
A Guide to Safety in Confined Spaces

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A Guide to Safety in Confined Spaces



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This guide is intended to be consistent with all existing OSHA standards; therefore, if an area is considered by the reader to be inconsistent with a standard, then the OSHA standard must be followed.

To obtain additional copies of this guide, or if you have questions about North Carolina occupational safety and health standards or rules, please contact:

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Additional sources of information are listed on the inside back cover of this guide.

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Foreword

Few occupational dangers can hide themselves as well as those that lie in confined spaces. A seemingly empty tank can be full of deadly gas. The atmosphere in a harmless looking tunnel can be searingly hot. Workers who enter these confined spaces must follow detailed safety procedures to protect themselves.

A Guide to Safety in Confined Spaces examines the rules and risks associated with working in these dangerous conditions. The booklet is divided into three sections. The first part deals with general safety practices for confined space work and the second with the requirements of the 1993 OSHA Permit-Required Confined Spaces Standard. A third part offers checklists to consider before entering a confined space.

In North Carolina, DOL inspectors enforce the federal Occupational Safety and Health Act through a state plan approved by the U.S. Department of Labor. The Occupational Safety and Health Division of the N.C. Department of Labor offers many educational programs to the public and produces publications, including this guide, to help inform people about their rights and responsibilities regarding occupational safety and health.

When looking through this guide, please remember the DOL mission is greater than just enforcement of regulations. An equally important goal is to help people find ways to create safe workplaces. In this case, *A Guide to Safety in Confined Spaces* provides valuable information that should be followed by all employees before and after they enter confined spaces.

Cherie Berry
Commissioner of Labor

Introduction

Many workplaces contain spaces that are considered to be “confined” because their configurations hinder the activities of any employees who must enter into, work in and 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. The term permit-required confined space refers to those spaces that meet the definition of a confined space and also contain health or safety hazards, thereby requiring a permit for entry.

- A *confined space* has limited or restricted means of entry or exit, is large enough for an employee to enter and perform assigned work, and is not designed for continuous occupancy by the employee. These spaces may include, but are not limited to, underground vaults, tanks, storage bins, pits and diked areas, vessels, and silos.
- A *permit-required confined space* is one that meets the definition of a confined space and has one or more of these characteristics: 1. contains or has the potential to contain a hazardous atmosphere, 2. contains a material that has the potential for engulfing an entrant, 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.

Despite efforts to address the hazards of confined spaces and identify related safety/health standards which apply, incidents of worker deaths continue to occur. The National Institute of Occupational Safety and Health Publication 94-103, *Worker Death in Confined Spaces*, reported the results of a study conducted on 480 worker deaths in 423 incidences that occurred between December 1983 through September 1993. Seventy of those investigations involved confined spaces where a total of 109 people died. In 25 of those incidences, there was more than one person killed. A 1986 NIOSH Alert 86-110, *Request for Assistance in Preventing Occupational Fatalities in Confined Spaces*, stated that people acting as rescuers accounted for more than 60 percent of the confined space fatalities.

OSHA estimates that about 239,000 general industry establishments employing 12 million people have confined spaces. Approximately 1.6 million people enter confined spaces annually. Through the combined actions of academia, industry and labor organizations applying scientific and analytical methods along with studying the best industry practices, the regulation contained in 29 *Code of Federal Regulations* 1910.146 was developed to reduce your chances of being a victim. This standard applies to all of general industry. If employers comply with the standard, OSHA estimates 53 worker deaths, 5,000 lost-day cases and 5,700 other accidents can be avoided annually. The road to safety starts with the evaluation of the workplace to see if there is a confined space.

Classification of a Confined Space

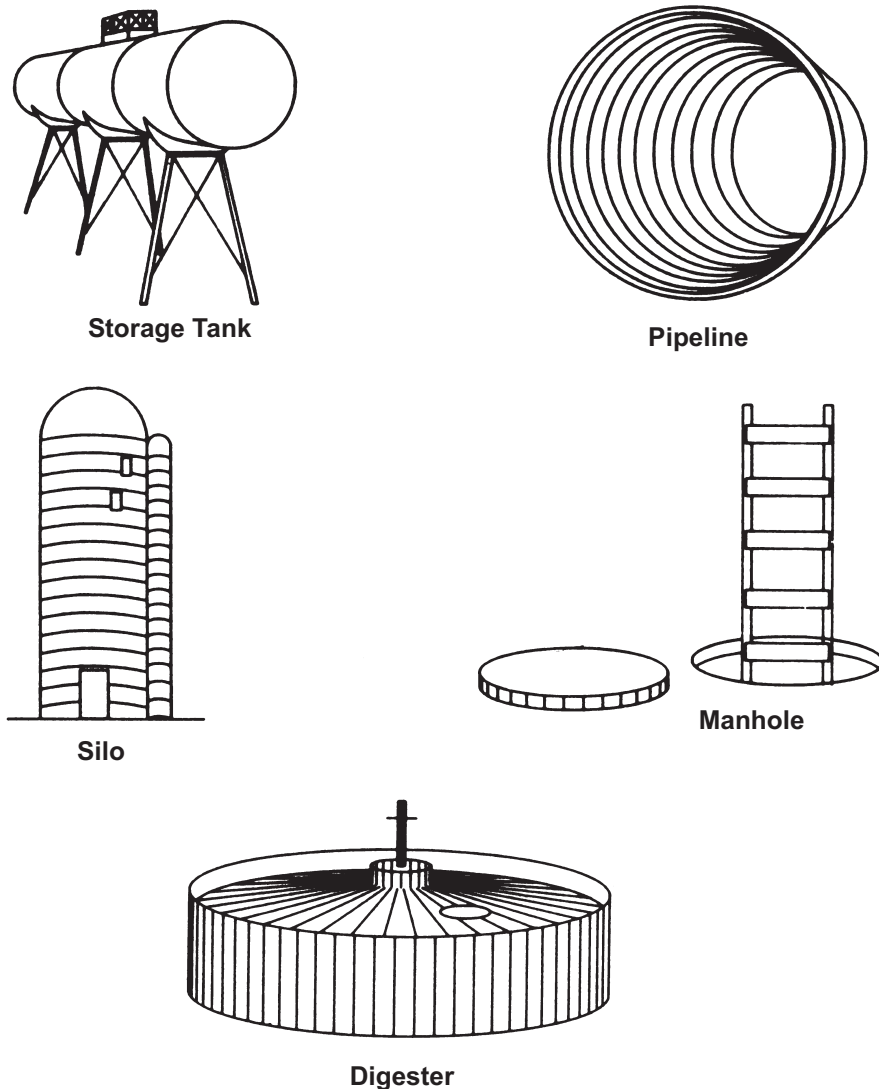
How Can You Identify a Confined Space?

NIOSH defines a confined space as one that, by design, has limited openings for entry and exit, unfavorable natural ventilation that could contain or produce dangerous air contaminants, and is not intended for continuous employee occupancy. Confined spaces include but are not limited to 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, and pipelines. Confined spaces can be found in many industrial settings, from steel mills to paper mills, from shipyards to farms, and from public utilities to the construction industry. The hazards associated with confined spaces can cause serious injury and death to workers. Two major factors lead to fatal injuries in confined spaces: (1) failure to recognize and control the hazards associated with confined spaces and (2) inadequate or incorrect emergency response. The emergency response is usually a spontaneous reaction to an emergency situation and can lead to multiple fatalities.

Confined spaces may be classified into two categories: (1) open-topped enclosures with depths that restrict the natural movement of air (e.g., degreasers, pits, selected types of tanks and excavations), and (2) enclosures with limited openings for entry and exit (e.g., sewers, tanks and silo). Figure 1 illustrates examples of common types of confined spaces.

Figure 1

Examples of Confined Spaces



The hazards found in any confined space are determined by the material being stored or used, by the process taking place inside the space, and by the effects of the external environment. Worker entry into confined spaces may occur during construction activities or during frequent necessary functions such as inspection, repair or maintenance. For purpose of discussion, hazards in confined spaces are separated into atmospheric hazards and physical hazards.

