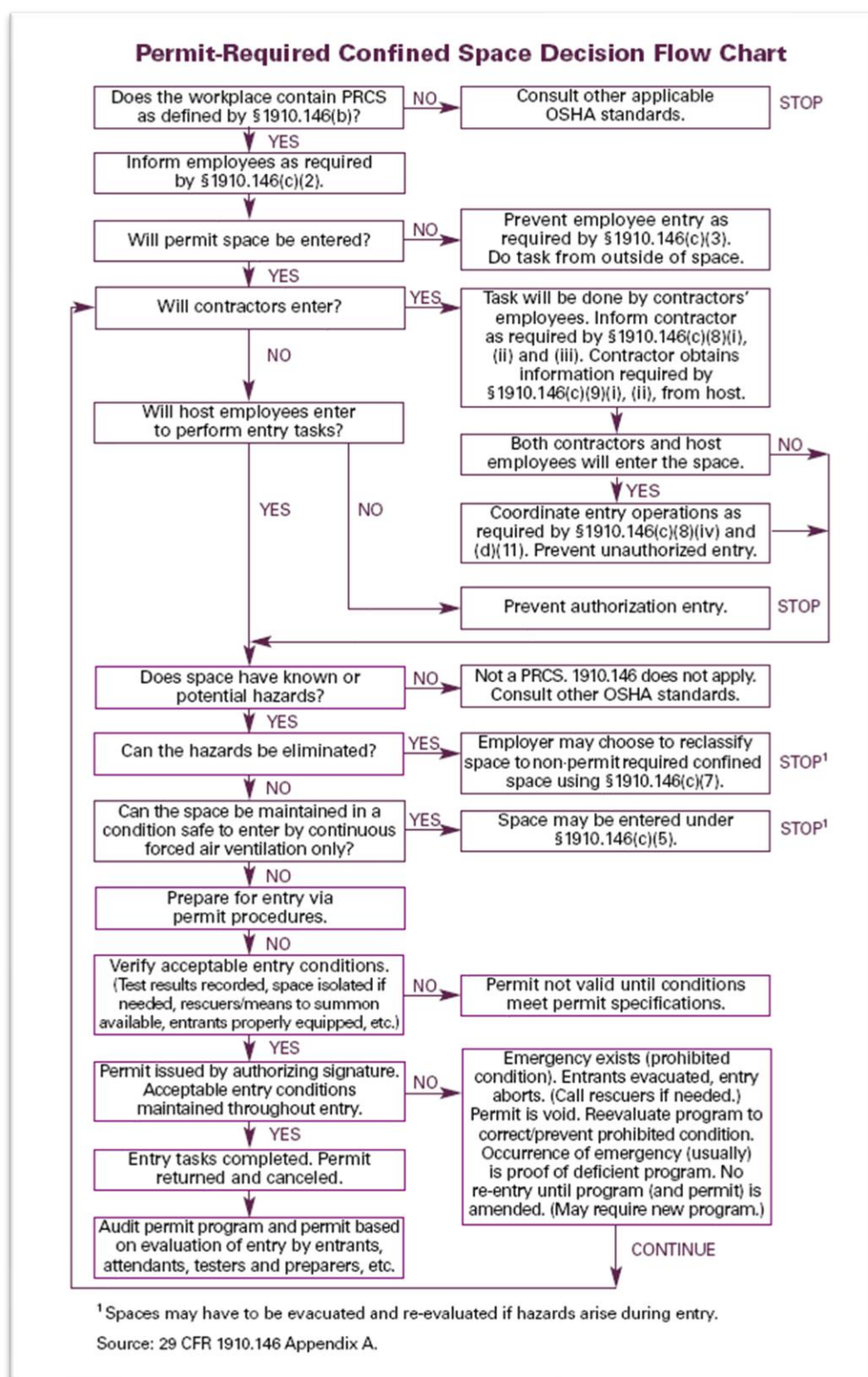
Using alternative entry procedures

Under certain conditions, you may use alternate procedures for worker entry into a permit space. For example, if you can demonstrate with monitoring and inspection data that the only hazard is an actual or potential hazardous atmosphere that can be made safe for entry using continuous forced air ventilation, you may be exempted from some entry requirements, such as permits and attendants. However, even in these circumstances, you must test the internal atmosphere of the space for oxygen content, flammable gases and vapors, and the potential for toxic air contaminants before any employee enters it. You must also provide continuous ventilation and verify that the required measurements are performed before entry.

6. A confined space entry is considered to have occurred when _____ crosses the plane of an opening into the space.

- a. a person's entire body
- b. any part of a person's body
- c. a person's hand
- d. a person's foot

Flow Chart



Module 2: Confined Space Program Elements

Introduction

Now that we've covered some of the basic concepts, we'll discuss the various components of a confined space entry program. If you allow employees entry into a permit space, you must develop and implement a written plan as part of your confined space entry program.

Elements of the confined space program

An effective confined space program will contain many important elements. Each of the elements should be describe in a written plan that includes a permit system. The items on the permit address the components of your written plan to ensure safety and health of all involved!

1. The employer must develop and implement a written plan as part of the Confined Space Program if _____.

- a. employees are not allowed to entry a permit space
- b. employees are required to enter a permit space
- c. whenever non-permit confined spaces are in the workplace
- d. the worker compensation issuing agency requires it

Workplace Evaluation Procedures- What is the written plan?

The written plan is an important element of the Confined Space Program because it helps to clarify what everyone is supposed to do and how to do it (a recurring theme). If everyone understands their duties and responsibilities, and is able to perform in a professional manner, the likelihood of serious accidents will decrease significantly. The written confined space safety plan should address the following:

- Identification of confined spaces
- Evaluation of permit spaces and hazards
- Development & implementation of safe entry operations
- Providing and maintaining all necessary equipment (PPE, monitors, etc.)
- Evaluating permit space conditions before & during entry operations
- Confined space entry team duties (authorized entrants, attendants, entry supervisors)
- Procedures for multiple spaces

- Confined space entry and rescue training
- Rescue & emergency procedures
- Entry permit procedures (issue, use, cancel)
- Measures implemented to prevent unauthorized entry
- Multi-employer entry procedures
- Procedures for concluding the entry (closing off the space)
- Review & evaluation of entry operations during the year (as needed)
- Annual permit space program review using the historic permits

2. A confined space written plan is important because it helps to _____.

- a. clarify duties and responsibilities
- b. complicate perceptions
- c. establish fault
- d. simplify procedures and practices

Identify Confined Spaces

The first step in confined space program development is to identify confined spaces. Next, evaluate each confined space to determine if it is a permit space. Keep in mind, permit space has one or more of the characteristics listed below.

1. Contains - or could contain - an atmospheric hazard.
2. Contains material that could trap or bury an entrant.
3. Is shaped such that an entrant could become trapped or asphyxiated.
4. Contains any other safety or health hazard that could harm an entrant.

Take a look at the [Confined Space Decision Tree](#) to help determine if you have permit or non-permit confined spaces.

3. The first step in confined space program development is to ____.

- a. place non-entry signs on all potential confined spaces
- b. analyze the characteristics of confined spaces
- c. identify confined spaces
- d. evaluate confined spaces

Warning signs

If a workplace contains permit spaces, the employer must inform exposed employees of their existence, location and the hazards they pose. When your employees will not enter confined spaces, you must place warning signs that prohibit entry and take other effective measures that prevent them from entering confined spaces. This can be done by posting danger signs such as "DANGER -- PERMIT-REQUIRED CONFINED SPACE -- AUTHORIZED ENTRANTS ONLY" or using an equally effective means.

Usually "effective measures" means making sure employees can't get into the confined space without unlocking or unbolting a hatch. It should not be easy to get in to a confined space. Hatches and covers must be relatively difficult to open.

4. "Effective measures" to prevent unauthorized entry means making sure employees can't get into the confined space without ____.

- a. showing proper identification
- b. getting permission from someone
- c. removing the posted "danger" sign
- d. unlocking or unbolting a hatch

Hazard identification procedures

Identify and evaluate permit space hazards before allowing employee entry. This should be done initially and prior to each entry if the space is designated a confined space. You must identify all existing or potential hazards in each permit space at your workplace. Those who enter permit spaces face two kinds of hazards: atmospheric and non-atmospheric. Atmospheric hazards affect the air in the space and can be flammable, toxic, corrosive, or asphyxiating.

Test atmospheric conditions in the permit space before entry operations and monitor the space during entry. Always test the atmosphere as most confined space injuries and fatalities are caused by hazardous atmospheres. Be especially careful when evaluating a space that could

contain an atmospheric hazard! The only way to identify an atmospheric hazard is to test for it from outside the space.

Perform appropriate testing for the following atmospheric hazards in this sequence: oxygen, combustible gases or vapors, and toxic gases or vapors. Remember "O-F-T" and you can't go wrong.

Always test for atmospheric hazards in the following order:

1. O - oxygen deficiency, enrichment or displacement
2. F - flammable or explosive atmospheres
3. T - toxic or corrosive atmospheres

Never assume a confined space is hazard-free. Non-atmospheric hazards include conditions such as:

- mechanized equipment
- loose materials
- excessive noise
- extreme temperatures
- low light
- difficult access
- psychological stress

5. Which of the following is the correct order for testing atmospheric hazards prior to entry into a confined space?

- a. Flammability/explosivity, Oxygen level, Toxicity/corrosivity (F-O-T)
- b. Toxicity/corrosivity, Flammability/explosivity, Oxygen level (T-F-O)
- c. Oxygen level, Flammability/explosivity, Toxicity/corrosivity (O-F-T)
- d. Oxygen level, Toxicity/corrosivity, Flammability/explosivity (O-T-F)

Procedures and practices

Once you analyze and determine the hazards and nature of the external and internal environment, you must develop procedures and practices to make sure the work is safe.

Establish and implement the means, procedures and practices to eliminate or control hazards necessary for safe permit space entry operations. Have ways to eliminate the hazards if they're

detected. Identify employee job duties. Entry supervisors, attendants and authorized entrants must know their jobs. We'll cover all of these topics in future modules.

Review established entry operations annually and revise the permit space entry program as necessary. An annual review and refresher training is important. Practice rescue if you have a team at least annually.

Entry permit system

Establish, in writing, and implement a system for the preparation, issue, use and cancellation of [entry permits](#). If it meets the requirements for a permit, you must complete the permit before entry. An entry permit must be developed and used for each entry into a permit-required confined space.

6. Once you analyze and determine the hazards and nature of the external and internal environment prior to confined space entry, you must ____.

