Module 8: Confined Spaces

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Lesson Summary

- Tags should read "Do Not Start" or have similar language to indicate the equipment is not to be operated.
- Formwork must be designed, fabricated, erected, supported, braced, and maintained so that it will be capable of supporting, without failure, all vertical and lateral loads that might be applied to it.
- Shoring equipment should be inspected and maintained properly. If its strength is not at the level required by the OSHA standard, it should be removed from use.
- Reinforcing steel for walls, piers, columns, and similar vertical structures must be adequately supported to prevent overturning and collapse. Employers must take measures to prevent unrolled wire mesh from recoiling. Such measures may include, but are not limited to, securing each end of the roll or turning over the roll.
- Forms and shores (except those used for slabs on grade and slip forms) must not be removed until the employer determines that the concrete has gained sufficient strength to support its weight and superimposed loads.

- Whenever a masonry wall is being constructed, employers must establish a limited access zone prior to the start of construction.

Module 8: Confined Spaces

Module Description

This module covers the safety regulations for spaces meeting the OSHA definitions of a "confined space" and/or a "permit-required confined space." It instructs about the hazards that may occur during work in these spaces.

A confined space is a space whose configuration and/or contents may present special dangers not found in normal work areas. Confined spaces may be poorly ventilated and, as a result, contain insufficient oxygen or hazardous levels of toxic gases. Working in a tight space can prevent a worker from keeping a safe distance from mechanical and electrical hazards in the space. Fumes from a flammable liquid that is used in a poorly ventilated area can reach explosive levels. Such hazards endanger both the workers in the confined space and others who become exposed to the hazards when they attempt to rescue injured workers.

Module Learning Objectives

At the conclusion of this module, students will be able to:

-
- Identify the characteristics of confined spaces
- Discuss atmospheric conditions found in confined spaces

- Summarize a prevention program
- Name the duties of employers and employees
- Explain the proper testing protocol

Lesson 1: Overview of Confined Spaces

Lesson Focus

At the end of this lesson, students will be able to:

- Describe the characteristics of confined spaces
- Describe the atmospheric conditions associated with confined spaces
- Explain how and why a prevention program should be implemented

Introduction

Confined spaces—such as manholes, crawl spaces, and tanks—are not designed for continuous occupancy and are difficult to exit in the event of an emergency. People working in confined spaces face life-threatening hazards including exposure to toxic substances, electrocutions, explosions, and asphyxiation. Construction workers often perform tasks in confined spaces. These spaces can present physical and atmospheric hazards that can be prevented if addressed prior to entering the space to perform work.

Confined Spaces

A "confined space" meets all of the following criteria:

- It is large enough and configured such that an employee can bodily enter it.
- It has an entry/exit that is limited or restricted is some manner.
- It is not designed for continuous occupancy by one or more employees.

A space may be **large enough and configured such that an employee can bodily enter** when there is enough space inside for an employee to enter and work, even if the portal to the space is very small. A confined space (and a permit-required confined space) must have an entry port that is large enough to allow full-body entry. If the entrance is too small for a worker to completely enter, or if the space itself is too small for a worker to completely enter, then OSHA's standard does not apply.

A space has a **limited or restricted means of exit** if a person could not readily escape from the space in an emergency. Any of the following factors indicate that a workspace has a limited or restricted means of exit:

- The need to use a ladder or movable stairs, or stairs that are narrow or twisted

- A door that is difficult to open or a doorway that is too small to exit while walking upright
- Obstructions such as pipes, conduits, ducts, or materials that a worker would need to crawl over or under or squeeze around
- The need to travel a long distance to a point of safety

A space is **not designed for continuous employee occupancy** if it is not designed with features such as ventilation, lighting, and sufficient room to work and move about that are needed if people are to occupy it continuously.

Permit-Required Confined Space

A permit-required confined space or "permit space" meets ALL of the requirements to be classified as a "confined space" AND meets ONE OR MORE of the following criteria:

- It contains, or has the potential to contain, a hazardous atmosphere.
- It contains a material that has the potential to engulf an employee who enters the space.
- The internal configuration is such that an employee entering the space could be trapped or asphyxiated by inwardly converging walls or by a floor with a downward slope tapering to a smaller cross section.
- It contains any other recognized safety or health hazard of a serious nature.

Confined spaces can be found in many industrial settings, from steel mills to paper mills, from factories to farms, and from public utilities to the construction industry.

Work Activities Covered by OSHA's Confined Spaces Standard

This standard applies to construction work performed in spaces meeting OSHA's definition of "confined spaces" except for certain activities that are subject to the confined spaces provisions of other OSHA construction standards, including the following:

- Diving operations are regulated by 29 CFR 1926 subpart Y.
- Excavation work is regulated by 29 CFR 1926 subpart P.
- Underground Construction, Caissons, Cofferdams and Compressed Air operations are regulated by 29 CFR 1926, subpart S.