A confined space:

- has limited or restricted means of entry or exit
- is large enough for an employee to enter and perform assigned work
- is not designed for continuous occupancy

Limited Openings for Entry and Exit

Confined space openings are limited primarily by size or location. Openings are usually small in size, perhaps as small as 18 inches in diameter. An access door or portal that is too small to allow an employee to walk upright and unimpeded through it is considered to be limited access or exit. These small openings may make it very difficult to get needed equipment in or out of the spaces.

Confined spaces can be hazardous, and they can be hazardous in varied ways. Oftentimes the confined space will not appear to be hazardous; it may have been entered on prior occasions without incident and may give no apparent sign of danger. At other times there may be ready indications of danger: the distinct odor of irritating or toxic atmospheres, the presence of arcing electrical equipment, continued mild shocks, or flowing grain or sand. By their nature, confined spaces concentrate hazards: atmospheric hazards, in that certain gases will displace breathable air, or that the confined space will allow the accumulation of toxic hazards or flammable or explosive atmospheres; and physical hazards, in that confined spaces limit the ability to avoid contact with electricity, moving mechanical components or machinery, or unstable substances. Recognition of the inherent capacity of these spaces to harbor hazardous agents is a significant element in any workplace hazard assessment. When confined spaces are recognized to be hazardous, provisions for minimizing the need for entry and for use of appropriate work practices and equipment can be made.

Access to open-topped spaces may require the use of ladders, hoists or other devices. Escape from such areas may be very difficult in emergency situations. Ladders and temporary, movable, spiral or articulated stairs are usually considered limited or restricted means of egress. Fixed industrial stairs that meet OSHA standards must be considered limited or restricted means of egress when the conditions or physical characteristics of the space, in light of the hazards present in it, would interfere with the entrant's ability to exit or be rescued in a hazardous condition.

A space has limited or restricted means of entry or exit if an entrant's ability to escape in an emergency would be hindered.

Not Designed for Continuous Worker Occupancy

Most confined spaces are not designed for workers to enter and work in them on a routine basis. They are designed to store a product, to enclose materials and processes, or to transport products or substances. The distance an employee must travel in a space such as a tunnel to reach a point of safety can be a determinant for classifying a space as a confined space. Therefore, occasional worker entry for inspection, maintenance, repair, cleanup or similar tasks is often difficult and dangerous due to chemical, distance or physical hazards within the space.

A confined space found in the workplace may have a combination of the above characteristics, which can complicate working in and around these spaces, as well as hamper rescue operations during emergencies. If a survey of your working area identifies one or more work spaces with the characteristics listed above, then please read the following information—someday it may save your life or the life of a co-worker.

NIOSH developed a classification scheme for atmospheric hazards in confined spaces, which is based on the oxygen content of the air, the flammability characteristics of gases or vapors, and the concentration of toxic substances that may be present in a confined space (Table 1). Listing a particular confined space as Class A, B or C is determined by the most hazardous condition present. The usefulness of this classification is that it provides a framework upon which recommendations for work practices and rescue procedures can be made. A detailed listing of safe work practices and procedures for confined-space work is given in the NIOSH criteria document, NIOSH Publication 80-106.

Table 1
Confined-Space Classification

	Class A	Class B	Class C
Characteristics	Immediately dangerous to life	Dangerous, but not immediately life threatening	Potential hazard
Oxygen	16 percent or less* (122 mm Hg) or greater than 25 percent (190 mm Hg)	16.1 percent to 19.4 percent* (122–147 mm Hg), or 21.5 percent to 25 percent (163-190 mm Hg)	19.5 percent to 21.4 percent* (148–163 mm Hg)
Flammability Characteristics	20 percent or greater of lower flammability limit	10 percent to 19 percent of lower flammability limit	10 percent of lower flammability limit or less
Toxicity	IDLH**	Greater than contamination level, referenced in 29 CFR Part 1910, Subpart Z less than IDLH**	Less than contamination level referenced in 29 CFR Part 1910, Subpart Z

*Based upon a total atmospheric pressure of 760 mm Hg (sea level)

**Immediately Dangerous to Life or Health

How Can You Identify a Permit-Required Confined Space?

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

- contains or has a potential to contain a hazardous atmosphere
- contains a material that has the potential for engulfing an entrant
- has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section
- contains any other recognized serious safety or health hazard immediately dangerous to life and health that prevents self-rescue

What Are the Hazards Involved in Entering and Working in Confined Spaces?

Many workplaces contain spaces configured in such a way to be considered “confined.” Confinement itself may pose entrapment hazards. Working in a confined space may keep employees closer to hazards. For example, confinement, limited access or restricted airflow can result in hazardous conditions that would not arise in an open workplace.

Hazardous Atmospheres

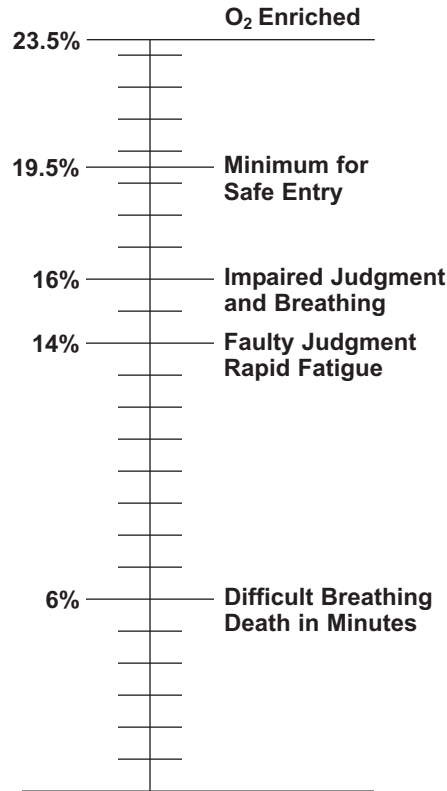
Many substances have short-term exposure limits, in addition to 8-hour time weighted average exposure limits. The permit-required confined space rule is intended to protect against short-term acute hazards. Exposures at or below the permissible exposure limits do not fall under the permit-required confined space rule. Other standards (see 29 CFR 1910, Subparts G and Z) address a broader range of health and safety concerns. Any substance that is not capable of causing death, incapacitation, impairment of ability to self-rescue, injury or acute illness due to health effects is not covered by the rule.

The atmosphere in a confined space may be extremely hazardous because of the lack of natural air movement. This characteristic of confined spaces can result in: (1) oxygen-deficient, (2) flammable or (3) toxic atmospheres.

Oxygen-Deficient Atmospheres

An oxygen-deficient atmosphere has less than 19.5 percent available oxygen (O₂). When oxygen levels drop below 17 percent, there is increased breathing volume, accelerated heartbeat and a deterioration of night vision, which is usually not noticeable. Oxygen atmospheres with 14 to 16 percent oxygen contribute to poor muscular coordination, rapid fatigue and intermittent respiration. At 6 percent oxygen, there is a rapid loss of consciousness and death in minutes. (See Figure 2).

Figure 2
Oxygen Scale



Any atmosphere with less than 19.5 percent oxygen should NOT be entered without a NIOSH-approved self-contained breathing apparatus or a NIOSH-approved supplied air breathing apparatus.

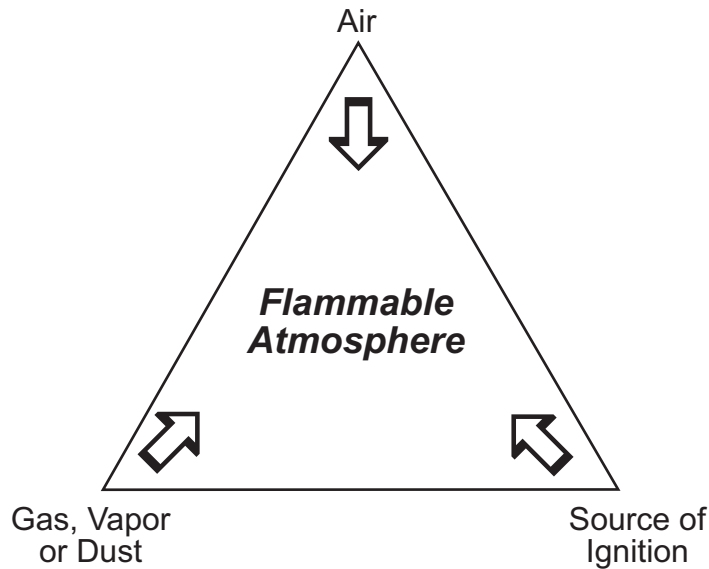
The oxygen level in a confined space can decrease because of the type of work being done, such as welding, cutting or brazing, or it can be decreased by certain chemical reactions (rusting) or through bacterial action (fermentation).