- a. categorize each space for entry approval
- b. establish and implement effective procedures and practices
- c. check with OSHA to ensure compliance
- d. get approval for confined space entry from local authorities

Employee Training for Authorized Entrants, Attendants, and Entry Supervisors

You must train entry procedures and practices for the specific space being entered. The training must specify the confined space entry team (supervisor, attendant, and entrant) duties and responsibilities. Ensure that at least one attendant is stationed outside the permit space for the duration of entry operations. Coordinate entry operations when employees of more than one employer are working in the permit space. Typically, the Entry Supervisor does this. You'll read more about confined space entry team duties and responsibilities in Module 7.

Controlling Confined Space Hazards

Your written confined space plan should establish the means, procedures and practices to eliminate or control hazards necessary for safe permit space entry operations.

These may include:

- specifying acceptable entry conditions;
- isolating the permit space;
- providing barriers;

- verifying acceptable entry conditions; and
- purging, making inert, flushing or ventilating the permit space.

7. Confined space training must specify the duties and responsibilities of the ____.

- a. confined space safety committee entry member
- b. confined space entry team supervisor, attendant, and entrant
- c. emergency confined space action plan coordinator
- d. confined space entry program manager or supervisor

Module 3: The Confined Space Entry Permit

Purpose of Confined Space Entry Permit

An entry permit is a document prepared by the employer or employer representative. It is designed to be used as a checklist to document the completion of all steps necessary to prepare for safe entry and work in a confined space.

The entry supervisor must sign the entry permit to:

1. ensure that acceptable conditions have been attained in the permit space and
2. authorize entry.

Further, you must post the permit near the confined space entry for entrants to verify that pre-entry procedures have been completed.

1. Who must sign the entry permit before it is considered valid?

- a. Safety officer
- b. Attendant
- c. Entry supervisor
- d. Department supervisor

Sections of the entry permit

The entry permit must include:

- The location of the permit space to be entered. The specific location with the facility or site should be noted.
- The purpose of the entry. The permit must state the specific purpose of the work being performed.
- The date and the authorized duration of the entry permit. The permit must indicate when and how long the work is going to occur.
- The names of authorized entrants, attendants, and entry supervisors. The permit must list all workers who will be working within the space, attending to the workers, and the person supervising the entry.
- The hazards of the permit space. All hazards (electrical, mechanical, environmental, etc.) must be listed.

- The measures used to eliminate, isolate, or control permit space hazards before entry. The permit must list the procedures used to totally eliminate a hazard, isolate the space from hazards, or control the hazards. Lockout, block out, and ventilation are common measures.
- The acceptable entry conditions. The permit must list acceptable [LELs](#), [PELs](#), etc.
- The results of initial and periodic tests performed, along with the names of the testers and when these tests were performed.
- The verified rescue and emergency services to be summoned. Enter the on-site or off-site rescue services.
- The communication system. List the type of equipment that will be used to make sure direct communication is available.
- The equipment to be used during entry. Tools, equipment, personal protective equipment, electrical protective equipment, fall protection, etc., must be listed.
- Any additional information necessary to ensure employee safety.
- Any additional permits issued to authorize special work in the space. For example, a Hot Work Permit may be required.

2. The confined space entry permit must indicate the ____.

- a. the location of past entry permits
- b. phone number of the local health department
- c. specific location within the facility or site
- d. the date OSHA approved the entry

Permit validity

The entry permit is valid once it has been signed by the entry supervisor. An entry permit is valid for more than one shift if it contains adequate information, and the following criteria is met:

- Names of all involved employees (entry team plus next shift).
- Clearly delineated transfer of responsibilities from one shift to another.
- Acceptable entry conditions are maintained.

- Entry operations remain consistent with terms of the entry permit.

3. When is the confined space entry permit valid?

- a. When OSHA approves it
- b. When the safety manager has reviewed it
- c. When the entry supervisor signs it
- d. When the form has been completed

Cancelling entry permits

The entry supervisor must cancel entry permits when an assignment is completed or when new conditions exist. New conditions must be noted on the canceled permit and used in revising the permit space program. The OSHA confined space standard requires that the employer keep all canceled entry permits for at least one year.

Entry permit maintenance

The entry permit should be kept on file for one year. The annual review of canceled permits allows employers to assess and revise, if needed, their permit space program to ensure that confined space workers are protected from space hazards. See below for a sample permit.

4. The OSHA confined space standard requires the employer to keep all canceled entry permits for at least ____.

- a. one year
- b. two years
- c. five years
- d. ten years

Sample Permit

A Sample Permit

XYZ Inc., Confined Space Entry Permit (Example)

Date & Time Issued _____	Date & Time Expires _____
Job site/space I.D. _____	Job Supervisor _____
Equipment to be worked on _____	Work to be performed _____
Entrants _____	
Stand-by personnel _____	

1. Atmospheric checks Time _____

Oxygen _____%	
Explosive _____% LFL	
Toxic _____PPM	

2. Tester's signature _____

3. Source isolation (No Entry) NA Yes No

Pumps or lines blinded, disconnected or blocked	NA	Yes	No
	___	___	___

4. Ventilation Modification

Mechanical	___	___	___
Natural Ventilation only	___	___	___

5. Atmospheric check after isolation and ventilation

Time _____	
Oxygen _____%	> 19.5%
Explosive _____%LFL	< 10%
Toxic _____PPM	< 10 PPM H ₂ S
Tester's signature _____	

6. Communication procedures _____

7. Rescue procedures: _____

8. Entry, standby, backup persons

Training completed? Yes ___ No ___	
Training current? Yes ___ No ___	

9. Equipment	NA	Yes	No
Direct reading gas monitor tested?	___	___	___
Safety harnesses/lifelines for entrants/standby crew?	___	___	___
Hoists	___	___	___
Powered communications?	___	___	___
SCBA's for entrants and standby crew?	___	___	___
Protective clothing?	___	___	___
All electric equipment listed Class I, Div I, Group D and non-spark producing?	___	___	___

10. Periodic atmospheric tests

Time _____	O ₂ _____%	Explosive _____%	Toxic _____%
Time _____	O ₂ _____%	Explosive _____%	Toxic _____%
Time _____	O ₂ _____%	Explosive _____%	Toxic _____%
Time _____	O ₂ _____%	Explosive _____%	Toxic _____%
Time _____	O ₂ _____%	Explosive _____%	Toxic _____%
Time _____	O ₂ _____%	Explosive _____%	Toxic _____%
Time _____	O ₂ _____%	Explosive _____%	Toxic _____%
Time _____	O ₂ _____%	Explosive _____%	Toxic _____%

We have reviewed the work authorized by this permit and the information contained herein. Written instructions and safety procedures have been received and are understood. Entry cannot be approved if any column is marked "no". This permit is not valid unless all appropriate items are completed.

Permit prepared by: (Supervisor) _____

Approved by: (Unit Supervisor) _____

Reviewed by: (CS Ops Personnel) _____

(Printed Name)

(Signature)

Module 4: Confined Space Atmospheric Hazards

Introduction

Many confined space accidents occur because the workers did not realize the dangers or potential dangers within or nearby the space. Workers may not take into account the new hazards and other conditions created during work in confined spaces. Thus, it is crucial to carefully identify all confined space hazards before entering a space.

Confined space hazard categories

Usually, confined space incidents are caused by multiple factors. There are two primary categories of hazards:

1. Atmospheric, or those that involve problems with the air in the space (lack of oxygen, the presence of other gases in the space, etc.) and
2. Non-atmospheric, physical, or those hazards that are caused either by equipment (rotors, sparks, etc.) or by other dangerous conditions (slippery surfaces, heat, etc.).

It is critical that you identify all the hazards in a space and determine how they can impact the health and safety of workers who enter this space.

1. What are the two basic types of confined space hazards?

- a. Ergonomic and physical
- b. Atmospheric and non-atmospheric
- c. Falls and overexposure
- d. Mechanical and dangerous surfaces

Hazardous atmospheres

A hazardous atmosphere is any atmosphere that may incapacitate, injure, or impair an employee's self-rescue or lead to acute illness or death to workers and rescuers who enter confined spaces.

The following are examples of hazardous atmospheres within a confined space:

- Flammable or explosive gas, vapor, or mist in a concentration greater than 10 percent of its lower flammable limit (LFL) or lower explosive limit (LEL).

- Combustible dust suspended in air, which obscures vision at a distance of five feet or less.
- Atmospheric oxygen concentration levels below 19.5 percent or above 23.5 percent at sea level.
- Atmospheric concentration of any substance with an acutely toxic effect above its PEL, and any other atmospheric condition that is IDLH.

This does not include atmospheric concentrations of substances that are not capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness.

Acceptable atmospheric conditions

For guidance, refer to sources of information such as a Safety Data Sheet (SDS) that comply with published scientific and industry information, and National Consensus Standards from organizations such as the [American Conference of Governmental Industrial Hygienists](#) (ACGIH) and the [National Institute for Occupational Safety and Health](#) (NIOSH).

2. Which of the following is an example of a hazardous atmosphere in a confined space?

- a. Combustible dust
- b. The temperature at 4 degrees Celsius
- c. The oxygen level is at 21%
- d. The concentration of toxic gas is below its PEL

Oxygen deficiency

The normal atmosphere is composed approximately of 20.9% oxygen and 78.1% nitrogen, and 1% argon with small amounts of various other gases.

- Oxygen deprivation is one form of asphyxiation. While it is desirable to maintain the atmospheric oxygen level at 21% by volume, the body can tolerate deviation from this ideal.
- When the oxygen level falls to 17%, the first sign of hypoxia is a deterioration of night vision which is not noticeable until a normal oxygen concentration is restored. Physiological effects are increased breathing volume and accelerated heartbeat.
- Between 14-16% physiologic effects are increased breathing volume, accelerated heartbeat, very poor muscular coordination, rapid fatigue, and intermittent respiration.

- Between 6-10% the effects are nausea, vomiting, inability to perform, and unconsciousness.
- Less than 6%, spasmodic breathing, convulsive movements, and death in minutes. Reduction of oxygen in a confined space may be the result of either consumption or displacement.
- The consumption of oxygen takes place during combustion of flammable substances, as in welding, heating, cutting, and brazing. A more subtle consumption of oxygen occurs during bacterial action, as in the fermentation process. Oxygen may also be consumed during chemical reactions as in the formation of rust on the exposed surface of the confined space (iron oxide). The number of people working in a confined space and the amount of their physical activity will also influence the oxygen consumption rate.
- A second factor in oxygen deficiency is displacement by another gas. Examples of gases that are used to displace air, and therefore reduce the oxygen level are helium, argon, and nitrogen. Carbon dioxide may also be used to displace air and can occur naturally in sewers, storage bins, wells, tunnels, wine vats, and grain elevators.