It is important to note that employers engaged in exempted activities are required to comply with the confined spaces standard if their workers are exposed to confined space hazards that are not specifically covered by the standards noted above.

Employer Responsibilities

All employers involved in construction activities are responsible for identifying all confined spaces that their employees may be working in and then determining whether any of these spaces meet the definition of permit spaces. The employer is then

responsible for ensuring that any workers in the space are properly protected from the identified hazards. If an employer has undertaken the necessary steps to identify permit spaces and has identified these on the worksite, they are responsible for informing their workers of the location of any such danger(s) presented by the spaces. This is often accomplished by posting proper warning signs.

OSHA's standard establishes duties for "entry employers," "host employers," and "controlling contractors." An **entry employer** is an employer whose employees actually enter a permit space. Multiple entry employers may be present on any given worksite if the employees of multiple employers enter the space. Each employer of workers entering a permit space is responsible for ensuring the safety of their employees and for complying with all applicable provisions of the confined spaces standard.

A **controlling contractor** is the employer with overall responsibility for construction at the worksite. This contractor is responsible for coordinating the entry operations when more than one employer will have employees in the permit space and when other activities on the site could result in a hazard in the space. Controlling contractors are also responsible for providing all information they have about any permit space hazards and the precautions previously used in the space.

A **host employer** is the employer that owns or manages the property where the construction work is taking place. This employer is responsible for sharing with the controlling contractor any information they might have regarding the hazards of any permit site. There can never be more than one host employer. In those cases where the owner of the property has contracted with another employer to manage any relevant permit space information that it might have, that managing entity becomes the host employer. In the absence of any such contractual agreement and information exchange, the owner of the property is the host employer.

Summary of OSHA's New Confined Spaces Standard

Every employer is responsible for taking the following steps to protect their employees against the hazards associated with confined spaces:

- They must designate a competent person to identify all confined spaces in which employees may work. OSHA defines a competent person as "one who is capable of identify and existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has the authority to take prompt corrective measures to eliminate them." It is not required that the competent person be an employee of any particular employer, but they must have the required authority.
- Before it begins work at a worksite, each employer must ensure that a competent person evaluates all confined spaces in which one or more of the employees it directs may work, and identifies each space that is a permit space, through consideration and evaluation of the elements of that space, including testing as necessary.



- In those cases where confined spaces are present, the employer is required to have a competent person determine if any of these spaces are "permit spaces."
- If a competent person determines one or more permit spaces are present, the entry employer must protect its employees from the hazards in that space.
- The employer must inform exposed employees by posting danger signs, or by any other equally effective means, of the existence and location of and the danger posed by each permit space
    - A sign reading "DANGER-PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" or using other similar language would satisfy the requirement for a sign.
- The employer must also inform, in a timely manner and in a manner other than posting, its employees' authorized representatives and the controlling contractor of the existence and location of, and the danger posed by, each permit space.
- The entry employer is required to train every worker who must enter the permit space, as well as others impacted by the presence of the space and/or related operations.
- The entry employer is required to plan for the safe rescue of all entrants who are unable to exit the space under their own power.

This is only a summary of the requirements of OSHA's Confined Spaces standard for construction operations. This new standard requires significant action and attention by those employers completing work on sites with confined spaces, especially permit spaces.

Identifying Permit Spaces

The thorough and proper identification of permit spaces is critical in order to determine whether or not precautions are required to protect employees entering these spaces—and if hazards exist, what controls are necessary. Failing to take these necessary steps can result in death or serious injury to the exposed workers. The competent person must answer four questions to determine if a confined space is a permit space. If the answer to *any* of these four questions is "yes," the space is a permit space, with all necessary controls required.

1. **Does the space contain or have the potential to contain a hazardous atmosphere?** This requires the identification of numerous potential hazards and testing, as necessary, to evaluate whether any of the following hazards are or may be present. This should be done PRIOR to workers entering the space.
    a. Oxygen deficiency or excess concentrations of oxygen; oxygen concentrations in the space must be between 19.5 and 23.5 percent
    b. Concentration of any flammable gas, vapor, or mist in excess of 10% of its Lower Explosive Limit (LEL)
    c. Airborne combustible dust at a concentration equal to or in excess of its Lower Explosive Limit (LEL)



d. Atmospheric concentrations of any substance that can cause death, incapacitation, impairment of the ability to self-rescue, injury or acute illness
e. The competent person must be familiar with the work to be done in the space and the potential for that work to introduce atmospheric hazards. For example, a confined space that is safe when entered can become deadly if inert gas welding inside the space leads to the inert gas displacing oxygen in the worker's breathing zone.
f. **Note:** Proper procedures for all required testing must be established as part of the employer's confined spaces entry program.