The oxygen level is also decreased if oxygen is displaced by another gas, such as carbon dioxide, argon, helium or nitrogen. Total displacement of oxygen by another gas, such as carbon dioxide, will result in unconsciousness, followed by death.

Flammable Atmospheres

Flammable atmospheres generally result from evaporation of flammable liquids, by-products of chemical reactions, enriched atmospheres or concentrations of combustible dusts. Two things make an atmosphere flammable: (1) the amount of oxygen in air and (2) a flammable gas, vapor or dust in the proper mixture. Different gases and combustible dusts have different flammable and explosive ranges. (See National Fire Protection Association publication 497-2012, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, and National Fire Protection Association publication 499-2013, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*). When a source of ignition (for example, a sparking or electrical tool) is introduced into a space containing a flammable atmosphere, a fire or an explosion can result. (See Figure 3.)

Figure 3
The Ignition Triangle



An oxygen-enriched atmosphere (above 23.5 percent) will cause flammable materials, such as clothing and hair, to burn violently when ignited and may cause some nonflammable materials to ignite. Therefore, NEVER use pure oxygen to ventilate a confined space. Ventilate with normal air.

Toxic Atmospheres

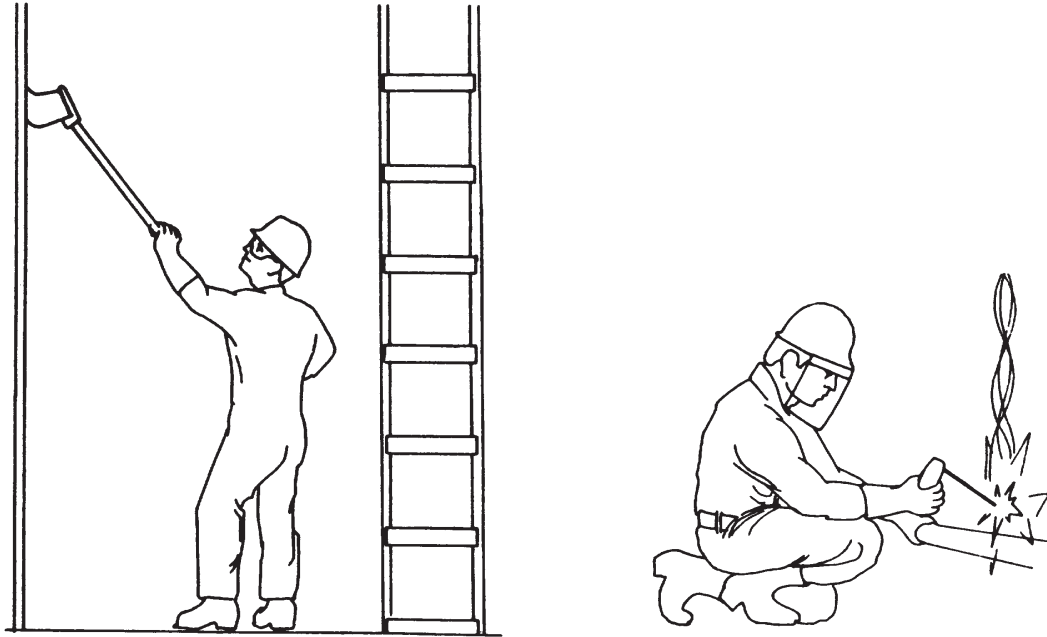
Because air cannot freely move in and out of confined spaces due to the design and configuration, the atmosphere inside a confined space can be very different from the atmosphere outside. Deadly gases may be trapped inside, particularly if the space is used to store or process chemicals or organic substances that may decompose. There may not be enough oxygen inside the confined space to support life, or the air could be so oxygen-rich that it is likely to increase the chance of fire or explosion if a source of ignition is present.

Toxic atmospheres can be caused by the following:

- *The product stored in the space.* The product may contain a toxic component, which could be absorbed into the walls and have the potential for release depending on the use of the space.
- *The type of work being performed in a confined space.* Examples of such include welding, cutting, brazing, painting, scraping, sanding and degreasing. Toxic atmospheres are generated in various processes. For example, cleaning solvents are used in many industries for cleaning/degreasing. The vapors from these solvents can build up to toxic levels in a confined space.
- *Areas adjacent to the confined space.* Toxicant produced by work near confined spaces can enter and accumulate in confined spaces. (Figure 4 illustrates work that may go on in confined spaces.)

Figure 4

Examples of Work in Confined Spaces



General/Physical Hazards

In addition to the areas discussed above, evaluation of a confined space should consider the following potential hazards:

Temperature Extremes

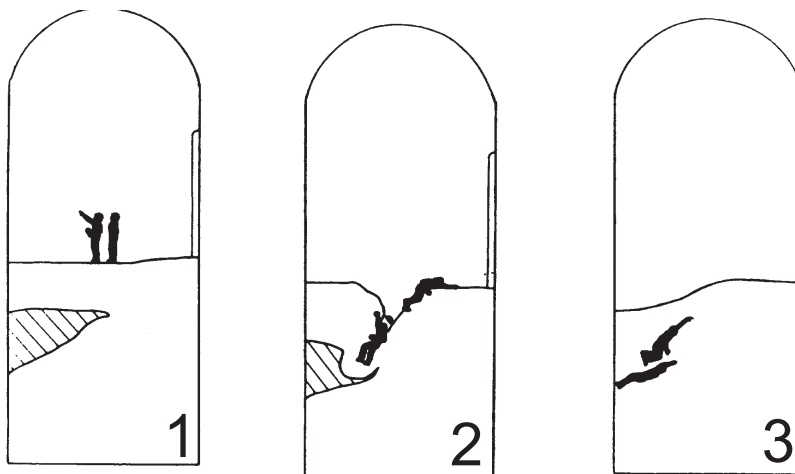
Extremely hot or cold temperatures can present problems for workers. For example, when possible, a steam tunnel should be allowed to cool before entering.

Engulfment Hazards

Loose granular material stored in bins and hoppers, such as grain, sand, coal or similar material, can engulf and suffocate a worker. The loose material can crust over, or bridge over, in a bin and break loose under the weight of a worker. (See Figure 5.)

Figure 5

The Hazard of Engulfment in Unstable Material



Noise

Noise within a confined space can be amplified because of the design and acoustic properties of the space. Excessive noise can not only damage hearing and reduce reaction time to hazards but can also affect communication. This can cause a shouted warning to go unheard.

Slick/Wet Surfaces

Slips and falls can occur on a wet surface, causing injury or death to workers. Spaces that have an internal configuration, inwardly converging walls, or a floor that slopes downward and tapers to a smaller cross-section, increase the hazards of slipping and falling. Different material contained in the space may react differently in a wet environment. A wet surface will also increase the likelihood for and effect of electric shock in areas where electrical circuits, equipment and tools are used.

Falling Objects

Workers in confined spaces should be mindful of the possibility of falling objects, particularly in spaces that have top-side openings for entry and where work is being done above the worker.