Aside from the natural development of these gases, or their use in the chemical process, certain gases are also used as inerting agents to displace flammable substances and retard pyrophoric reactions. Gases such as nitrogen, argon, helium, and carbon dioxide, are frequently referred to as non-toxic inert gases but have claimed many lives.

The use of nitrogen to inert a confined space has claimed more lives than carbon dioxide. The total displacement of oxygen by nitrogen will cause immediate collapse and death. Carbon dioxide and argon, with specific gravities greater than air, may lie in a tank or manhole for hours or days after opening. Since these gases are colorless and odorless, they pose an immediate hazard to health unless appropriate oxygen measurements and ventilation are adequately carried out.

3. At what percentage of oxygen do accelerated heartbeat and poor muscular coordination occur?

- a. Less than 6%
- b. Falls below 5%
- c. Between 14-16%
- d. Between 6-10%

Oxygen enrichment

Oxygen enrichment refers to air containing more than 23.5 percent oxygen. This dangerous condition is an extreme fire hazard in which static electricity from materials such as hair or clothing can provide the ignition source needed to start a fire. This environment also allows any fire to burn more readily. Oxygen enrichment does not occur naturally and should be investigated.

Oxygen enrichment can be caused by leaking oxygen cylinders or hoses that have been brought into or near the space. Always ventilate confined spaces with normal, ambient air. Never use pure oxygen.

Combustible and flammable gases

Atmospheres containing combustible or flammable gases or vapors can be dangerous because of the threat of fire and explosion.

Three ingredients are necessary for an atmosphere to become flammable or explosive:

1. an ignition source (heat or flame),
2. fuel (combustible gas or vapor), and
3. oxygen.

However, the proportions of fuel and oxygen in a mixture must be within the flammable range for this mixture to be readily ignitable.

4. What are the three ingredients necessary for an atmosphere to become flammable or explosive?

- a. Proper sequence, gas, fuel
- b. Fuel, gas, ignition source
- c. Ignition source, fuel, oxygen
- d. Oxygen, ignition source, proper sequence

Lower Flammability Limits (LFL) and Lower Explosive Limits (LEL)

The lower explosive limit, or LEL, is the lowest atmospheric concentration of fuel in the fuel-air mixture at which a gas or vapor can explode. The lower flammable limit, or LFL, is the lowest concentration at which the gas or vapor will burn. Fuel concentrations below the LEL and LFL

will not explode or burn because there is not enough fuel in the mixture and is considered too "lean".

For example, the lean flammability limit for Jet A (aviation kerosene) in air at sea level is a concentration (by volume or partial pressure) of about 0.7%. The rich flammability limit is about 4.8% by volume or partial pressure. Flammability limits are not absolute, but depend on the type and strength of the ignition source.

Upper Explosive Limit (UEL) and Upper Flammability Limit (UFL)

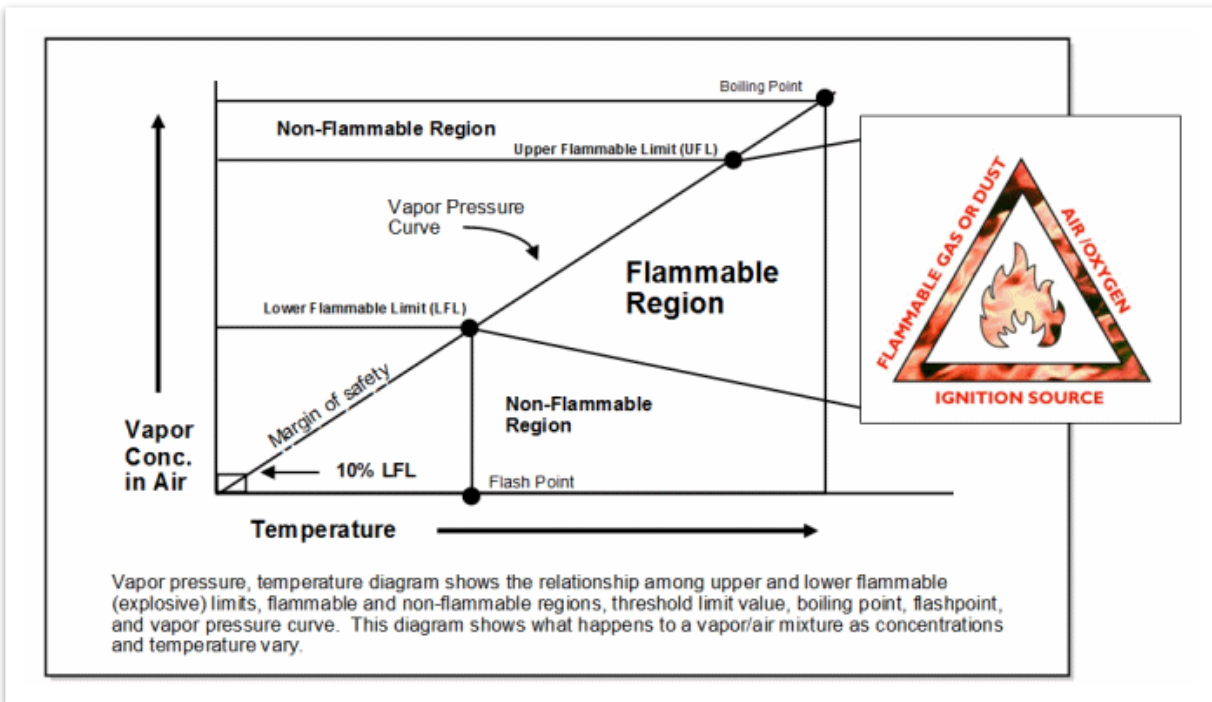
The highest atmospheric concentration of a gas or vapor in the fuel-air mixture that can explode is called the upper explosive limit, or UEL. The upper flammability limit, or UFL, is the maximum fuel concentration above which the mixture will not burn. Above this concentration, the mixture will not explode or burn because it has too much fuel and is considered too "rich".

The composition of a fuel vapor and air mixture can change over time and may fluctuate within a confined space. Fluctuations occur because the fuel-air mixture moves around the space, particularly when people or other things create air currents that disturb the atmosphere. Consequently, the mixture is not uniformly distributed within the space.

Flammable Range

Gases or vapors can only be explosive or flammable between their LEL/LFL and UEL/UFL. This is called the explosive/flammable range. Substances with a wide explosive/flammable range are considered to be more hazardous since they are readily ignitable over a wider range. However, any concentration of combustible gas or vapor should be of serious concern in a confined space. Workers should be especially careful when ventilating a space containing a gas or vapor above its UEL/UFL. In order to reduce the concentration below the LEL, this procedure will first bring the gas or vapor within its explosive/flammable range. When it does, the possibility of an exposure or fire exists.

The diagram on the right shows the relationship among the lower and upper explosive/flammability limits, explosive/flammable and non-explosive/flammable regions, flash points, and the vapor pressure curve. It also reveals what happens to a vapor/air mixture as concentrations and temperatures vary.



5. The explosive/flammable range exists ____.

- a. above the LEL/UFL
- b. below the UEL/UFL
- c. between the LEL/LFL and UEL/UFL
- d. below the LEL/LFL and above the UEL/UFL

Combustible dust atmospheres

Finely powdered dust from combustible materials such as wood, metal, or grain can be fuel for powerful explosions. Dust clouds can develop as result of handling dusty materials or when solid materials are reduced to smaller particles from processes such as grinding, drilling, or crushing.

Airborne combustible dust at an explosive concentration would obscure vision at a distance of five feet (1.52 meters) or less. A direct reading instrument may be used to measure actual dust concentrations.

Toxic atmospheres

Substances regarded as toxic in a confined space can cover the entire spectrum of gases, vapors, and finely-divided airborne dust in industry. Toxic gases may be present in a confined space because:

- toxic substances are used as part of the production process, (for example, in producing polyvinyl chloride, hydrogen chloride is used as well as vinyl chloride monomer, which is carcinogenic).
- the biological and chemical "breakdown" of the product being stored in a tank, or
- maintenance activities (welding) being performed in the confined space.

Four common types of toxic gases encountered in confined spaces are:

1. **Hydrogen Sulfide (H₂S)** - "sewer gas" a colorless gas with the odor of rotten eggs. Excessive exposure has been linked to many confined space deaths. Hydrogen sulfide causes a loss of our sense of smell, causing people to mistakenly think that the gas has left the space. Hydrogen sulfide inhibits the exchange of oxygen on the cellular level and causes asphyxiation.
2. **Carbon monoxide (CO)** - is an odorless, colorless gas that is formed by burning carbon-based fuels (gas, wood). Carbon monoxide inhibits the body's ability to transport oxygen to all parts of the body.
3. **Methane (CH₄)** is a natural gas produced from the decay of organic matter. It is a flammable, explosive, colorless, and odorless gas. It can displace oxygen to the point of oxygen deficiency in a confined space, causing dizziness, unconsciousness, and asphyxiation.
4. **Solvents** - many solvents, such as kerosene, gasoline, paint strippers, degreasers, etc. are not only flammable, but if inhaled at high concentrations can cause central nervous system (CNS) effects. CNS effect can include dizziness, drowsiness, lack of concentration, confusion, headaches, coma and death.

(Source: University of South Carolina)

Remember, atmospheric changes may occur due to the work procedure, the product stored, or a nearby gas line leak. The atmosphere may be safe upon entry but can change very quickly.

- The work performed within the confined space (such as welding, degreasing, painting, or sanding) may produce toxic atmospheres.
- Toxic gases and vapors from adjacent areas can migrate to and collect in the confined space.
- Vapors may be released from the sludges on the bottom or scales on walls of emptied confined spaces, such as storage tanks, that previously contained flammable or toxic chemicals. Vapor release may be accelerated by wall scraping and sludge removal from confined spaces.

Confined spaces prevent toxic substances from escaping, diluting, or readily dissipating. Instead, substances can become trapped and a buildup occurs, whereby the concentrations of toxic substances reach dangerous levels.

The atmosphere inside a confined space can change rapidly and unexpectedly. Also, any ignition source (such as sparks from grinding or welding equipment, static electricity, or unapproved electrical equipment that is not non-sparking or even smoking) can initiate an explosion.

6. Which of the following gases inhibits the body's ability to transport oxygen to all parts of the body?

- a. Methane
- b. Carbon monoxide
- c. Hydrogen sulfide
- d. Nitrogen

Irritant/Corrosive Atmospheres

Irritant or corrosive atmospheres can be divided into primary and secondary groups.