2. **Does the space contain a material with the potential to engulf an entrant?** Engulfment is the surrounding of a person by liquid or fine solid substance that can be breathed in to cause death by filling or plugging the respiratory system, or that exert sufficient force on the body to cause strangulation, constriction, or crushing. The competent person completing the analysis must consider whether any liquid or flowable solid could enter the space in any manner such as through a pipe or manhole in an operating water or sewer system.

3. **Does the space have an internal configuration such that an employee entering the space could be trapped or asphyxiated by inwardly converging walls or by a floor with a downward slope tapering to a smaller cross section?** A confined space with a small cross section can develop a hazardous atmosphere rapidly in inadequate ventilation is provided. This type of space can also prevent a worker from escaping the space or render rescue more difficult.

4. **Does the space contain any other recognized serious safety or health hazard that might pose an immediate danger to the worker's life or health or that might impair their ability to escape from the space if necessary?** Consideration must be given to all potential hazards, including fire and explosion, mechanical, electrical, hydraulic, and pneumatic energy, temperature extremes, radiation, chemicals, biological hazards, and much more.

Examples of Confined Spaces

Examples of confined spaces may include, but are not limited to, the following:

- Storage tanks
- Compartments of ships
- Process vessels
- Pits
- Silos
- Vats
- Wells
- Sewers
- Digesters
- Degreasers
- Reaction vessels

- Boilers
- Ventilation and exhaust ducts
- Tunnels
- Underground utility vaults
- Pipelines

Characteristics of Confined Spaces

Internal Configuration

- Open Space: There are no obstacles, barriers, or obstructions within the space. An example of this might be some large, open water tanks with no internal walls, barriers, or baffles.
- Obstructed Space: The permit space contains some type of obstruction that a rescuer would need to maneuver around. An example of this type of space would be a baffle or mixing blade.

Elevation

- Elevated space: A permit space where the entrance portal or opening is above grade by four feet or more. This type of space usually requires knowledge of high-angle rescue procedures.
- Non-elevated space: A permit space with the entrance portal located less than four feet above grade. This type of space will allow the rescue team to transport an injured employee normally, without special procedures.

Portal Size

- Restricted Portals: A restricted portal is one of 24 inches or less in its smallest dimension. Portals of this size are too small to allow a rescuer to simply enter the space while using a Self-Contained Breathing Apparatus (SCBA).
- Unrestricted Portals: An unrestricted portal is one greater than 24 inches in its smallest dimension. These portals allow relatively free movement into and out of the permit space.

Space Access

- Horizontal Portal: This type of portal is located on the side of the permit space. Use of retrieval lines could be difficult when using this type of portal to access a confined space.
- Vertical Portal: This type of portal is located either on the top of the permit space (rescuers must climb down to enter the space) or at the bottom of the permit space (rescuers must climb up to enter the space). Vertical portals may require knowledge of rope techniques.

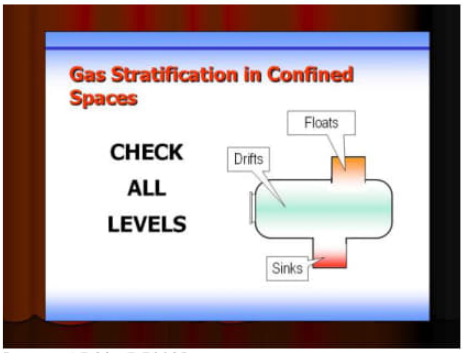


The hazards associated with confined spaces that can cause serious injury and death to workers are numerous and potentially complex. Two of the major factors which lead to fatal injuries in confined spaces are:

- The failure to recognize and control the hazards associated with confined spaces.
- Inadequate or incorrect emergency response. If the emergency response is a spontaneous reaction to an emergency situation, as opposed to an appropriately planned and executed response, this can lead to multiple fatalities.

Atmospheric Hazards

In those instances when there is reason to believe that unsafe atmospheric conditions might be encountered, it is critical to test the atmosphere of a confined space prior to entry by any employees, except in certain circumstances. Testing must take stratified atmospheres—those with distinct layers created by the differing weights of the gasses—into account. Methane, for example, is lighter than air and would be found at the top of a confined space, while hydrogen sulfide (heavier than air) would be found at the bottom. Pre-entry testing must cover the top, middle, and bottom of the confined space and should be tested in the direction of travel and to each side.



[source CAL-OSHA]

Depending on the findings of the initial monitoring, the activities taking place in the space, the history of the space, and other factors, it may be necessary to continue monitoring the atmosphere throughout entry operations.