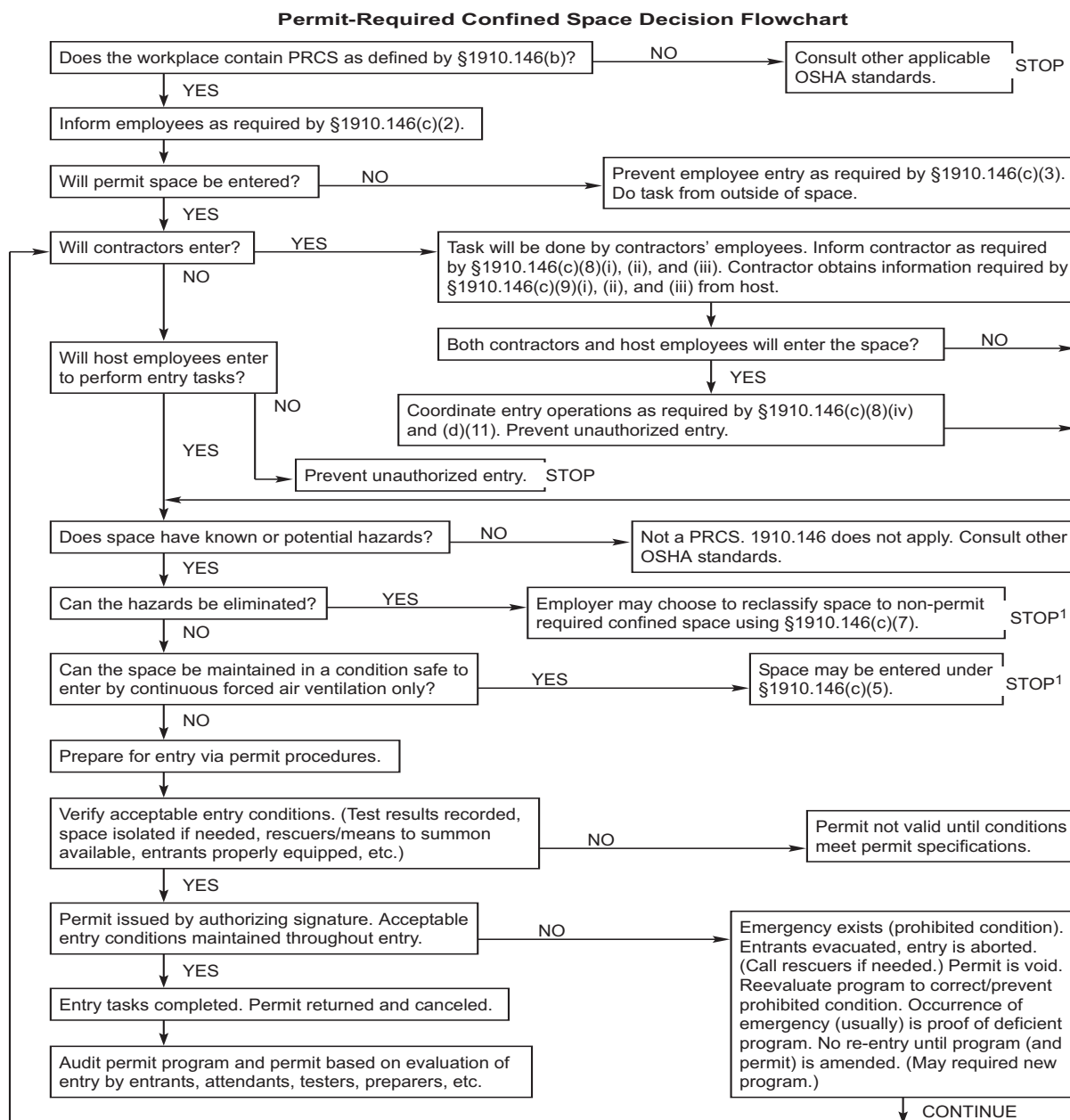
Requirements of the Standard

Who Is Covered?

Employers who have employees working in general industry are covered by this standard. All employers in general industry are required to evaluate the workplace to determine if any space is a permit-required confined space. An employer who finds such a space must implement the requirements of Title 29 *Code of Federal Regulations* Part 1910.146.

General

In general, employers must evaluate the workplace to determine if spaces are permit-required confined spaces. (See Decision Flowchart.) The survey requirement can be met through reviewing existing records and the employer's knowledge of the space, provided that the information is adequate to make the correct classification of the space.



¹Spaces may have to be evacuated and re-evaluated if hazards arise during entry.

If there are permit spaces in the workplace, the employer must inform exposed employees of the existence, location, and danger posed by the spaces. This can be accomplished by posting danger signs or by another equally effective means. The following language, or other similar language, would satisfy the requirements for such a sign:

**DANGER
PERMIT-REQUIRED CONFINED SPACE
AUTHORIZED ENTRANTS ONLY**

Alternative methods, such as additional training, may be used where they are truly effective in warning all employees who could reasonably be expected to enter the space. This requirement can be met in a number of ways. A space can combine permanent closing, placing physical barriers on the space such as bolting and locking the space with supplemental training, and posting of the space. It is the employer's obligation to ensure that alternative methods are at least as effective as a sign. In some cases, employers may have to provide training in addition to signs, to protect employees who do not speak English or who have difficulty understanding or interpreting signs.

If a space has a locked entry cover, panel or access door that can only be opened with special tools, signs may be unnecessary if the employer ensures that all affected employees are informed about the space and know that it is not to be opened without taking proper precautions, including temporary signs, to restrict unexpected or unknowing entry.

Entry Options

The employer has the options of having no entrants, using contractor entrants, using the host employer entrants, or a combination of host and contractor entrants.

No Entrant

If an employer, after identifying a permit-required confined space at the worksite, decides that employees or contractor employees will not enter the space, the employer must:

- take effective measures to prevent its employees from entering the permit spaces and meet other requirements of paragraphs (c)(1), (2), (6) and (8).

Contractor Entrant

If the employer (host) arranges for employees of another employer (contractor) to perform work that involves permit space entry, the host employer must:

- Develop a permit-required confined space program covering contractor operations.
- Inform the contractor that the workplace contains permit-required confined spaces.
- Ensure that the contractor has reviewed the host employer's permit-required confined space program and has its own permit-required confined space program in place prior to entry.
- Apprise the contractor of any precautions or procedures that the host employer has implemented for the protection of employees in or near permit spaces. (At a minimum, this information must include the applicable material safety data sheet or hazard information on the contents, coatings or liners; potential hazardous atmospheres; sampling data base; and residue(s) found or anticipated in the permit space. All information generated in the original evaluation of the permit space must also be provided.)
- Coordinate entry operations with the contractor when the employer and contractor(s) will be working in or near the permit space. (There should be absolutely no doubt by any permit space entrant, attendant and entry supervisor regarding who the controlling employer is and whose policy and permit space practices are to be followed.)
- Debrief the contractor at the conclusion of the entry operation regarding the permit space program followed and regarding any hazards confronted or created in permit space entry operations.

Host Employer's Entrant

If the host employer's employees are to enter permit spaces, the employer must develop a written permit space program (see example programs in Appendix C to 29 CFR 1910.146), which must be made available to employees or their representatives.

Within the program the employer has some flexibility in entering the space depending on the conditions identified. Sometimes the employer can change a permit-required confined space to a non-permit-required confined space by use of alternate entry procedures.

Alternate Entry Procedures

Under certain conditions, the employer may use alternate procedures for worker entry into a permit space. For example, if employers can demonstrate with monitoring and inspection data that the only hazard is an actual or potential hazardous atmosphere, which can be made safe for entry by the use of continuous forced air ventilation alone, they may be exempted from some requirements, such as permits, attendants and rescue apparatus. Even in such circumstances, however, the internal atmosphere of the space must be tested first for oxygen content, second for flammable gases and vapors, and third for potential toxic air contaminants before any employee enters.

The frequency of testing depends on the nature of the permit space and the results of the initial testing. Periodic testing is critical to ensure the space is maintained within the limits of the acceptable entry conditions. All permit space atmospheres are dynamic due to variables such as temperature, pressure, physical characteristics of the hazardous substances, and the variable efficiency of the ventilation equipment and air delivery system.

Entry under alternative means would not be acceptable if atmospheric hazards in the space would quickly increase if the ventilation stopped. Sufficient time must be made available for an entrant to safely exit the space if the ventilation stops.

The entrant or the entrant's authorized representative must be provided the opportunity to observe all testing of the space during the operation.

Testing the Atmosphere

As previously discussed in Part 1, the atmosphere in a confined space may be hazardous due to: (1) low oxygen levels; (2) flammable or explosive concentrations of gases, vapors or dusts; or (3) toxic levels of gases and vapors. Therefore, the air in a confined space must be tested first for oxygen, then for flammable or combustible gases and vapors, and then for toxic gases and vapors.