1. The primary irritants exert no systemic toxic effects (effects on the entire body). Examples of primary irritants are chlorine, ozone, hydrochloric acid, hydrofluoric acid, sulfuric acid, nitrogen dioxide, ammonia, and sulfur dioxide.
2. A secondary irritant is one that may produce systemic toxic effects in addition to surface irritation. Examples of secondary irritants include benzene, carbon tetrachloride, ethyl chloride, trichloroethane, trichloroethylene, and chloropropene.

Irritant gases vary widely among all areas of industrial activity. They can be found in plastics plants, chemical plants, the petroleum industry, tanneries, refrigeration industries, paint manufacturing, and mining operations.

Prolonged exposure at irritant or corrosive concentrations in a confined space may produce little or no evidence of irritation. This may result in a general weakening of the defense reflexes from changes in sensitivity. The danger in this situation is that the worker is usually not aware of any increase in his/her exposure to toxic substances.

Examples of Corrosives

- Bleach
- Ammonia
- Acids

7. Which category of irritants produces systemic toxic effects if exposure occurs in a confined space?

- a. Primary irritant
- b. Secondary irritant
- c. Acute irritant
- d. Chronic irritant

The Safety Data Sheet (SDS)

To find out information on the hazardous substances used in a confined space, read the product label and/or the SDS. Labels provide general product information, and the SDS gives useful information on proper use and handling, special precautions, and first aid treatment. When a chemical product is purchased, the manufacturer or supplier of the product provides an SDS. The SDS must be readily available to any employee who wishes to learn about a product that he or she comes into contact with. If you have any questions, contact your safety Department, the manufacturer or supplier of the product, the [NIOSH Pocket Guide to Chemical Hazards](#), or a consultant. Here is a [sample SDS](#)

Monitoring and testing for hazardous atmospheres

Atmospheric testing is required for two distinct purposes:

1. Evaluation of the hazards of the permit space, and

2. Verification that acceptable entry conditions for entry into that space exist

Continual monitoring in confined spaces is necessary because there are unseen and odorless contaminants (or oxygen-deficient atmospheres) that can kill or incapacitate workers. Monitoring is the only way to detect whether a hazardous atmosphere has developed during entry. If this is the case, employees will be alerted to the change so they can leave the space immediately.

Of those contaminants that have odor, some can be detected by our senses only at low concentration. Hydrogen sulfide, for example, will deaden the sense of smell at high concentrations. Because of this, employees might assume that a confined space is safe when it is not. There is no substitute for testing the air in a confined space prior to entry. A worker can also be exposed to a contaminant through skin contact while working in a confined space.

Atmospheric monitoring is necessary whenever:

- A safe atmosphere cannot be ensured.
- An existing hazardous atmosphere cannot be removed.
- The confined space cannot be physically isolated from the penetration of hazardous materials.
- There is reason to suspect the development of a hazardous atmosphere during work activity.

8. Which of the following is listed as a reason for atmospheric testing?

- e. An existing hazardous atmosphere cannot be removed
- f. A safe atmosphere can be ensured
- g. The confined space can be isolated
- h. There is no reason to assume hazardous atmospheres exist

The "OFT" order of testing in confined spaces

Always test for atmospheric hazards in the following order:

1. Oxygen is tested first because most combustible gas and toxic atmosphere meters are oxygen-dependent and will not provide reliable readings when used in oxygen-deficient atmospheres. In addition, both oxygen-deficient and oxygen-enriched atmospheres are extremely hazardous to workers' health and safety. Oxygen levels should be between 19.5% - 23.5%.
2. Flammable or explosive gases and vapors are tested next because the threat of fire and explosion is both more immediate and more life-threatening, in most cases, than exposure to toxic gases and vapors. Flammability limits should be less than 10% of the Lower Flammability Limit (LFL)
3. Toxic atmospheres are tested last. Many modern direct-reading instruments provide simultaneous readings of multiple gases. Readings should be less than recognized ACGIH exposure limits or other published exposure levels (e.g. OSHA PELs, NIOSH RELs).

Atmosphere Sampling Procedure

The atmosphere of a confined space should be analyzed using equipment of sufficient sensitivity and specificity to identify and evaluate any hazardous atmospheres that may exist or arise, so that appropriate permit entry procedures can be developed, and acceptable entry conditions stipulated for that space.

Evaluation and interpretation of this data, and development of the entry procedure, should be done by, or reviewed by, a technically qualified professional (e.g., OSHA consultation service, or certified industrial hygienist, registered safety engineer, certified safety professional, certified marine chemist, etc.) based on evaluation of all serious hazards.

The atmosphere of a permit space should be tested for residues of all contaminants identified by evaluation testing to determine that residual concentrations at the time of testing and entry are within the range of acceptable entry conditions.

When monitoring for entries involving a descent into atmospheres that may be stratified, the atmospheric envelope should be tested a distance of approximately 4 feet (1.22 m) in the direction of travel and to each side. If a sampling probe is used, the entrant's rate of progress should be slowed to accommodate the sampling speed and detector response.

Results of testing (i.e., actual concentration, etc.) should be recorded on the permit in the space provided adjacent to the stipulated acceptable entry condition.

If entrants leave the confined space for any reason, they should once again test the atmosphere within confined spaces because it can change rapidly.

Test results that show the composition of an atmosphere to which employees are actually exposed (even if the employees are using respirators) must be available so that they can be reviewed by members of the entry team or representatives.

9. Oxygen levels in a confined space should be maintained at ____.

- a. more than 30%
- b. less than 10%
- c. 25%-30%
- d. 19.5%-23.5%

Direct-reading testing instruments

Electronic gas detectors and color-indicator gas detector tubes are the most common types of instruments used for determining oxygen content, lower explosive limit, and toxic atmospheres.

Purchasing monitoring equipment

The typical confined space gas monitors will offer up to four independent sensors for the detection of oxygen, combustible gas, carbon monoxide, and hydrogen sulfide. Before purchasing confined space testing equipment, it is important to evaluate the instrument:

- Accuracy.
- Environmental operating range:
 - Remote sampling capability.
 - Operating temperature.
 - Relative humidity.
- Intrinsic safety for explosive atmospheres.
- Specificity for contaminant of interest.

- Warm-up time.
- Response time.
- Ruggedness.
- Ease of use and maintenance.
- Vendor support.
- Sensor and battery life.
- Data-logging capabilities.

What does "immediately dangerous to life or health" (IDLH) mean?

This term refers to any condition in a permit space that would:

1. Cause irreversible adverse health effects; or
2. Interfere with self-rescue; or
3. Cause immediate or delayed threat to life or health.

Permissible Exposure Limits (PELs)

Permissible exposure limits, or PELs, are occupational exposure standards that refer to the maximum concentration of airborne chemicals to which nearly all healthy persons can be exposed day after day without adverse health effects. Workers' exposure to concentration of materials in excess of the PEL can result in detrimental health effects, including illness and/or death.

10. A space that can cause irreversible adverse health effects is designated as ____.

- a. an OSHA regulated health or safety space
- b. Immediately Dangerous to Life or Health (IDLH)
- c. Potential Health Hazard Space (PHHS)^b
- d. an imminent high hazard area

Real-Life Accident

A 49-year-old worker suffocated inside of a chemical tank at the Port of New Orleans. The Occupational Safety and Health Administration (OSHA) said the Illinois company sent three workers into a tank in October 2015 without first testing the air quality or providing them lifelines. As a result, one of the workers was killed and the others were hospitalized.

Penalties

OSHA proposed \$226,000 in fines against the company in connection with nine safety violations. Two of the nine proposed violations were classified as "willful," which is the most serious category. This category is reserved for situations where an employer knows of an unsafe condition or practice but does nothing about it.

Before the worker's death, OSHA cited the company for almost 30 violations. Many of those violations were related to failure to take proper precautions when sending workers into confined spaces filled with dangerous chemicals.

Module 5: Non-Atmospheric Hazards

Types of physical hazards encountered in confined spaces

Hazardous atmospheres are not the only hazards within confined spaces. As we'll see there are many actual and potential non-atmospheric hazards within confined spaces, and we need to be aware of them to make sure they are eliminated.

Mechanical Hazards

If activation of electrical or mechanical equipment would cause injury, each piece of equipment should be manually isolated to prevent inadvertent activation before workers enter or while they work in a confined space.

The interplay of hazards associated with a confined space, such as the potential of flammable vapors or gases being present, and the build-up of static charge due to mechanical cleaning, such as abrasive blasting, all influence the precautions which must be taken.

- To prevent vapor leaks, flashbacks, and other hazards, workers should completely isolate the space.
- To completely isolate a confined space, the closing of valves is not sufficient.
- All pipes must be physically disconnected, or isolation blanks bolted in place.
- The pipes blanked or disconnected should be inspected and tested for leakage to check the effectiveness of the procedure.
- Other areas of concern are steam valves, pressure lines, and chemical transfer pipes.

A less apparent hazard is the space referred to as a void, such as double walled vessels, which must be given special consideration in blanking off and inerting. Other special precautions must be taken in cases where flammable liquids or vapors may re-contaminate the confined space.

1. What should be done if the activation of electrical or mechanical equipment could cause injury while working in a confined space?

- a. Stay clear of the equipment
- b. Isolate each piece of equipment
- c. Post warning signs
- d. Do not permit entry

Skin Contact Hazards

Toxic solvents, chemical removers, and flammable and combustible liquids can harm employees' eyes and skin. Workers should understand the hazards associated with the materials used and contained in the space. This includes training in accordance with the Hazard Communication Standard. Hazards may include:

- Organ damage by absorption through the skin or eye.
- Eye or skin irritation.
- Defatting of skin.

Requirements and Example Solutions:

- Use appropriate personal protective equipment (PPE).
- Clean up spills or other releases of flammable, combustible, toxic, corrosive and irritant materials as work progresses.
- Ensure that washing facilities are available.

Limited Access Hazards

When working in confined or enclosed spaces, egress may be blocked by:

- Improperly located equipment.
- Temporary ventilation ducts and hoses running through the entrance.
- "Interference" such as piping, ventilation ducts, and electrical wiring.

Requirements and Example Solutions:

- When employees work in confined or enclosed spaces with limited access, the access must not be blocked or impeded by ventilation ducts, hoses, or other equipment.
- More than one means of access must be provided where practical.
- Additional openings should be considered for ducts, hoses, and other equipment.