Oxygen Deficiency

Oxygen deficiency occurs from chemical or biological reactions which displace or consume oxygen from within a confined space. Consumption of oxygen takes place during combustion of flammable substances, as occurs in welding, cutting, or brazing operations. Oxygen may also be displaced by other gases which may inert, hazardous, or flammable.

A more subtle form of oxygen consumption occurs during bacterial action, as in the fermentation process. Oxygen deficiency can result from bacterial action in excavations and manholes which are near garbage dumps, landfills, or swampy areas. Oxygen may also be consumed during slow chemical reactions, as in the formation of rust on the exposed surface of metal tanks, vats, and ship holds.

Important Facts about Oxygen and Oxygen Deficiency:

- Ambient air has an oxygen content of approximately 21 percent.
- When the oxygen level drops below 17 percent, one of the first signs of hypoxia is deterioration of night vision, which is usually not noticeable.
- Physiologic effects include increased breathing volume and an accelerated heartbeat.
- Between the oxygen concentrations of 14 percent and 16 percent, the physiologic effects consist of:
    - Increased breathing volume
    - An accelerated heartbeat
    - Poor muscular coordination
    - Impaired judgment
    - Impaired attention
    - Impaired coordination
    - Rapid fatigue
    - Intermittent respiration
- Between the oxygen levels of 6 percent and 10 percent, the physiological effects are:
    - Nausea
    - Vomiting
    - Inability to perform
    - Unconsciousness
- At concentrations of less than 6 percent, there is a rapid loss of consciousness and death in minutes.

NIOSH FACE Report - FACE 8844

At the time of the incident the victim had been working as a sub-contractor in various manholes on this system for slightly over 4 hours. He told a co-worker that he was going to install a plug in the lines leading to the manhole where the incident occurred (to keep out the ground water) and that he would then meet the worker for lunch. The victim planned to pump the water out of the manhole after lunch and then construct a baffle in the manhole. This manhole contained approximately one foot of water and 2-3 Inches of mud at the bottom. A wooden ladder had been left in the manhole since the time of construction, but the manhole had not been opened since it was installed six months prior to the incident. His co-worker arrived on the scene a few minutes later and saw the victim lying at the bottom of the manhole. The co-worker ran to a nearby home and telephoned for help. The local fire department responded to the call and four firefighters were on the scene within four minutes. One firefighter immediately descended the ladder to check the victim. As he reached the victim, he said he felt as though “someone had put a piece of cellophane over my face.” The firefighter began climbing the ladder to

escape from the manhole, but he was extremely dizzy and had to be pulled from the manhole by two other firefighters. Testing of the manhole on the day following the incident still showed oxygen levels at various depths within the manhole:

- 5 feet below surface 20.5% oxygen
- 7 feet below surface 20.0% oxygen
- 9 feet below surface 14.0% oxygen
- 11 feet below surface 6.5% oxygen
- 13 feet below surface 4.0% oxygen

Oxygen Displacement: Inert Gases and Simple Asphyxiants

A simple asphyxiating atmosphere contains a gas, or gases, that are physiologically inert and which do not produce any ill effects on the body. However, in sufficient quantity, a simple asphyxiant will displace enough oxygen to result in an atmosphere unable to support life.

The ambient, or normal, atmosphere is composed of approximately 21 percent oxygen, 78 percent nitrogen, and 1 percent argon, with small amounts of various other gases. If the oxygen content drops below 19.5%, the atmosphere is considered oxygen deficient. If 100 percent nitrogen, for example—a non-toxic, colorless, odorless gas—is used to inert (displace oxygen in) a confined space, it would cause immediate collapse and death to the worker if the confined space is not adequately ventilated before worker entry. Other examples of simple asphyxiants that have claimed lives in confined spaces are carbon dioxide, argon, and helium.

Safe Work Practices

- Consider each entry to a confined space to be potentially deadly. Proper testing and safe entry procedures must be followed for each entry.
- Identify and label confined spaces in the workplace.
- Provide written safe-work procedures for entering a confined space and ensure that workers are trained in these procedures.
- Isolate the confined space from adjacent piping by blanking, blinding, or disconnecting the piping.
- Assess the hazards before entering a confined space, including testing for oxygen levels if necessary.
- Provide ventilation for spaces with actual or potential hazardous atmospheres.

Flammable Atmospheres

A flammable atmosphere generally results from vaporization of flammable liquids, by-products of chemical reaction, enriched oxygen atmospheres, or concentrations of flammable gases or combustible dusts. Three components are necessary for an atmosphere to become flammable: fuel and oxygen, the proper mixture of fuel and oxygen, and a source of ignition.



The proper mixture of fuel and oxygen will vary from gas to gas within a fixed range. This range is between the lower flammability limit (LFL) and the upper flammability limit (UFL). These terms are synonymous with the lower explosive limit (LEL) and the upper explosive limit (UEL).