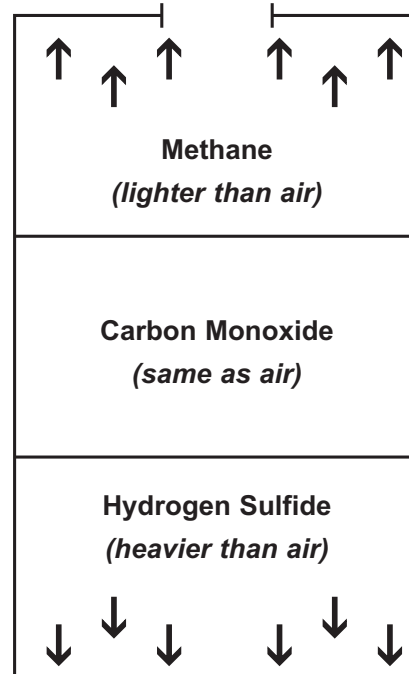
Before the monitoring process begins, the employer must understand when an employee is considered to be exposed to a hazardous substance. The results of air sampling and exposure monitoring that show the composition of an atmosphere to which an employee is actually exposed (even if the employee is using a respirator) are considered an employee exposure record under 29 CFR 1910.1020(c)(5). If the employer as a result of sampling does not allow entry into the confined space, the sample would not be considered as an exposure record because no employee would have been exposed to the atmosphere sampled.

It is important to understand that some gases and vapors are heavier than air and will settle to the bottom of a confined space. Also, some gases are lighter than air and will be found around the top of the confined space. Therefore, it is necessary to test all areas (top, middle, bottom) of a confined space with testing instruments that are calibrated in accordance with the manufacturer's recommendations to determine what atmospheric conditions are present (see Figure 6). (See Appendix B to 29 CFR 1910.146, Procedures for Atmospheric Testing.)

NOTE: Some multi-atmosphere testers require a supply of oxygen to conduct tests. A test for the percentage of oxygen is required to be conducted first.

Figure 6

Testing the Atmosphere From the Outside, Top to Bottom



If testing reveals oxygen-deficiency or the presence of toxic gases or vapors, the space must be ventilated and retested before workers enter. If ventilation is not possible and entry is necessary (for emergency rescue, for example), workers must have appropriate respiratory protection.

Never trust your senses to determine if the air in a confined space is safe! You cannot see or smell many toxic gases and vapors, nor can you determine the level of oxygen present.

Ventilation

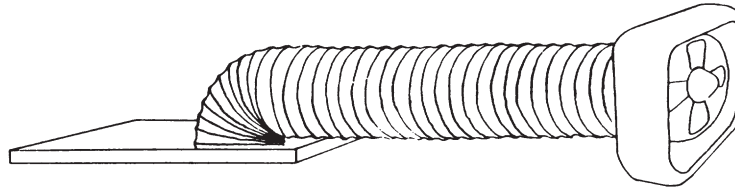
Ventilation by a blower or fan may be necessary to remove harmful gases and vapors from a confined space. There are several methods for ventilating a confined space. The method and equipment chosen are dependent upon the size and configuration of the confined space openings, the gases to be exhausted (for example, are they flammable?), and the source of makeup air.

For example, under certain conditions where flammable gases or vapors have displaced the oxygen but are too rich to burn, forced air ventilation may create a dangerous condition by diluting them until they are within the explosive range. It may be necessary to use inert gases (such as carbon dioxide, nitrogen, argon, etc.) to reduce flammable gases or vapors to safe levels within the confined space. However, the space should be well-ventilated and retested before a worker may enter.

A common method of ventilation requires a large hose, one end attached to a fan and the other lowered into a manhole or opening. For example, a manhole would have the ventilating hose run to the bottom to blow out all harmful gases and vapors (see Figure 7). The air intake should be placed in an area that will draw in fresh air only. An air supply taken next to a vehicle or compressor exhaust system could draw in one hazardous gas while exhausting another. Ventilation should be continuous where possible, because in many confined spaces the hazardous atmosphere will accumulate again when the flow of air is stopped. Periodic testing must be conducted to ensure that the atmosphere inside the confined space is safe. Remember that any testing information concerning the space has to be made available to the entrant or the entrant's authorized representative.

Figure 7

Ventilating With Fan and Trunk Hose



Respirators

Respirators are devices that protect workers from breathing unsafe levels of toxic particles, gases and vapors. Two basic types of respirators are air-purifying, which filter dangerous substances from the air, and air-supplying, which deliver a supply of safe breathing air from a tank or an uncontaminated area nearby. (See Figure 8.)

Figure 8

Two Basic Types of Respirators

Air-Purifying Respirators
(Do **Not** Use in Oxygen-Deficient Atmospheres)

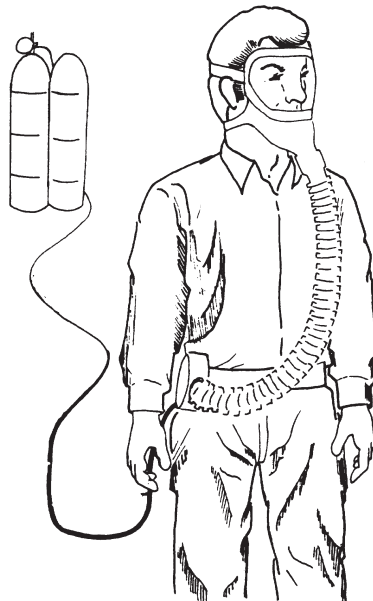


Half-mask

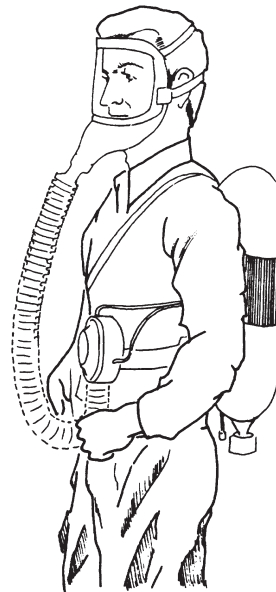


Full-Facepiece

Air-Supplying Respirators



*Supplied Air Respirator with
Auxiliary, Escape-only SCBA*



*Self-contained Breathing
Apparatus*

Selecting the proper NIOSH-approved respirator for the job, the hazard and the person is very important, as is thorough training in the use and limitations of respirators. A respirator protection program is required when employees are required to use a respirator. (See 29 CFR 1910.134, Respirator Protection Program.) Only NIOSH-approved positive pressure, pressure-demand SCBAs or positive pressure, pressure-demand airline respirators with escape provisions can be used in oxygen-deficient or unknown atmospheres.

Isolation of Energy Sources

In a confined space, it may be very hard to separate the employee from the sources of hazardous energy. The close quarters in which the employee works increases the likelihood of the injury. The activation of electrical or mechanical equipment and the release of material through lines connected to the confined space are major causes of injury. A lockout/tagout program is required. (See 29 CFR 1910.147, The Control of Hazardous Energy, and 29 CFR 1910.333(b), Working on or near Exposed Deenergized Parts). Specific procedures to lockout/tagout specific pieces of equipment are required before entering the space. It is essential to deenergize and lock out all electrical circuits and physically disconnect mechanical equipment prior to any work in the confined space. All lines must be physically disconnected, blanked off, or isolated using a double block and bleed system. Only employees trained in lockout/tagout procedures should conduct lockout/tagout operations. All actions must be verified to ensure the safety of items and that they are safely placed out of and returned to service. (See Figures 9 and 10.)