2. When employees work in confined or enclosed spaces with limited access, ____.

- a. the access must not be blocked or impeded by equipment
- b. the access must be wide enough for two entrants
- c. at least 2 access points must be provided
- d. ventilation must be removed during operations

Slip and Trip Hazards

Workers can be exposed to slippery working surfaces and tripping hazards. This places workers at risk of:

- Slipping off oily and greasy ladders.
- Slipping and falling on oily surfaces.
- Tripping over equipment, hoses, and structures.

Requirements and Example Solutions:

- All spills should be cleaned up immediately.
- Visual inspection should be conducted.
- Adequate illumination should be provided.
- Housekeeping should be maintained.

Fall Hazards

Fall hazards are a leading cause of workplace fatalities. Employees are often required to work in dangerous environments that may include fall hazards. Accidents involving elevation equipment such as ladders, scaffolds, and aerial lifts are often serious, even fatal. Here are just a few scenarios where falls could occur:

- Deck Openings and Edges
- Falls from roof edges
- Falls from floor openings
- Falls into open holes

- Falls from ladders
- Falls from scaffolds

Personal Fall Protection System

If fall hazards are identified through a hazard assessment, employees must be protected from falls by the use of personal fall protection equipment including body harnesses and lifelines. Guardrails may be used to protect workers along floor openings or edges, in lieu of personal fall protection.

3. Employees must be protected from falls in confined spaces by the use of ____.

- a. hole covers
- b. personal fall arrest protection only
- c. personal fall protection and guardrails
- d. warning signs and cones

Work Environment Temperature Related Hazards

A thermal hazard is a dangerous condition caused by excessive heat or cold or a hot surface. Employees engaged in continuous heavy work while wearing PPE (e.g., body suit and respirator) in warm surroundings are particularly susceptible to thermal hazards. Heat stress may lead to heat exhaustion, heat cramps, heat stroke, loss of consciousness, or death. A confined space entry permit must address any hazards from heat or cold within confined spaces. A combination of PPE use, heat-producing equipment, work activity, and environmental conditions can cause temperature-related illnesses.

Four factors influence the interchange of heat between people and their environment. They are:

1. air temperature,
2. air velocity,
3. moisture contained in the air, and
4. radiant heat.

Because of the nature and design of most confined spaces, moisture content and radiant heat are difficult to control. As the body temperature rises progressively, workers will continue to function until the body temperature reaches approximately 102°F. When this body

temperature is exceeded, the workers are less efficient, and are prone to heat exhaustion, heat cramps, or heat stroke. In a cold environment, certain physiologic mechanisms come into play, which tend to limit heat loss and increase heat production. The most severe strain in cold conditions is chilling of the extremities so that activity is restricted. Special precautions must be taken in cold environments to prevent frostbite, trench foot, and general hypothermia.

Heat-related illnesses include:

- Heat Stress
- Heat Stroke
- Heat Cramps
- Dehydration

Cold-related illnesses include:

- Hypothermia
- Frost Bite

The following precautions for heat-related illnesses are recommended:

- Plenty of fluids
- Frequent breaks
- Ice vest
- Shaded or cooled break areas
- Ventilation
- Awareness training

The following precautions for cold-related illnesses are recommended:

- Appropriate insulated PPE
- Warming areas for breaks
- Awareness training

4. Employees engaged in continuous heavy work in a confined space while wearing body suits and respirators susceptible to ____.

- a. impaired hearing
- b. poor vision
- c. hypothermia
- d. heat stress

Communication Problems

Communication between the worker inside and the standby person outside is of utmost importance. If the worker should suddenly feel distressed and not be able to summon help, an injury could become a fatality. Frequently, the body positions that are assumed in a confined space make it difficult for the standby person to detect an unconscious worker. When visual monitoring of the worker is not possible because of the design of the confined space or location of the entry hatch, a voice or alarm-activated explosion proof type of communication system will be necessary.

Excessive Noise Hazards

Noise problems are usually intensified in confined spaces because the interior tends to cause sound to reverberate and thus expose the worker to higher sound levels than those found in an open environment. This intensified noise increases the risk of hearing damage to workers which could result in temporary or permanent loss of hearing. Noise in a confined space which may not be intense enough to cause hearing damage may still disrupt verbal communication with the emergency standby person on the exterior of the confined space. If the workers inside are not able to hear commands or danger signals due to excessive noise, the probability of severe accidents can increase.

If noise levels are high, a hearing conservation program may need to be implemented. Use of tools and equipment may produce high noise levels, which could lead to permanent hearing loss, and often necessitates a hearing conservation program. Some examples of excessively loud operations include:

- Use of high-pressure water and steam guns
- Abrasive Blasting
- Needle Gunning
- Scaling

- Grinding

Requirements and Example Solutions:

- Hearing protection
- Hearing conservation program

5. Grinding, abrasive blasting, and using high-pressure hoses in confined spaces may result in ____.

- a. disorientation
- b. cold stress
- c. hearing impairment
- d. segmental vibration injury

High-Pressure Hazards

The use of high-pressure equipment may expose operators and bystanders to the following hazards:

- Contact with high-pressure steam, water, grit, or air streams from cleaning equipment.
- Contact with uncontrolled high-pressure hoses.

Injuries associated with these hazards include:

- Loss of body parts (for example, fingers, or hands)
- Lacerations
- Burns
- Loss of sight

Requirements and Example Solutions:

- Use appropriate PPE.
- Control access to the area.
- Inspect hoses and connections prior to use.
- Use pressure equipment according to the manufacturer's recommendations.

- Warning: Do not use oxygen for cleaning (blow-off), operation of air tools, or ventilation

6. What is the requirement for the use of oxygen when cleaning (blowing-off), operating air tools, or using ventilation?

- a. Keep oxygen pressure below 20 mmHg
- b. Do not use oxygen
- c. Inspect daily
- d. Pressure must be less than 80% oxygen

Electrical Hazards

Potential Hazards:

All workers who work with electrical equipment in wet or damp locations have an increased risk of getting shocked or electrocuted due to:

- Faulty electrical connection in power tools.
- Open lighting parts.
- Broken insulation on power cables and cords.

Requirements and Example Solutions:

- Portable electrical tools must be grounded or double insulated.
- Temporary lighting must be grounded.
- All electrical tools or equipment should undergo a visual inspection prior to use.
- All portable electric hand tools and temporary lighting systems should utilize Ground Fault Circuit Interrupters (GFCI).
- Electrical tools and equipment should correspond with the requirements of the job.
- Electrical equipment and tools should be used with proper circuit protection for the voltage and amperage used.
- Only qualified electricians should attempt to repair electrical tools and equipment.

A Ground Assurance Program should be in place for all electrical tools and equipment used including:

- Records of tools inspected and repaired.
- Records of electrical boxes inspected and repaired.
- Records of electrical extension cords inspected and repaired.
- Recall of records of the above.
- The requirements of the Ground Assurance Program should be performed on a regular basis.

7. All portable electric hand tools and temporary lighting systems should use ____.

- a. class II insulated equipment
- b. in-line fuses
- c. two-way switches
- d. Ground Fault Circuit Interrupters (GFCI)

Vibration

Whole body vibration may affect multiple body parts and organs depending upon the vibration characteristics. Segmental vibration, unlike whole body vibration, appears to be more localized in creating injury to the fingers and hands of workers using tools, such as pneumatic hammers, rotary grinders or other hand tools which cause vibration.

Impact Hazards

Workers may be exposed to impact hazards from:

- Sparks
- Metal particles
- Grinding debris
- Paint debris

Injuries may include:

- Particles becoming imbedded in the skin
- Eye damage

- Skin burns
- Skin trauma

Requirements and Example Solutions:

- Use PPE properly.
- Use powered equipment such as portable grinders with guards and according to the manufacturer's recommendations.

It's important to understand that moving equipment or parts and energized or pressurized systems can be extremely dangerous in confined spaces. Examples include shafts, couplings, gears, belts, conveyors, mixers, rotors, and compressing devices. If you get caught in moving equipment, you will most likely suffer a fatal injury. The equipment will not stop rotating or moving.

8. What is the most likely outcome if you get caught on a rotating shaft while working in a confined space?

- a. A near-miss incident
- b. A fatality
- c. A serious injury
- d. Property damage

Entrapment hazards

Entrapment hazards in confined spaces include inwardly converging walls or floors that slope downward and taper to a smaller cross-section (such as air plenums).

Engulfment

Engulfment refers to the surrounding or burial of the worker in a liquid or loose, finely divided solid material, such as sand or grain. Such materials can suffocate a worker. Examples include:

- Accidental dumping of a product on a worker.
- A worker walking on unstable material such as settled grain. Such materials could conceal a void underneath that gives way under the weight of the worker, resulting in engulfment.

Other Physical Hazards

Some physical hazards cannot be eliminated because of the nature of the confined space or the work to be performed. These hazards include such items as scaffolding, surface residues, and structural hazards.

- **Scaffolding** in confined spaces has contributed to many accidents caused by workers, materials falling, improper use of guard rails, and lack of maintenance to insure worker safety. The choice of material used for scaffolding depends upon the type of work to be performed, the calculated weight to be supported, the surface on which the scaffolding is placed, and the substance previously stored in the confined space.
- **Surface residues** in confined spaces can increase the already hazardous conditions of electrical shock, reaction of incompatible materials, liberation of toxic substances, and bodily injury due to slips and falls. Without protective clothing, additional hazards to health may arise due to surface residues.
- **Structural hazards** within a confined space such as baffles in horizontal tanks, trays in vertical towers, bends in tunnels, overhead structural members, or scaffolding installed for maintenance increase the likelihood of being injured.

9. Walking on unstable material such as grain in a confined space can result in a fatality by _____.

- a. being unable to exit
- b. a fall
- c. entrapment
- d. engulfment

Module 6: Controlling Confined Space Hazards

Introduction

Once hazards are identified, it is critical to institute appropriate control measures to eliminate or, if not possible, reduce and control confined space hazards. This module discusses the "Hierarchy of Controls" strategies to control confined space hazards. The moment of entry is critical in confined or enclosed space operations. Injuries from fires, explosions, falls, and unsafe atmospheres may be avoided with careful preparation and adequate testing. Remember, acceptable entry conditions must be attained before entry and those safe conditions must be maintained throughout the duration of an entry. This module also explains some of the procedures and precautions that should be in place to safeguard entrants while they are working in the confined space.

Hazard Elimination and Substitution

Elimination

The highest priority in controlling hazards in confined spaces should be given to the attempt to totally eliminate the hazard so that entry will be completely safe. That's not possible in many situations, but the attempt should still be considered. For instance, if there is a hazardous atmosphere in the confined space, forced-air ventilation of the space might be the answer to completely eliminate the hazard.