Example: The explosive range for methane is between 5% and 15% in air. Concentrations below 5% methane are below the explosive range, and concentrations above 15% are too rich to support combustion. If a confined space contains 27% methane and forced ventilation is started, the introduction of air into the confined space may dilute the methane in air, taking it into the explosive range. Extreme care must be taken until the concentration is no greater than 10% of the LEL, in this case .5% or lower, at which time entry may be permitted if all other conditions are safe and stable.

Toxic Gases

Toxic gases may be present in confined spaces for the following reasons:

- The manufacturing process may use any of a wide variety of toxic gases. For example, in producing polyvinyl chloride, hydrogen chloride is used, as well as vinyl chloride monomer.
- There may be biological or chemical processes occurring within the product stored in the confined space. For example, decomposing organic material in a tank or sump can liberate hydrogen sulfide.
- The operation performed in the confined space can liberate a toxic gas. For example, welding can liberate oxides of nitrogen, ozone, and carbon monoxide.
- Toxic gases may be -involved when acids are used for cleaning the interior of a confined space.

Solvents

Hydrocarbon solvents are frequently used in industry as degreasing agents. These agents can cause unconsciousness by depressing the central nervous system. Some chlorinated hydrocarbon solvents, such as chloroform, have been used as anesthetic agents. In addition, certain chlorinated or fluorinated hydrocarbon solvents are toxic to the heart and have been associated with sudden death in confined spaces. The solvent methylene chloride can be toxic both because of its solvent properties and also because it is metabolized in the body to form carbon monoxide.

Physical Hazards

In addition to the atmospheric hazards in a confined space, physical hazards also must be addressed. Physical hazards cover the entire spectrum of hazardous energy and its control, the physical layout of the environment, and processes underway or previously underway. These hazards include those associated with:

- Mechanical, electrical, and hydraulic energy



- Engulfment
- Communication problems
- Noise
- The size of the openings into the confined space itself

Engulfment

Engulfment in liquids or loose materials is one of the leading causes of death from physical hazards in confined spaces. Engulfment and suffocation are hazards associated with storage bins, silos, and hoppers where grain, sand, gravel, or other loose materials are stored, handled, or transferred, as well as vessels used for liquid storage. The behavior of such materials can be unpredictable, and entrapment and burial can occur in a matter of seconds.

In some cases, material being drawn from the bottom of storage bins can cause the surface to act like quicksand. When a storage bin is emptied from the bottom, the flow of material may form a funnel-shaped path over the outlet. The rate of material flow increases toward the center of the funnel. During an unloading operation, the flow rate can become so great that once a worker is drawn into the flow path, escape is virtually impossible.

Other Physical Hazards

The nature of confined-space work may make it difficult to separate the worker from hazardous forms of energy (e.g., isolation) such as powered machinery, electrical energy, and hydraulic or pneumatic lines.

Examples of physical hazards often encountered in a confined space include the following:

- Activation of electrical or mechanical equipment can cause injury to workers in a confined space. Therefore, it is essential to de-energize and lock out all electrical circuits and physically disconnect mechanical equipment prior to any work in confined spaces.
- Release of material through lines which are an integral part of the confined space poses a life-threatening hazard. All lines should be physically disconnected, blanked off, or should use a double block and bleed system.
- Falling objects can pose a hazard in confined spaces, particularly in spaces which have topside openings for entry, through which tools and other objects may fall and strike a worker.
- Extremely hot or cold temperatures can make work inside a confined space hazardous. If a confined space has been steam cleaned, for example, it should be allowed to cool before any entry is made.
- Wet or slick surfaces can cause falls in confined spaces. In addition, wet surfaces can provide a grounding path and increase the hazard of electrocution in areas where electrical equipment, circuits, and tools are used.

- Noise within confined spaces can be amplified because of the design and acoustic properties of the space. Excessive noise is not only harmful to the worker's hearing but can affect communication and cause shouted warnings to go unheard.

Prevention Program

The worker who is required to enter and work in a confined space may be exposed to a number of hazards, ranging from an oxygen-deficient or toxic atmosphere to the release of hazardous energy (electrical/mechanical/hydraulic/chemical). Therefore, it is essential for employers to develop and implement a comprehensive, written confined-space entry program.