Figure 9

Examples of Lockout

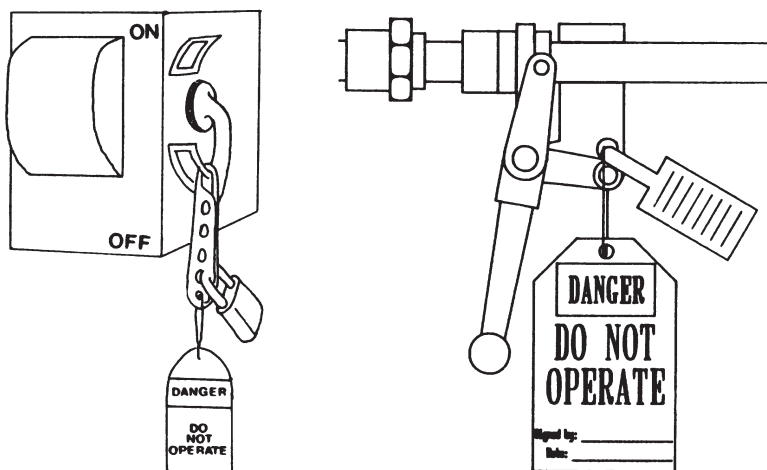
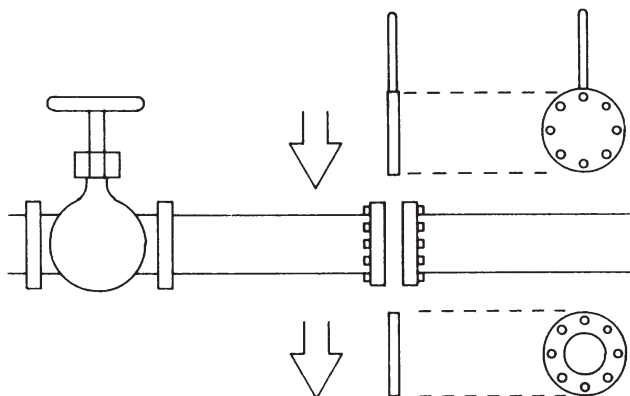


Figure 10

Method of Blanking Hydraulic/Pneumatic Lines



Written Program

The employer who allows employees to enter must develop and implement a written program for permit-required confined spaces. (See Appendix C to 29 CFR 1910.146, Examples of Permit-Required Confined Space Programs.)

The OSHA standard requires the employer's program to include, at a minimum:

- measures to prevent unauthorized entry
- procedures to identify and evaluate the hazards of permit spaces before employees enter
- means, procedures and practices necessary for safe permit entry operations
- provisions for providing properly maintained protective equipment, including necessary personal protective equipment, to trained employees at no cost
- provisions to evaluate permit space conditions
- provisions for one attendant outside the permit space
- provisions for multiple space monitoring if one attendant is used
- procedures for designation of persons who have active roles in entry operations, their duties and how they are to be trained
- procedures for making the rescue service or emergency team decision
- procedures for emergency rescue operation
- procedures for implementing a system for the preparation, issuance, use and cancellation of entry permits
- procedures to coordinate multiple entry operations
- procedures for permit closing at end of operations
- procedures for review of entry operation when the employer has reason to believe that measures taken under the permit space program may not protect employees, and requiring program revision to correct deficiencies found to exist before subsequent entries are authorized
- provisions for reviewing the permit space program using canceled permits within one year after each entry and to revise the program as necessary to ensure that employees participating in entry operations are protected from permit space hazards

Permit System

A permit, signed by the entry supervisor and verifying that pre-entry preparations have been completed and that the space is safe to enter, must be posted at entrances or otherwise made available to entrants before they enter a permit space. (See Appendix D to 29 CFR 1910.146, Sample Permits.)

The duration of entry permits must not exceed the time required to complete an assignment. Also, the entry supervisor must terminate entry and cancel permits when an assignment has been completed or when conditions that are not allowed arise. New conditions must be noted on the canceled permit and used in revising the permit space program. The standard also requires the employer to keep all canceled entry permits for at least one year.

Entry Permits

Entry permits must include the following information:

- test results
- tester's initials or signature
- name and signature of supervisor who authorizes entry
- name of permit space to be entered, authorized entrant(s), eligible attendants and individual(s) authorized to be entry supervisor(s)

- purpose of entry and known space hazards
- measures to be taken to isolate permit spaces and to eliminate or control space hazards, i.e., locking out or tagging of equipment and procedures for purging, making inert, ventilating and flushing permit spaces
- name and telephone numbers of rescue and emergency services
- date and authorized duration of entry
- acceptable entry conditions
- communication procedures and equipment to maintain contact during entry
- additional permit(s), such as for hot work, that have been issued to authorize work in the permit space
- special equipment and procedures, including personal protective equipment, alarm systems and rescue equipment
- any other information needed to ensure employee safety

Training and Education

Before an initial work assignment begins, the employer must provide proper training for all employees who are required to work in permit spaces. Upon completing this training, employers must ensure that employees have acquired the understanding, knowledge and skills necessary for the safe performance of their duties. Additional training is required when (1) the job duties change, (2) there is a change in the permit space program or the permit space operation presents a new hazard, and (3) when an employee's job performance shows deficiencies. Training is also required for rescue team members, including cardiopulmonary resuscitation and first-aid training (see Emergencies). Employers must certify that training has been accomplished.

Upon completion of training, employees must receive a certificate of training that includes the employee's name, signature or initials of trainer(s), and dates of training. The certification must be made available for inspection by employees and their authorized representatives.

In addition, the employer also must ensure that employees are trained in their assigned duties.

Duties

Authorized Entrant's Duties

- know space hazards, including information on the mode of exposure (e.g., inhalation or dermal absorption), signs or symptoms, and consequences of the exposure
- use appropriate personal protective equipment properly (e.g., face and eye protection, and other forms of barrier protection such as gloves, aprons and coveralls)
- as necessary, maintain communication (i.e., telephone, radio, visual observation) with attendants to enable the attendant to monitor the entrant's status as well as to alert the entrant to evacuate
- exit from permit space as soon as possible when ordered by an authorized person, when the entrant recognizes the warning signs or symptoms of exposure exist, when a prohibited condition exists, or when an automatic alarm is activated
- alert the attendant when a prohibited condition exists or when warning signs or symptoms of exposure exist

Attendant's Duties

- remain outside permit space during entry operations unless relieved by another authorized attendant
- perform non-entry rescues when specified by employer's rescue procedure
- know existing and potential hazards, including information on the mode of exposure, signs or symptoms, consequences of the exposure, and their physiological effects
- maintain communication with and keep an accurate account of those workers entering the permit-required space

- order evacuation of the permit space when a prohibited condition exists, when a worker shows signs of physiological effects of hazard exposure, when an emergency outside the confined space exists, or when the attendant cannot effectively and safely perform required duties
- summon rescue and other services during an emergency
- ensure that unauthorized persons stay away from permit spaces or exit immediately if they have entered the permit space
- inform authorized entrants and entry supervisor of entry by unauthorized persons
- perform no other duties that interfere with the attendant's primary duties

Entry Supervisor's Duties

- know space hazards including information on the mode of exposure, signs or symptoms, and consequences of exposure
- verify emergency plans and specified entry conditions such as permits, tests, procedures and equipment before allowing entry
- ensure that determinations and supporting data from required tests are documented and are made available to each employee who enters the permit space or that employee's authorized representative
- ensure that the entrant or the entrant's authorized representative are afforded the opportunity to observe any testing of the confined space prior to and during the operation
- terminate entry and cancel permits when entry operations are completed or if a new condition exists
- take appropriate measures to remove unauthorized entrants or persons who attempt to enter
- ensure that entry operations remain consistent with the entry permit and that acceptable entry conditions are maintained

Rescue

On-Site Rescue

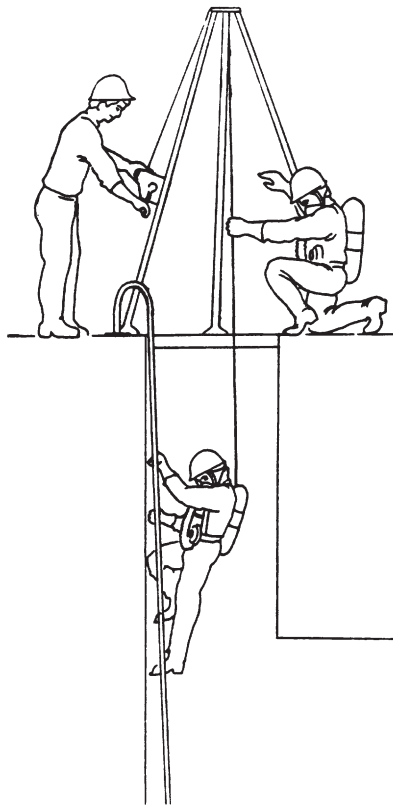
Over 50 percent of the workers who die in confined spaces are attempting to rescue other workers. Rescuers must be trained in and follow established emergency procedures and use appropriate equipment and techniques (including lifelines, respiratory protection and standby persons). Steps for safe rescue should be included in all confined space entry procedures. Rescue procedures should be well planned, and drills should be frequently conducted on emergency procedures. An unplanned rescue, such as when someone instinctively rushes in to help a downed co-worker, can easily result in a double fatality or even multiple fatalities if there is more than one would-be rescuer.