Substitution

If elimination is not possible, it may be acceptable to replace toxic substances with less toxic or non-toxic substances so that hazardous atmospheres are not created. One primary control measure effective in preventing toxic hazardous atmospheres from developing in the first place is the use of less toxic products that vaporize less readily. Keep less of the product at the site and keep containers closed inside the confined space at all times.

1. Which of the following should be considered the top priority in the Hierarchy of Control strategies?

- a. Elimination
- b. Substitution
- c. Engineering controls
- d. Administrative controls

Confined space engineering controls

Engineering controls may be employed to control hazards through design or redesign a confined space so that hazardous atmospheres and substances do not develop in the workspace. Examples of engineering controls include:

- installing automatic ventilation systems;
- redesigning the entrance so that unlimited access is possible; and
- redesigning an old confined space with a safer configuration.

Confined space administrative controls

Administrative controls attempt to mitigate or eliminate exposure to hazards through changes in policies and procedures, and work practices such as:

- rotating workers;
- safe entry procedures; and
- good housekeeping practices.

Confined spaces should be cleaned/decontaminated of hazardous materials to the extent feasible before entry. Cleaning/decontamination should be the preferred method of reducing exposure to hazardous materials. PPE should be worn by confined space entrants to provide appropriate protection against the hazards which may be present.

Personal protective equipment (PPE)

If the hazard cannot be eliminated or reduced to a safe level through engineering and/or administrative controls, PPE should be used. A qualified person should determine the types of PPE needed by entrants, including rescue teams.

2. What should be the preferred method of reducing exposure to hazardous materials in a confined space?

- a. Designing automatic detectors
- b. Cleaning/decontamination
- c. Force air ventilation
- d. Purging with nitrogen

Controlling Toxic Atmospheres

One primary control measure effective in preventing toxic hazardous atmospheres from developing in the first place is the use of less toxic products that vaporize less readily. Keep less of the product at the site and keep containers closed inside the confined space at all times.

Ventilating confined spaces

Ventilation is one of the most common control methods used in confined spaces to eliminate hazardous atmospheres.

Ventilation helps to:

- Provide adequate oxygen to the air in the space.
- Control atmospheric contaminants.
- Prevent fire and explosion hazards.
- Control heat and humidity.

When ventilation is used to remove atmospheric contaminants from the confined space, the space should be ventilated until the atmosphere is within the acceptable ranges. Ventilation should be maintained during the occupancy if there is a potential for the atmospheric conditions to move out of the acceptable range.

Once it has been determined that the confined space contains a harmful atmosphere, the next step is to clear it. Ventilation blows out oxygen-deficient or contaminated atmospheres and replaces harmful vapors with clean, fresh air. Make sure to ventilate the space thoroughly so that there are no contaminated pockets left, and then test the atmosphere again.

For permit spaces that are deep or have areas leading away from the entry point, the atmosphere may be layered or may be different in remote areas. For these spaces, testing must be done in the area surrounding the worker, which is considered four (4) feet in the direction of travel and to each side. If a sample probe is used to do the testing, then the worker must move slowly enough so that testing is completed, keeping the equipment "response time" in mind, before he/she moves into the new area.

Welding, cutting, burning, and continuous brazing generate hazardous fumes and dusts that can be more effectively removed by local exhaust ventilation systems at or near the point of generation.

When ventilation is not possible or feasible, alternate protective measures or methods to remove air contaminants and protect occupants should be determined by the qualified person prior to authorizing entry.

Continuous Forced Air Conditions

Conditions regarding continuous forced air ventilation should be used as follows:

- Employees should not enter the space until the forced air ventilation has eliminated any hazardous atmosphere,
- Forced air ventilation should be so directed as to ventilate the immediate areas where an employee is or will be present within the space,
- Continuous ventilation is maintained until all employees have left the space, and
- Air supply for forced air ventilation should be from a clean source.

3. When testing for hazardous atmospheres in a confined space, the area surrounding the worker is considered ____.

- a. a 5-foot "bubble" around, above, and below the worker
- b. no more than 6 feet in front of the worker
- c. 4 feet in the direction of travel and to each side
- d. to be within arms-length in each direction

Considerations to ensure proper ventilation

Initially determine:

- Number and size of openings.
- Volume and configuration of the space to be entered.
- Capacity and positioning of the ventilation equipment to be used.
- Existing and potential atmospheric hazards.

After beginning ventilation:

- Routinely test the confined space until levels stabilize at acceptable entry conditions.

Once entry and work start:

- Continue ventilation and frequent atmospheric testing for the entire duration of entry.
- Consider atmospheric hazards created by work in the space.

4. When is ventilation required for work in a confined space?

- a. For the entire duration of the entry
- b. Until testing determines a safe atmosphere
- c. Every 30 minutes while work is conducted
- d. When testing detects a change in conditions

Respiratory Protection

Respirators protect workers against insufficient oxygen environments, harmful dusts, fogs, smokes, mists, gases, vapors, and sprays. These hazards may cause cancer, lung impairment, diseases, or death.

Respirators protect the user in two basic ways.

- The first is by the removal of contaminants from the air. Respirators of this type include particulate respirators, which filter out airborne particles, and air-purifying respirators with cartridges/canisters which filter out chemicals and gases.
- Other respirators protect by supplying clean respirable air from another source. Respirators that fall into this category include airline respirators, which use compressed air from a remote source, and self-contained breathing apparatus (SCBA), which include their own air supply.

Respiratory protection is needed in confined spaces whenever:

- An emergency exists and entry cannot be delayed. Assume that an IDLH atmosphere exists.
- There is an inert atmosphere or testing shows that an IDLH exists and additional ventilation cannot reduce concentrations to safe levels.
- Current testing indicates atmosphere to be safe, but unsafe conditions could reasonably be expected to develop at any time.

5. Respiratory protection in a confined space would NOT be necessary when ____.

- a. an IDLH condition is assumed to exist
- b. inert gases could rise to unacceptable levels
- c. an unsafe condition is possible
- d. oxygen levels are at or above 19.5%

Confined Space Inspections

Inspecting your confined space entry program, procedures, and practices is an important part of the safety management system evaluation. Use a checklist like this to help identify strengths and weaknesses in the program.

1. ____ Are confined spaces thoroughly emptied of any corrosive or hazardous substances, such as acids or caustics, before entry?
2. ____ Are all lines to a confined space, containing inert, toxic, flammable, or corrosive materials valved off and blanked or disconnected and separated before entry?
3. ____ Are all impellers, agitators, or other moving parts and equipment inside confined spaces locked-out if they present a hazard?
4. ____ Is either natural or mechanical ventilation provided prior to confined space entry?
5. ____ Are appropriate atmospheric tests performed to check for oxygen deficiency, toxic substances and explosive concentrations in the confined space before entry?
6. ____ Is adequate illumination provided for the work to be performed in the confined space?
7. ____ Is the atmosphere inside the confined space frequently tested or continuously monitored during conduct of work?
8. ____ Is there an assigned safety standby employee outside of the confined space when required, whose sole responsibility is to watch the work in progress, sound an alarm if necessary, and render assistance?
9. ____ Is the standby employee appropriately trained and equipped to handle an emergency?

10. ____ Is the standby employee or other employees prohibited from entering the confined space without lifelines and respiratory equipment if there is any question as to the cause of an emergency?
11. ____ Is approved respiratory equipment required if the atmosphere inside the confined space cannot be made acceptable?
12. ____ Is all portable electrical equipment used inside confined spaces either grounded and insulated, or equipped with ground fault protection?
13. ____ Before gas welding or burning is started in a confined space, are hoses checked for leaks?
14. ____ Are compressed gas bottles forbidden inside of the confined space?
15. ____ Is the confined area tested for a flammable/explosive atmosphere prior to using electrical equipment/lights within the confined space?
16. ____ If the confined space may contain a potentially flammable/explosive atmosphere, are only intrinsically safe equipment and lights used within the confined space?
17. ____ If employees will be using oxygen-consuming equipment-such as salamanders, torches, and furnaces, in a confined space, is sufficient air provided to assure combustion without reducing the oxygen concentration of the atmosphere below 19.5 percent by volume?
18. ____ Whenever combustion-type equipment is used in a confined space, are provisions made to ensure the exhaust gases are vented outside of the enclosure?
19. ____ Is each confined space checked for decaying vegetation or animal matter which may produce methane?
20. ____ Is the confined space checked for possible industrial waste which could contain toxic properties?
21. ____ If the confined space is below the ground and near areas where motor vehicles will be operating, is it possible for vehicle exhaust or carbon monoxide to enter the space?

6. What is a common tool to discover actual confined space conditions and program strengths and weaknesses?

- a. A brainstorming session
- b. A checklist
- c. A statistical analysis
- d. A safety committee discussion

Module 7: The Confined Space Entry Team

Management responsibilities

Your safety department will probably be responsible for developing the confined space program. Your line managers should always be responsible for deploying or implementing the program. Remember, safety is a line responsibility, not a staff support responsibility. Line and staff managers should:

- Ensure that a list of confined spaces is maintained,
- Ensure that canceled permits are reviewed for lessons learned,
- Ensure training of entry team members (authorized entrants, attendants, and entry supervisors) and other affected persons are conducted,
- Ensure coordination with outside emergency responders,
- Ensure personal protective equipment is in compliance with standards, and
- Maintain a master inventory of identified confined spaces.