The following elements are recommended as a guide in developing a confined space program:

- Identification of all confined spaces at the facility/operation
- Posting a warning sign at the entrance of all confined spaces
- Evaluation of hazards associated with each type of confined space
- Performing a job safety analysis for each task to be performed in the confined space

Confined Space Entry Procedures

Confined space entry procedures should include the following:

- Initial plan for entry
- Assigned standby attendant(s)
- A rescue plan
- Communication between workers inside the confined space and standby attendants about rescue procedures, conditions, monitoring information, and more
- Specified work procedures within the confined space

Issuance of Confined Space Entry Permit

Before entry begins, an entry supervisor evaluates the work to be done and the conditions present in the space and prepares an entry permit to authorize entry. A confined-space entry permit is an authorized approval in writing that:

- Specifies the location and type of work to be done
- Certifies that the space has been evaluated and tested by a qualified person, and that all necessary protective measures have been taken to ensure the safety of the worker
    - This must include testing and monitoring the air quality in the confined space to ensure that the oxygen level is between 19.5 and 23.5 percent by volume and the flammable range is less

than 10 percent of the LFL (lower flammable limit) for any flammable materials.

Before entry begins, the entry supervisor identified on the permit must sign the entry permit and make the completed permit available to all authorized entrants by posting it at the entry portal or by any other equally effective means, so that the entrants can confirm that pre-entry preparations have been completed.

Confined Space Preparation

Confined space preparation activities may include:

- Isolation, lockout/tagout
- Purging and ventilation
- Cleaning processes
- Requirements for special equipment and tools

Safety Equipment and Protective Clothing

Safety equipment and protective clothing including the following may be required for use in confined space entry operations:

- Head protection
- Hearing protection
- Hand protection
- Foot protection
- Body protection
- Respiratory protection
- Safety belts
- Lifelines, full body harness
- Mechanical-lift device-tripod

Training

Workers and supervisors must be trained in the selection and use of the following:

- Safe entry procedures
- Respiratory protection
- Lifelines and retrieval systems
- Protective clothing

Safety Meetings

Employers must conduct safety meetings prior to the start of work in a permit-required confined space to discuss confined space safety, including the following:

- The availability and use of proper ventilation equipment

- Monitoring the air quality while workers are in the space
- Roles and responsibilities of all persons involved in the entry operation
- Acceptable safe conditions that must be present at the time of entry and during the time work takes place in the space
- Means of communication used to maintain contact with those working in the space
- The specific rescue plan developed for entry operation

Lesson Summary

- Confined spaces are large enough for an employee to bodily enter them, have a restricted entrance and exit, and are not designed for continuous occupancy.
- Permit-required confined spaces, or permit spaces, meet additional requirements, including having the potential to contain a hazardous atmosphere or otherwise lead to asphyxiation for workers.
- All employers present on a worksite, including the entry employer, the controlling contractor, and the host employer have responsibilities to keep workers safe in confined spaces.
- Testing and monitoring the air quality is required in a confined space to ensure that the oxygen level is between 19.5 and 23.5 percent by volume and the flammable range is less than 10 percent of the LFL (lower flammable limit) of any flammable materials.
- Oxygen deficiency results from many sources, including chemical or biological reactions that displace or consume oxygen from within a confined space. The consumption of oxygen takes place during combustion of flammable substances, as occurs in welding, cutting, or brazing operations. A more subtle form of consumption of oxygen occurs during bacterial action, such as in the fermentation process.
- Engulfment in liquids or loose materials is one of the leading causes of death from physical hazards in confined spaces. Engulfment and suffocation are hazards associated with storage bins, silos, and hoppers where grain, sand, gravel, or other loose materials are stored, handled, or transferred, as well as vessels used for liquid storage.
- Other possible physical hazards include wet surfaces, hot or cold temperatures, or falling objects.

Lesson 2: Safety and Training Education

Lesson Focus

At the end of this lesson, students will be able to:

- Describe the duties of employers and employees related to confined spaces
- Identify the proper rescue and emergency services
- Explain the testing protocols for confined spaces

Duties of Employers and Employees

All employees required to enter confined spaces must be instructed as to the nature of the actual and potential hazards involved, the necessary precautions to be taken, and the use of protective and emergency equipment required. Employers must ensure that a qualified entry attendant is present any time workers will be inside the space.

Duties of Attendants

An attendant:

- Knows the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of potential exposures
- Is aware of possible behavioral effects of chemical and environmental hazard exposure on authorized entrants
- Continuously maintains an accurate count of authorized entrants in the permit space and ensures that the means used to identify authorized entrants is accurate and effective
- Remains outside the permit space during entry operations until relieved by another attendant
- Communicates with authorized entrants as necessary to monitor entrant status
- Monitors activities inside and outside of the space

An entrant must exit the space:

- If the attendant detects a prohibited condition
- If the attendant detects the behavioral effects of hazard exposure on an authorized entrant
- If the attendant detects a situation outside of the space that could endanger the authorized entrants

Providing Assistance

An attendant must summon rescue and other emergency services as soon as she or he determines that authorized entrants may need assistance to escape from permit space hazards.