Remember: An unplanned rescue could be your last.

A standby person should be assigned to remain on the outside of the confined space and be in constant contact (visual or speech) with the workers inside. The standby person should not have any other duties but to serve as standby and know who should be notified in case of emergency. Standby personnel should not enter a confined space until help arrives, and then only with proper protective equipment, lifelines, and respirators (see Figure 11).

Figure 11

Entry With Hoist and Standby Personnel



The employer has overall responsibility for employee safety. If an off-site rescue service is used, the employer must verify the availability of the service each time a permit space entry is scheduled or attempted. If the off-site rescue service indicates, for any reason, that it would be unable to respond to a rescue summons, entry shall not be authorized unless adequate alternative rescue service is arranged.

Rescue Service Decision

The standard requires the employer to ensure that rescue service personnel are provided. The employer must decide who is going to be the rescue team or emergency service. (See Appendix F to 29 CFR 1910.146, Rescue Team or Emergency Service Decision.) The employer can use an outside team or a rescue service such as the fire department. In making this rescue service decision, the employer must answer the following questions about the rescue team or service:

- What hazards will the rescuers encounter?
- Do they have the capability to recognize those hazards?
- Are they equipped to cope with those hazards?
- Do they have the capability to work near or within those hazards safely?
- Do they have the ability to respond to the different hazards?
- Can the rescue team reach the victim in time to effect a rescue?
- Has the service maintained its proficiencies?

If an outside rescue service is selected, the employer must:

- Inform the team or service of any hazards they may confront in the rescue operations.
- The team must be provided access to all permit spaces from which the rescue may be necessary. (This is done so that the rescue team or service can develop rescue plans and practice operations.)

If an employee team is selected the employer must:

- Provide affected employees with appropriate personal protective equipment.
- Train the employees so that they are proficient in the use of the PPE.
- Train the affected employees to perform assigned rescue duties.
- Ensure that at least one member of the rescue team holds current basic first aid and cardiopulmonary resuscitation certifications.
- Ensure those affected employees practice permit space rescues at least once every 12 months. (This can be done by simulated rescue operations in which they remove dummies, mannequins or people from actual permit spaces or from representative permit spaces.)

A new non-mandatory Appendix F, Rescue Team or Rescue Service Evaluation Criteria, was added to 29 CFR 1910.146 to assist in the selection of a rescue team or emergency service.

3

Checklists

Recommendations for Safe Entry: A Checklist

Do not enter a confined space until you have considered every question and have determined the space to be safe.

Use the following checklist to evaluate the confined space.

Yes No

- ☐ ☐ Is entry necessary?

Testing

Yes No

- ☐ ☐ Are the instruments used in atmospheric testing properly calibrated?
- ☐ ☐ Was the atmosphere in the confined space tested?
- ☐ ☐ Was oxygen at least 19.5 percent and not more than 23.5 percent?
- ☐ ☐ Were toxic, flammable or oxygen-displacing gases/vapors present?
- Hydrogen sulfide
 - Carbon monoxide
 - Methane
 - Carbon dioxide
 - Other (list)
-
- ☐ ☐ Has the authorized entrant or the entrant's authorized representative been provided an opportunity to observe the periodic testing of the permit space?

Monitoring

Yes No

- ☐ ☐ Will the atmosphere in the space be monitored while work is going on?
- ☐ ☐ Will the atmosphere in the space be monitored continuously while work is going on?
- ☐ ☐ Will the atmosphere in the space be monitored periodically while work is going on? (if yes, give the interval: _____)

Remember—Atmospheric changes occur due to the work procedure or the product stored. The atmosphere may be safe when you enter, but it can change very quickly.

Cleaning

Yes No

- ☐ ☐ Has the space been cleaned before entry is made?
- ☐ ☐ Was the space steamed?
- ☐ ☐ If the space was steamed, was it allowed to cool?

Ventilation

Yes No

- ☐ ☐ Are the appropriate operator's instructions available?
- ☐ ☐ Has the space been ventilated before entry?

- ☐ ☐ Will ventilation be continued during entry?
- ☐ ☐ Is the air intake for the ventilation system located in an area that is free of combustible dusts and vapors and toxic substances?
- ☐ ☐ If the atmosphere was found unacceptable and then ventilated, was it retested before entry?

Isolation

Yes No

- ☐ ☐ Does the company have a lockout/tagout program?
- ☐ ☐ Are the employees trained?
- ☐ ☐ Are the specific lockout/tagout procedures available at the worksite?
- ☐ ☐ Has the space been isolated from other systems?
- ☐ ☐ Has electrical equipment been locked out?
- ☐ ☐ Have disconnects been used where possible?
- ☐ ☐ Has mechanical equipment been blocked, chocked and disengaged where necessary?
- ☐ ☐ Have lines under pressure been blanked and bled?

Clothing/Equipment

Yes No

- ☐ ☐ Has a certified personal protective equipment hazard analysis been conducted per 29 CFR 1910.132(a)?
- ☐ ☐ Have the entrants been trained in the use of personal protective equipment per 29 CFR 1910.132(f)?
- ☐ ☐ Is special clothing required (boots, chemical suits, glasses, etc.)? (If so, specify: _____)
- ☐ ☐ Is special equipment required (for example, rescue equipment, communications equipment, etc.)? (If so, specify: _____)
- ☐ ☐ Are special tools required (for example, sparkproof tools)? (If so, specify: _____)

Respiratory Protection

Yes No

- ☐ ☐ Is respiratory protection required (for example, air-purifying, supplied air, self-contained breathing apparatus, etc.)? (If so, specify type: _____)
- ☐ ☐ Does the employer have a respiratory protection program?
- ☐ ☐ Are the affected employees included in the program?
- ☐ ☐ Are NIOSH-approved respirators of the type required available at the worksite?
- ☐ ☐ Can you get through the opening with a respirator on? (If you do not know, find out before you try to enter.)

Training

Yes No

- ☐ ☐ Have you been trained in the proper use of a respirator?
- ☐ ☐ Have you received first-aid/CPR training?
- ☐ ☐ Have you been in confined space entry and do you know what to look for?

Standby/Rescue

Yes No

- ☐ ☐ Will there be a standby person on the outside in constant visual or auditory communication with the person on the inside?
- ☐ ☐ Will the standby person be able to see and/or hear the person inside at all times?
- ☐ ☐ Has the standby person been trained in rescue?
- ☐ ☐ Will safety lines and harnesses be required to remove a person?
- ☐ ☐ Are company rescue procedures available to be followed in the event of an emergency?
- ☐ ☐ Are you familiar with emergency rescue procedures?
- ☐ ☐ Do you know who to notify and how in the event of an emergency?

Permit

The permit is an authorization in writing that states that the space has been tested by a qualified person and that the space is safe for entry; what precautions, equipment, etc., are required; and what work is to be done.

Yes No

- ☐ ☐ Has a confined space entry permit been issued?
- ☐ ☐ Does the permit include a list of emergency telephone numbers?