1. Who should be responsible for implementing the confined space program?

- a. Safety managers
- b. Line managers
- c. Employees
- d. Entry team supervisors

Confined Space Entry Supervisor responsibilities

The Confined Space Entry Supervisor holds a key position with important responsibilities. This position is in charge of confined space work and should:

- Ensure requirements for entry have been completed before entry is authorized
- Authorizing entry and overseeing entry operations
- Ensure confined space monitoring is performed by personnel qualified and trained in confined space entry procedures
- Ensure a list of monitoring equipment and personnel qualified to operate the equipment is maintained by the employer

- Ensure that the rescue team has simulated a rescue in a confined space within the past twelve months
- Know the hazards that may be faced during entry, including the mode, signs or symptoms, and consequences of exposure
- Fill out a permit when it is required
- Determine the entry requirements and that conditions are acceptable for entry
- Notify all involved employees of the permit requirements
- Post the permit in a conspicuous location near the job
- Renew the permit or have it reissued as needed (a new permit is required every shift)
- Determine the number of attendants required to perform the work
- Perform duties as the confined space attendant if required
- Ensure the attendant knows how to communicate with the entrants and how to obtain assistance
- Ensuring measures are in place to keep unauthorized personnel clear of the area
- Ensure the confined space entry is barricaded or guarded to prevent entry while work is not in progress.
- Post any required barriers and signs
- Remain alert to changing conditions that might affect the conditions of the permits, (i.e., require additional atmospheric monitoring or changes in personal protective equipment)
- Serving as an attendant, as long as the person is trained and equipped appropriately for that role
- Change and reissue the permit, or issue a new permit as necessary
- Ensure periodic atmospheric monitoring is done according to permit requirements
- Ensure that personnel doing the work and all support personnel adhere to permit requirements
- Ensure the permit is canceled when the work is done

- Ensure the confined space is safely closed and all workers are cleared from the area
- Checking the work at least twice a shift to verify and document permit requirements are being observed (more frequent checks should be made if operations or conditions are anticipated that could affect permit requirements)
- Ensuring that necessary information on chemical hazards is kept at the work site for the employees or rescue team
- Ensuring a rescue team is available and instructed in their rescue duties (e.g., an on-site team or a prearranged outside rescue service)
- Ensuring at least one member of the rescue team has current certification in first aid and CPR
- Terminating entry procedures as required

2. How often should the entry supervisor verify and document to make sure permit requirements are being observed?

- a. Before the end of each shift
- b. At the end of the project
- c. At least twice a shift
- d. At the beginning of each shift

Confined Space Entrant responsibilities

Employees who are granted permission to enter a confined space should:

- Read and observe the entry permit requirements
- Stay alert to the hazards that could be encountered in a confined space
- Use the protective equipment required by the permit

Confined space entrants must immediately exit the confined space when:

- Ordered to do so by the attendant
- Automatic alarms sound
- They perceive they are in danger

- They notice physiological stresses or changes in themselves or co-workers (e.g., dizziness, blurred vision, shortness of breath).

3. What must confined entrants do if they notice physiological stresses or changes in themselves or co-workers?

- a. Notify the confined space supervisor
- b. Administer first aid to other entrants
- c. Immediately exit the confined space
- d. Continue to observe behaviors in other entrants

Confined Space Attendant responsibilities

The Attendant should be stationed outside the work space and should:

- Be knowledgeable of, and be able to recognize potential confined space hazards;
- Maintain a sign-in/sign-out log with a count of all persons in the confined space and ensure all entrants sign in/sign-out;
- Monitor surrounding activities to ensure the safety of personnel;
- Maintain effective and continuous communication with personnel during confined space entry, work and exit;
- Order personnel to evacuate the confined space if he/she:
 - Observes a condition which is not allowed on the entry permit;
 - Notices the entrants acting strangely, possibly as a result of exposure to hazardous substances;
 - Notices a situation outside the confined space which could endanger personnel;
 - Notices within the confined space a hazard which has not been previously recognized or taken into consideration;
 - Must leave his/her work station; or
 - Must focus attention on the rescue of personnel in some other confined space that he/she is monitoring;
- Immediately summon the Rescue Team if crew rescue becomes necessary; and

- Keep unauthorized persons out of the confined space, order them out, or notify authorized personnel of the unauthorized entry.

4. What should confined space attendants do if they notice entrants behaving strangely?

- a. Order entrants to evacuate the confined space
- b. Monitor behaviors for 15 minutes
- c. Ask entrants if they are "Okay"
- d. Ask entrants if they want to take a break

Confined Space Rescue Team responsibilities?

The Rescue Team members should:

- Complete a training drill using mannequins or personnel in a simulation of the confined space prior to the issuance of an entry permit for any confined space and at least annually thereafter;
- Respond immediately to rescue calls from the Attendant or any other person recognizing a need for rescue from the confined space;
- In addition to emergency response training, receive the same training as that required of the authorized entrants; and
- Have current certification in first-aid and CPR.

5. When must a confined space rescue team conduct a training drill?

- a. If there is a potential situation requiring rescue
- b. Initially and annually thereafter
- c. Prior to confined space entry and annually thereafter
- d. After a confined space emergency has occurred

Module 8: Confined Space Rescue

Introduction

Two-thirds of all confined space fatalities occur among would-be rescuers. To prevent deaths, it is critical to use good confined space entry practices so that there is no need for rescue operations. Remember, even a well-planned rescue can end up as a body retrieval. Rescues can be performed by any employee or a professional rescuer so long as he or she has been fully trained and qualified to act as a rescuer. Qualifications include knowledge of and experience working with all hazards associated with rescue and confined space entry operations.

Why confined spaces kill so many people

Confined spaces are deceiving. A confined space often appears to be harmless; no danger signs are apparent, and the space may have been entered on prior occasions without incident. However, a worker cannot assume that conditions have not changed and that the space is safe for entry each time.

1. What is always the preferred method for confined space emergencies?

- a. Third-party rescue
- b. Entry rescue
- c. Self-rescue
- d. Non-entry rescue

Confined space emergencies

A confined space emergency is any occurrence inside or outside the space, including failure of hazard control or monitoring equipment that may endanger authorized confined space entrants. Believe it or not, during emergencies, rescuers end up as confined space fatalities more often than those being rescued. So, why is that? Fatalities can occur when the rescuers:

- Are overcome by their emotions
- Take unnecessary chances
- Do not know the hazards involved
- Do not have a plan of action
- Lack confined space rescue training

It is important to know that the period of time for successful rescue is very limited. Otherwise, a rescue attempt will become body retrieval. After only four minutes without oxygen, it is very likely that a worker will experience asphyxiation, which may result in brain damage or death.

Preventing confined space rescuer fatalities

Planning the rescue is paramount. Make sure rescue team members understand their duties, and practice, practice, practice!

Ensure that the rescuer does not travel a greater distance than allowed by the air supply, self-contained breathing apparatus (SCBA), and escape cylinders. Analyze distance, space configurations, physical obstacles, and total time needed to enter the space, perform rescue operations, and leave the space. Leave the space immediately whenever a problem arises with respiratory protection equipment or whenever the attendant orders evacuation. Everyone involved in a rescue should assume that the space is deadly, and that entry rescue may be required in the worst case!

2. A worker will likely experience asphyxiation from a lack of oxygen after ____.

- a. four minutes
- b. 30 seconds
- c. two minutes
- d. one minute

Confined space rescue training topics

At a minimum, training must include:

- Recognition of permit space hazards.
- Control of permit space hazards.
- Use of atmospheric monitoring equipment.
- Use and maintenance of personal protective equipment (PPE).
- Use and maintenance of rescue equipment.
- Annual practice of permit space rescues.
- Proficiency in first aid and cardiopulmonary resuscitation (CPR).
- Documentation of training.

Three rescue strategies

Depending on the severity of the emergency, different rescue strategies or methods can be used. When the emergency is minor, self-rescue is often the best approach; however, if the worker is disabled, it is likely that non-entry or entry rescue may need to be used. Entry rescue involves putting others at risk and should be used only if absolutely necessary.

1. Because of the speed at which confined space hazards can incapacitate and kill, self-rescue is the preferred plan. The self-rescue plan provides entrants with the best chance of escaping a permit space when hazards are present. Whenever authorized entrants recognize their own symptoms of exposure to a dangerous atmosphere, or when a prohibited condition is detected, entrants are still able to escape from the space unaided and as quickly as possible.

Self-rescue is vitally important because the entrant is:

- conscious and alert
 - able to recognize his or her own signs and symptoms
 - still physically able to evacuate space more rapidly than waiting for someone else to rescue him or her
 - able to alert fellow workers of impending dangers
 - not endangering anyone else
2. Non-entry rescue is the next-best approach when self-rescue is not possible because non-entry rescue can be started right away and prevents additional personnel from being exposed to unidentified and/or uncontrolled confined space hazards. Usually, equipment and other rescue aids are employed to assist in removing endangered entrants. In situations where configuration of the space or other elements prevent the removal of the worker, entry rescue may be the only solution.
 3. Entry rescue involves rescuers entering the space to retrieve the entrant and/or provide the victim with emergency assistance such as CPR, first aid, and air via SCBA or a supplied air respirator (SAR), if needed. An entry rescue plan needs to be developed ahead of time in the event of an emergency for which the non-entry rescue plan is not appropriate.

3. When self-rescue is not possible, which confined space rescue strategy is the next best for most emergencies?

- e. Entry rescue
- a. Partial entry rescue
- b. Non-entry rescue
- c. Call fire department

Informing Rescuers

It's important that rescuers are provided with vital information so that they can most effectively perform rescue operations. Rescuers will need to know:

- number of victims and location of emergency
- length of time victims have been exposed to hazard.
- suspected cause of accident
- all information on entry permit, including:
 - atmospheric testing results
 - isolation procedures
 - Safety Data Sheet (SDS) information

The rescue Plan

It's important to think through the rescue process proactively to make sure it is successful. Rescue plans may involve on-site rescue teams, or they may rely on off-site rescue service providers. A thorough rescue plan includes:

- a barricade area for crowd control
- additional ventilation option
- control of other hazards (cave-ins, traffic, etc.)
- protective clothing and equipment
- appropriate lighting equipment (explosion-proof)
- methods of communication

- a standby rescue team
- victim removal procedures and devices
- available emergency vehicles
- medically trained personnel

4. Which of the following is considered vital information needed by confined space rescuers?

- a. Communication methods
- b. Ventilation options
- c. Identity of standby personnel
- d. Entry permit information

Rescue Simulations

It's crucial that members of a rescue team practice simulated confined space rescues for each unique confined space at a facility. As mentioned earlier, rescue drills should be conducted in simulated spaces or, if possible, in the specific confined spaces that will be entered in an emergency. Scheduled drills should also be conducted at least once every 12 months or more frequently if deemed necessary.

Re-evaluating rescue plans

Re-evaluate the plan whenever:

- Conditions change within the space.
- Workers discover any new hazards.
- There are changes in the rescue personnel and/or personnel availability.
- New equipment is purchased.
- Routine proficiency training results are unsatisfactory.
- A rescue plan is found to be deficient (e.g., a failed simulated rescue).

5. How often should rescue teams practice confined space rescues?

- a. Every two years
- b. At least every 12 months
- c. Only as needed
- d. Every 5 years

On-Site Rescue

Because most rescue service providers are unable to rescue within the four-minute time limit, most employers develop their own rescue teams. At least one on-site rescue team member should be trained in first aid and CPR.