The attendant must:

- Warn unauthorized persons that they must stay away from the permit space
- Inform the authorized entrants and the entry supervisor if unauthorized persons have entered the permit space

- Perform non-entry rescues as specified by the employer's rescue procedure
- Perform no duties that might interfere with the attendant's primary duty to monitor and protect the authorized entrants

Rescue and Emergency Services

The employer of a designated rescue team is required to ensure that the team members have received all training required for authorized entrants and have also been trained to perform their assigned rescue duties. That employer is also responsible for providing all members of the rescue team with necessary personal protective and rescue equipment, including respirators, and must train them on how to use it.

It is best that all rescuers are trained in first aid and CPR, but at a minimum one rescue team member must be certified. Employers must ensure that the team practices or performs rescue exercises at least annually and that rescue services are provided access to permit spaces in order to allow for the practicing of rescue operations.

All members of the rescue team must be informed of the hazards of each permit space before entering a space. All rescue services must agree to notify the employer in the event the service becomes unavailable. The employer must provide the service with access to the permit space so the service can develop an appropriate rescue plan and practice rescue as necessary.

If the entry employer designates an off-site rescue service, including a local fire department, it must determine that the service has the ability and equipment to carry out a rescue in the particular permit space or type of permit space in which the entrant is working.

Whether using their own on-site rescue team (consisting of its own or another contractor's employees) or an off-site team, such as a local fire department or other rescue service, the employer must make certain that the rescue team is able to respond in time to enable the injured worker to receive whatever medical attention is needed. This must be done by contacting the rescue team prior to entry and informing them of the nature of the space and the hazards involved. In some cases, this may require a standby rescue team, such as when the entrant is working in an atmosphere that is immediately dangerous to life or health (IDLH) and is wearing an airline respirator or a self-contained breathing apparatus.

Non-entry rescue that is conducted without entry into the confined space is preferred. This can be conducted by such means as a rope or winch. Non-entry rescue is required unless the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue of the entrant. Whenever non-entry rescue is selected, the entry employer must ensure that retrieval systems or methods are used whenever an authorized entrant enters a permit space, and must confirm, prior to entry, that emergency assistance would be available in the event that non-entry rescue fails.



Employees Designated to Rescue

An employer whose employees have been designated to provide permit space rescue and emergency services must:

- Provide affected employees with the personal protective equipment (PPE) needed to conduct permit space rescues safely, and train affected employees so they are proficient in the use of that PPE, at no cost to those employees
- Train affected employees to perform assigned rescue duties; the employer must ensure that such employees successfully complete the training required to establish proficiency as an authorized entrant
- Train affected employees in basic first aid and cardiopulmonary resuscitation (CPR); the employer must ensure that at least one member of the rescue team holds a current certification in first aid and CPR
- Ensure the employees practice making permit space rescues at least once every 12 months, by means of simulated rescue operations in which they remove dummies, mannequins, or actual persons from the actual permit spaces or from representative permit spaces

Duties of Authorized Entrants

The duties include:

- Knowing the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure
- Properly using equipment as required
- Communicating with the attendant as necessary to enable the attendant to monitor entrant status and to enable the attendant to alert entrants of the need to evacuate the space
- Exit the space immediately if acceptable entry conditions cannot be maintained, if a hazard arises, or if ordered to leave the space by the designated Attendant

An authorized entrant must alert the attendant whenever:

- The entrant recognizes any warning sign or symptom of exposure to a dangerous situation
- The entrant detects a prohibited condition

Duties of Entry Supervisors

Duties include:

- Knowing the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure
- Verifying, by checking that the appropriate entries have been made on the permit, that all tests specified by the permit have been conducted and that all procedures and equipment specified by the permit are in place before endorsing the permit
- Verifying that rescue services are available and that the means for summoning them are operable
- Removing unauthorized individuals who enter, or who attempt to enter, the permit space during entry operations
- Determining whenever responsibility for a permit space entry operation is transferred and doing so at intervals dictated by the hazards and operations performed within the space

Rescue and Emergency Services

Each authorized entrant should use a chest or full body harness, with a retrieval line attached at the center of the entrant's back, near shoulder level, above the entrant's head, or at another point from which the employer can establish the ability to successfully remove the entrant. Wristlets may be used in lieu of the chest or full body harness if the employer can demonstrate that the use of a chest or full body harness is infeasible or creates a greater hazard and that the use of wristlets is the safest and most effective alternative.

The other end of the retrieval line should be attached to a mechanical device or a fixed point outside the permit space in such a manner that rescue can begin as soon as the rescuer becomes aware that rescue is necessary. A mechanical device should be available to retrieve personnel from vertical-type permit spaces more than five feet deep.

If an injured entrant is exposed to a substance for which a Safety Data Sheet (SDS) or other similar written information is required to be kept at the worksite, that SDS or written information shall be made available to any emergency responders and medical facility treating the exposed entrant.