Sample Permits

Confined Space Entry Permit

Date and Time Issued: _____ Date and Time Expires: _____

Job site/Space I.D.: _____ Job Supervisor: _____

Equipment to be worked on: _____ Work to be performed: _____

Stand-by personnel: _____

1. Atmospheric Checks: Time _____
 Oxygen _____ %
 Explosive _____ % L.F.L.
 Toxic _____ PPM

2. Tester's signature: _____

3. Source isolation (No Entry): N/A Yes No
 Pumps or lines blinded, () () ()
 disconnected, or blocked () () ()

4. Ventilation Modification: N/A Yes No
 Mechanical () () ()
 Natural Ventilation only () () ()

5. Atmospheric check after isolation and ventilation:
 Oxygen _____ % > 19.5 %
 Explosive _____ % L.F.L. < 10 %
 Toxic _____ PPM < 10 PPM H(2)S
 Time _____

Tester's signature: _____

6. Communication procedures: _____

7. Rescue procedures: _____

8. Entry, standby and back up persons: Yes No
 Successfully completed required training? () ()
 Is it current? () ()

9. Equipment: N/A Yes No
 Direct reading gas monitor—tested () () ()
 Safety harnesses and lifelines
 for entry and standby persons () () ()
 Hoisting equipment () () ()
 Powered communications () () ()
 SABA or SCBA for entry and
 standby persons () () ()
 Protective Clothing () () ()
 All electric equipment listed
 Class I, Division I, Group D
 and non-sparking tools () () ()

10. Periodic atmospheric tests:
 Oxygen _____ % Time _____ Oxygen _____ % Time _____
 Oxygen _____ % Time _____ Oxygen _____ % Time _____
 Explosive _____ % Time _____ Explosive _____ % Time _____
 Explosive _____ % Time _____ Explosive _____ % Time _____
 Toxic _____ % Time _____ Toxic _____ % Time _____
 Toxic _____ % Time _____ Toxic _____ % Time _____

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 squares are marked in the "No" column. This permit is not valid unless all appropriate items are completed.

Permit Prepared By: (Supervisor) _____

Approved By: (Unit Supervisor) _____

Reviewed By (Cs Operations Personnel): _____

(printed name)

(signature)

This permit to be kept at job site. Return job site copy to Safety Office following job completion.

Copies: White Original (Safety Office)
 Yellow (Unit Supervisor)
 Hard (Job site)

ENTRY PERMIT

PERMIT VALID FOR 8 HOURS ONLY. ALL COPIES OF PERMIT WILL REMAIN AT JOB SITE UNTIL JOB IS COMPLETED

DATE: _____ SITE LOCATION and DESCRIPTION _____

PURPOSE OF ENTRY _____

SUPERVISOR(S) in charge of crews _____ Type of Crew Phone # _____

COMMUNICATION PROCEDURES _____

RESCUE PROCEDURES (PHONE NUMBERS AT BOTTOM) _____

BOLD DENOTES MINIMUM REQUIREMENTS TO BE COMPLETED AND REVIEWED PRIOR TO ENTRY

REQUIREMENTS COMPLETED	DATE	TIME
Lock Out/De-energize/Try-out	_____	_____
Line(s) Broken-Capped-Blanked	_____	_____
Purge-Flush and Vent	_____	_____
Ventilation	_____	_____
Secure Area (Post and Flag)	_____	_____
Breathing Apparatus	_____	_____
Resuscitator—Inhalator	_____	_____
Standby Safety Personnel	_____	_____
Full Body Harness w/"D" ring	_____	_____
Emergency Escape Retrieval Equipment	_____	_____
Lifelines	_____	_____
Fire Extinguishers	_____	_____
Lighting (Explosive Proof)	_____	_____
Protective Clothing	_____	_____
Respirator(s) (Air Purifying)	_____	_____
Burning and Welding Permit	_____	_____

Note: Items that do not apply enter N/A in the blank.

**RECORD CONTINUOUS MONITORING RESULTS EVERY 2 HOURS

CONTINUOUS MONITORING**	Permissible _____
TEST(S) TO BE TAKEN	Entry Level _____
PERCENT OF OXYGEN	19.5% to 23.5%
LOWER FLAMMABLE LIMIT	Under 10%
CARBON MONOXIDE	+50 PPM
Aromatic Hydrocarbon	+ 1 PPM * 5PPM
Hydrogen Cyanide (Skin)	+10 PPM
Hydrogen Sulfide	*20 PPM (Ceiling)
Sulfur Dioxide	+ 5 PPM
Ammonia	*50 PPM

*Short-term exposure limit: Employee can work in the area up to 15 minutes.

+8 hr. Time Weighted Avg.: Employee can work in area 8 hrs (longer with appropriate respiratory protection).

REMARKS: _____

GAS TESTER NAME & CHECK #	INSTRUMENT(S) USED	MODEL &/OR TYPE	SERIAL &/O UNIT #
---------------------------	--------------------	-----------------	-------------------

_____	_____	_____	_____
-------	-------	-------	-------

SAFETY STANDBY PERSON IS REQUIRED FOR ALL CONFINED SPACE WORK

SAFETY STANDBY PERSON(S)	CHECK #	CONFINED SPACE ENTRANT(S)	CHECK #	CONFINED SPACE ENTRANT(S)	CHECK #
--------------------------	---------	---------------------------	---------	---------------------------	---------

_____	_____	_____	_____	_____	_____
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SUPERVISOR AUTHORIZING—ALL CONDITIONS SATISFIED _____ DEPARTMENT/PHONE _____

AMBULANCE 2800 FIRE 2900 Safety 4901 Gas Coordinator 4529/5387

Sample Confined Space Entry Training Lesson Plan

Objectives: The employee should be able to

- explain what is a confined space
- tell the difference between a confined space and a permit-required confined space
- understand the process in deciding if there is a hazard in the confined space
- be able to tell what precautions to take to protect employees involved in the confined space entry
- understand the responsibilities of the entrant, attendant and entry supervisor
- demonstrate how to use the equipment

What Topics Will Be Covered?

- definition of types of confined spaces
- hazards in the confined space
- responsibilities of the entry supervisor, attendant, and entrant
- entry permit

Explanation of OSHA Regulations Related to Confined Spaces

- personal protective equipment hazard analysis and training certification (1910.132)
- respiratory protection program (1910.134)
- permit required confined space program (1910.146)
- lockout/tag out program (1910.147 and 1910.333)
- hazard communication program (1910.1200)

What Is a Confined Space?

What Is a Permit-Required Confined Space?

Where Are the Confined Spaces in the Worksite?

What Are the Potential Hazards?

What Alternate Methods Are Used by the Employer?

What Are the Responsibilities of the Entry Supervisor, Entrant and Attendant?

Confined Space Entry Permits

Review and Questions

References

U.S. Department of Labor, OSHA Federal Register (63:66018-66036), Permit-Required Confined Spaces, 12/01/1998;

U.S. Department of Labor, OSHA 3138, 1998 (Revised), Permit-Required Confined Spaces

OSHA Directives, CPL 02-00-100—Application of the Permit-Required Confined Spaces (PRCS) Standards, 29 CFR 1910.146, 05/05/1995

NIOSH Publication 87-113, A Guide to Safety in Confined Spaces; U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute of Occupation Safety and Health

NIOSH Publication 94-103, Worker Deaths in Confined Spaces; U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute of Occupation Safety and Health

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or visit the NCDOL home page on the Internet: <http://www.nclabor.com>.

Occupational Safety and Health Division

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Local Telephone: 919-807-2900 Fax: 919-807-2856

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 3rd Floor)

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Education, Training and Technical Assistance Bureau

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Telephone: 919-807-2875 Fax: 919-807-2876

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Consultative Services Bureau

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Telephone: 919-807-2899 Fax: 919-807-2902

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Raleigh, NC 27699-1101
Telephone: 919-807-2923 Fax: 919-807-2924

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Raleigh District Office (3801 Lake Boone Trail, Suite 300, Raleigh, NC 27607)
Telephone: 919-779-8570 Fax: 919-420-7966
Asheville District Office (204 Charlotte Highway, Suite B, Asheville, NC 28803-8681)
Telephone: 828-299-8232 Fax: 828-299-8266
Charlotte District Office (901 Blairhill Road, Suite 200, Charlotte, NC 28217-1578)
Telephone: 704-665-4341 Fax: 704-665-4342
Winston-Salem District Office (4964 University Parkway, Suite 202, Winston-Salem, NC 27106-2800)
Telephone: 336-776-4420 Fax: 336-767-3989
Wilmington District Office (1200 N. 23rd St., Suite 205, Wilmington, NC 28405-1824)
Telephone: 910-251-2678 Fax: 910-251-2654

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Telephone: 919-807-2950 Fax: 919-807-2951

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Telephone: 919-807-2850 Fax: 919-807-2849

Physical Location:
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(Old Revenue Building, 5th Floor)

N.C. Department of Labor (Other than OSH)

1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-733-7166 Fax: 919-733-6197