Each member of the rescue team should be trained to:

- Properly use and maintain PPE and rescue equipment
- Act as a rescuer in annual simulated emergencies
- Assume individual roles and take on any emergency

Off-Site Rescue

Remember that while the window of opportunity for a rescue is very brief—only four minutes—the response time for an off-site rescue team may be considerably longer. After four minutes have lapsed, the victim could suffer brain damage or die. In some emergencies, rescuers may have even less than four minutes to act. Other situations may allow more time. To make sure your confined rescue plan is effective, make sure you:

- Arrange for local rescue/fire departments to provide rescue services.
- Supply the number and description of each permit required confined space in the facility ahead of time.
- Disclose all known hazards associated with the space(s) so that appropriate rescue plans can be developed.
- Provide access to the space so that off-site rescue personnel can familiarize themselves with the site, develop a rescue plan in advance, and practice rescue operations.

6. What should an employer do if a confined space rescue service provider cannot rescue within the four-minute time limit?

- a. Rely on self-rescue
- b. Use an Emergency Medical Service (EMS)
- c. Develop a rescue team
- d. Wait for the hazard to resolve itself

Off-site Rescue Services

The emergency services should be familiar with the exact site location, types of permit-required confined spaces and the necessary rescue equipment.

Pre-planning will ensure that the emergency service is capable, available and prepared. If the employer relies on an off-site rescue service, the employer must contact the provider to verify they are available to conduct rescue operations if requested. The verification task is usually assigned to the entry supervisor. If the off-site rescue service indicates for any reason that it would be unable to respond to a rescue summons, entry must not be authorized unless and until an adequate back-up rescue service is arranged and confirmed.

For Employers

Calling emergency responders to provide rescue services can be a suitable way of providing for rescues in a permit-required confined space. Pre-planning will ensure that the emergency service is capable, available and prepared. Prior to the start of the rescue work operation, employers must evaluate prospective emergency responders and select one that has:

- Adequate equipment for rescues, such as: atmospheric monitors, fall protection, extraction equipment, and self-contained breathing apparatus (SCBA) for the particular permit-required confined spaces. The ability to respond and conduct a rescue in a timely manner based on the site conditions and is capable of conducting a rescue if faced with potential hazards specific to the space. Such hazards may include:
 - Atmospheric hazards (e.g., flammable vapors, low oxygen)
 - Electrocution (e.g., unprotected, energized wires)
 - Flooding or engulfment potential
 - Poor lighting
 - Fall hazards

- Chemical hazards
- Agreed to notify the employer in the event that the rescue team becomes unavailable.

Employers must also:

- Inform the emergency responders of potential hazards when they are called to perform a rescue at the worksite; and
- Provide emergency responders with access to all permit-required confined spaces. Access may include:
 - Information on access routes, gates or landmarks
 - A project site plan if necessary
 - GPS coordinates if in a remote location

Employers should also ensure that:

- The most efficient means to contact emergency responders is available;
- Any changes to the project site conditions are communicated to the rescue service; and
- Emergency responders are willing to visit the site and conduct a joint training exercise with the employer.

For Emergency Service Providers

The following are some questions responders should be able to answer when an employer requests their services:

- Are you able to respond and conduct a rescue in a timely manner based on the site conditions?
- Do you have the appropriate equipment for response and rescue, such as: atmospheric monitors, fall protection, extraction equipment, and self-contained breathing apparatus (SCBA) for the particular permit-required confined spaces?
- Are you prepared for the hazards the employer has identified?
 - Atmospheric hazards (e.g., flammable vapors, low oxygen)
 - Electrocution (e.g., unprotected, energized wires)
 - Flooding or engulfment potential
 - Poor lighting
 - Fall hazards
 - Chemical hazards

- Are you trained for the hazards identified by the employer?
 - Hazard Communication training (HAZCOM)
 - Respiratory Protection training
 - Hazardous Material training
 - HAZWOPER training
 - Hazard recognition
 - Can you cope with other hazards the company may have identified on the site?
 - Do you need to develop a new procedure for these hazards/conditions?
- Has the employer provided you with the exact location of the work site?
 - Information on access routes, gates or landmarks
 - A project site plan if necessary
 - GPS coordinates if in a remote location
- Can you visit the site and hold a practice rescue?
- Does the company know the best way to contact you?
- How would the company communicate any changes to site conditions throughout the project?
- Could other emergencies or group training preclude you from responding and how will that be communicated?

OSHA encourages all emergency service providers to work closely with employers who request their services for permit-required confined space rescues. Pre-rescue planning, communication, and effective coordination of rescue activities are critical in the event that a life-threatening incident should occur.

Private sector commercial emergency service providers are covered by Federal OSHA and must comply with the provisions of 1926.1211. State and local government emergency service providers in a state with an OSHA approved state plan must comply with these requirements. See [OSHA's State Plans Webpage](#) for information on state-plan requirements.

Entry vs. Non-Entry

If the worker is physically able to use rescue equipment (safety retrieval line, rope, wristlets, etc.), rescuers may choose not to enter the space. Instead, they can provide appropriate equipment and assistance necessary to bring the worker out of the space (a non-entry rescue). In situations in which the worker is unresponsive, atmospheric hazards are extremely high, or significant time has elapsed before rescuers arrive at the site, emergency rescue personnel may decide that the risks associated with entering outweigh the potential for a successful rescue. If this is the case, rescuers may elect not to go into the confined space until conditions warrant a safe entry.

Non-entry rescue is the preferred method for confined space emergencies. It's important to remember that the confined space Attendant should not perform entry rescue. Rescue requiring entry should be performed by a trained rescue team or emergency service providers.

7. If the off-site rescue service cannot respond to a rescue summons, entry must not be authorized unless and until ____.

- a. the employer assumes liability for injuries or damages
- b. the confined space entry team volunteers as rescuers
- c. an adequate back-up rescue service is arranged and confirmed
- d. the entry supervisor assumes responsibility for rescue

Rescue Equipment

The importance of having the right rescue equipment on hand can't be stressed enough. Rescue equipment may include:

- Full body harness with retrieval line attached.
- Wristlets (may be used in rescue when it can be shown that they are the safest and most effective means of rescue).
- Hand-cranked mechanical winch and tripod (required when entrant is five feet or more below the entrance).
- Ladder.
- Explosion-proof lighting.
- SCBA/SAR.
- Stretcher.
- Approved head protection.

Full Body Harness and Retrieval Lines

All authorized entrants and rescuers entering permit spaces are required to use full body harnesses and retrieval lines, unless it is determined that the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue operation.

What kind of equipment should be used for lowering or lifting entrants?

Only devices designed by the manufacturer and approved for moving humans should be used. The equipment must enable a rescuer to remove the injured employee from the space quickly without injuring the rescuer or further harming the victim.

If there is even a remote possibility of other atmospheric contaminants, even though monitoring equipment readings appear to be within the normal ranges, rescuers should still use appropriate respiratory protection. Play it safe:

- Wear SCBA or SAR.
- Do not use air purifying respirators for confined space rescue.

8. All entrants and rescuers entering permit-required confined spaces are required to use ____.

- a. ladders
- b. air-purifying respirators
- c. full body harnesses
- d. head protection

Module 9: Confined Space Training Requirements

Introduction

It's important that the employer provides training so that all employees who are required to perform confined space entry operations acquire the understanding, knowledge, and skills necessary for the safe performance of their duties in confined spaces.

Confined space training triggers

Training should be provided to each affected employee:

- before the employee is first assigned duties under this section
- whenever the employee demonstrates inadequate knowledge
- before there is a change in assigned duties
- whenever there is a change in permit space operations that presents a hazard for which an employee has not been trained
- whenever there are deviations from the permit space entry procedures

The training should establish employee proficiency in his or her confined space entry procedures and which task is being performed within the confined space.

1. Which of the following situations "trigger" the need for confined space training?

- f. An annual refresher for entrants
- a. A change in assigned duties
- b. Once the employee has been on site for 2 weeks
- c. A change of supervisors

General Training Topics

All employees who will enter confined spaces must be trained in entry procedures. Personnel responsible for supervising, planning, entering or participating in confined space entry and rescue must be trained in their duties prior to any confined space entry.

Training should include:

- Explanation of the general hazards associated with confined spaces;

- Discussion of specific confined space hazards associated with the facility, location or operation;
- Reason for, proper use, and limitations of PPE and other safety equipment required for entry into confined spaces;
- Explanation of permits and other procedural requirements for conducting a confined space entry;
- A clear understanding of what conditions would prohibit entry;
- How to respond to emergencies;
- Duties and responsibilities as a member of the confined space entry team; and
- Description of how to recognize (1) symptoms of overexposure to probable air contaminants in themselves and co-workers, and (2) methods for alerting attendants.

Refresher training should be conducted to maintain employee competence in entry procedures and precautions. If employees do not enter a confined space to perform work for an extended period of time (at least annually), they should be provided an opportunity to practice entry procedures.

2. If the confined space entry team does not enter a confined space at least annually, what action should be taken?

- a. Have the team practice entering a confined space
- b. Have the team attend a refresher course
- c. Decertify the confined space team
- d. Schedule a confined space entry for the team within 6 months

Specific Training

Those entry team members who are responsible for monitoring confined space atmospheres should receive training on the proper use of monitoring and testing instruments. Training should include proper use of monitoring instruments such as:

- Proper use of the equipment;
- Knowledge of calibration;
- Knowledge of sampling strategies and techniques; and

- Knowledge of [PELs](#), [TLVs](#), [LELs](#), [UELs](#), etc.

Training for Attendants

Training should include the following:

- Procedures for summoning rescue or other emergency services, and
- Proper utilization of equipment used for communicating with entry and emergency/rescue personnel.

3. Entry team members who are responsible for monitoring confined space atmospheres should receive specific training on ____.

- a. the history of monitoring strategies
- b. proper use of the specific equipment
- c. categories of confined spaces
- d. general field calibration techniques

Training for Emergency Response Personnel

Training should include the following:

- Rescue plan and procedures developed for each type of confined space that are anticipated to be encountered
- Use of emergency rescue equipment
- First aid and CPR techniques
- Work location and confined space configuration to minimize response time

Verification of Training

Periodic assessment of the effectiveness of employee training should be conducted by a qualified person. Training sessions should be repeated as often as necessary to maintain an acceptable level of personnel competence.

- If confined space entry team members routinely work in confined spaces, refresher training may be brief.

- If confined space entry is rarely accomplished, team members should complete more comprehensive refresher training at least annually.

Make sure documentation of training verifies knowledge and skills. The training should include a written test and a practical demonstration requirement. The confined space entry team members should be able to "prove" they know what to do and how to do it. A competent person should certify the employees have demonstrated adequate knowledge and skills.

4. What methods should be used to verify adequate employee knowledge and skills following confined space training?

- g. Written test and demonstration
- h. Either a written test or demonstration
- a. Demonstration
- b. Written test