Testing Protocol

OSHA FactSheet

Procedures for Atmospheric Testing in Confined Spaces[1]

Atmospheric testing is required for two distinct purposes: evaluation of the hazards of the permit space and verification that acceptable conditions exist for entry into that space.

A confined space is one that is large enough to enter and perform assigned work in; it has limited or restricted ways to enter or exit the space; and it was not designed to be occupied continuously by a worker.

Evaluation testing

The atmosphere within a confined space must be tested using equipment that is designed to detect the chemicals that may be present at levels that are well below the defined exposure limits. Evaluation testing is done to:

- determine what chemical hazards are or may become present in the space's atmosphere, and
- identify what steps must be followed and what conditions must be met to ensure that atmospheric conditions are safe for a worker to enter the space.

The testing results and the decisions about what steps must be followed before entry must be evaluated by, or reviewed by, a technically qualified professional like an OSHA consultation service, a certified industrial hygienist, a registered safety engineer, or a certified safety professional. The technically qualified professional must consider all of the serious hazards in his/her evaluation or review.

A permit space is a confined space that has one or more of the following features: it has or may contain a hazardous atmosphere; it contains a material that can engulf a person who enters; it has an inside design that could trap or asphyxiate a person who enters (inwardly converging walls, or a floor that slopes downward to a smaller section); or it has any other serious safety or health hazards.

Verification Testing

Before a permit space that may have a hazardous atmosphere can be entered, the atmosphere must be tested using the steps identified on the permit (developed during evaluation testing). Verification testing is done to make sure that the chemical hazards that may be present are below the levels necessary for safe entry, and that they meet the conditions identified on the permit. Test the atmosphere in the following order: (1) for oxygen, (2) for combustible gases, and then (3) for toxic gases and vapors.[2] The testing results -- the actual test concentrations -- must be recorded on the permit near the levels identified for safe entry.

Duration of Testing

For each test required on the permit, you must allow enough time for the air from the space to be drawn into the equipment and for the sensor (or other detection device) to react to the chemical if it is present. This is considered the "minimum response time" and it will be noted by the manufacturer in the operator's manual. Be aware that you will need to add time to this "minimum response time" if you have attached hosing or a probe extension to the inlet. The additional time is needed to allow the air from the different depths of the space to be pulled into the equipment inlet.

Testing Conditions in Spaces that May Have Layered Atmospheres

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.

Retesting the Space During Entry or Before Re-Entry

Test the permit space routinely to make sure that the atmospheric conditions continue to be safe for entry.[3]

[1] Title 29 Code of Federal Regulations 1910.146, Appendix B.
[2] 29 CFR 1910.146(c)(5)(ii)(C) and (d)(5)(iii).
[3] 29 CFR 1910.146(c)(5)(ii)(F) and (d)(5)(ii).

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

For more complete information:

OSHA Occupational Safety and Health Administration

U.S. Department of Labor
www.osha.gov
(800) 321-OSHA

DSTM 9/2005

Lesson Summary

- Employers should assign attendants to monitor confined spaces. These attendants must know the relevant hazards, recognize the signs of exposure, maintain a count of authorized entrants in the space, and remain outside the space during entry operations.
- An attendant must summon rescue and other emergency services as soon as she or he determines that authorized entrants may need assistance to escape from permit space hazards.
- Whether using their own on-site rescue team (consisting of its own or another contractor's employees) or an off-site team, such as a local fire department or other rescue service, the employer must make certain that the rescue team is able to respond in time to enable the injured worker to receive whatever medical attention is needed.
- Authorized entrants must know the hazards that may be faced during entry, properly use equipment as required, communicate with the attendant as necessary, and exit the space immediately if acceptable entry conditions cannot be maintained.
- Atmospheric testing of the confined space must be conducted regularly, and the results must be posted. If the confined space meets the requirements of a permit space, the necessary additional precautions must be taken.

Module 9: Cranes, Derricks, Hoists, Elevators and Conveyors

Module Description

This module is intended for workers who want to learn more about cranes, derricks, hoists, elevators, and/or conveyors. We will discuss the topics of cranes and derricks, helicopters, base-mounted drum hoists, overhead hoists, conveyors, and aerial lifts in detail in this module along with the safety measures required when handling such machinery. This module will also cover the topics included in OSHA 29 CFR 1926 Subparts N and CC.

Module Learning Objectives

At the conclusion of this module, students will be able to:

- Distinguish between the different types of cranes
- Name the procedures for proper inspection and maintenance
- Summarize guidelines for proper equipment testing and load rating capacities
- Discuss the proper procedures for crane operators and co-workers
- Outline regulations for load handling and handling equipment

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