



# Confined Spaces Safety Training Program



## Goal

This program is designed to help companies develop a general industry safety training program for permit-required confined spaces.

## Objective

At the end of this program, employees will demonstrate general knowledge of the hazards of working in confined spaces and appropriate measures to take to prevent injuries and illnesses.

## Characteristics of Confined Spaces

Confined spaces are dangerous because they can be unsafe in design and may contain harmful substances, affect breathing, increase fire hazards, or limit an employee's ability to enter and exit easily. The Occupational Safety and Health Administration (OSHA) outlines confined space safety requirements for general industry in 29 Code of Federal Regulations (CFR) [1910.146](#). (Separate

requirements for confined spaces in construction are found in 29 CFR [1926 Subpart AA.](#))

Generally speaking, a confined space is an area that:

- is large enough and configured so that an employee can bodily enter and perform assigned work;
- has limited or restricted means for entry or exit, such as tanks, vessels, silos, storage bins, hoppers, vaults, or pits; and
- is not designed for continuous employee occupancy.

A permit-required confined space is a more hazardous area that has one or more additional characteristics:

- contains or has a potential to contain a hazardous atmosphere;

- contains a material that could engulf an employee;
- has an inside layout that could trap or smother (asphyxiate) an employee, such as walls that lean inward or a floor that slopes downward to a smaller cross-section; or
- contains any other recognized serious safety or health hazard.

Employers must inform employees of the locations and hazards of permit-required confined spaces. This is often done by posting signs around the space that state, "DANGER – PERMIT-REQUIRED CONFINED SPACE – AUTHORIZED ENTRANTS ONLY." Only authorized and trained personnel with a permit from the entry supervisor may enter a permit-required confined space.

Under certain circumstances, employees may enter a confined space without a permit if all hazards can be removed by isolating the confined space or the only hazard is atmospheric, which can be controlled by ventilation. In this instance, the employer must perform pre-entry atmospheric testing and provide continuous atmospheric monitoring thereafter.

## Atmospheric Hazards

### Oxygen-Deficient Atmospheres

Normal air contains about 20.8% oxygen by volume. Oxygen-deficient atmospheres have less than 19.5% oxygen by volume. Changes in normal concentrations are a serious hazard in confined spaces. (See Table 1).

Oxygen levels decrease as a result of:

- welding, cutting, or brazing;

## OXYGEN EXPOSURE TABLE (Physiological Reactions)

Oxygen % at Sea Level	Physiological Effects
>23.5%	Explosive atmosphere; Extremely hazardous; Oxygen-enriched environment
19.5% to 23.5%	Normal breathable air; No adverse effects; Average working conditions
15% to 19.5%	Fatigue; Loss of stamina; Decreased ability to work
12% to 15%	Exhaustion; Increased respiration; Impaired coordination
10% to 12%	Confusion and anxiety; Poor judgment; Lack of coordination
8% to 10%	Mental failure; Fainting and vomiting; Loss of consciousness
6% to 8%	At eight minutes = 100% Fatal
4% to 6%	Lack of self-control; Convulsions and coma; Respiratory arrest; Death

- chemical reactions such as rusting;
- bacterial action such as fermentation;  
or
- displacement by other gases such as carbon dioxide or nitrogen.

### Oxygen-Enriched Atmospheres

Oxygen-enriched atmospheres occur when oxygen levels exceed 23.5% by volume. At that point, the atmosphere becomes flammable, and materials such as clothing or hair will burn rapidly when ignited. Unattended or leaking oxygen lines or cylinders can increase oxygen concentration to an unsafe level.

## Toxic Atmospheres

Toxic atmospheres can be caused when:

- products stored in a confined space get absorbed into the walls and give off toxic gases during removal;
- welding, sanding, or degreasing occur in the confined space; and
- hazardous liquids, vapors, mists, solid materials, or dust are produced nearby, then enter and gather inside the confined space.

## Toxic Gases

Toxic gases can irritate the skin, eyes, nose, and throat. Some can prevent the body from using oxygen effectively, and all of them can injure or kill. Some of the most common toxic gases found in confined spaces are:

- carbon monoxide, a colorless, tasteless, and odorless byproduct of combustion and
- hydrogen sulfide, a colorless gas with the distinct smell of rotten eggs.

Before employees begin work, employers should investigate any confined space to determine whether any of these conditions exist and take proper precautions to safeguard employees.

## Atmospheric Testing

Hazardous gases can be found at the top, middle, or bottom of a confined space and can vary in density. Atmospheric testing must be performed at all three levels to determine which gases are present. If a toxic or combustible gas or an oxygen-deficient or enriched atmosphere is present, employers must ventilate and retest the confined space



before permitting entry. If ventilation is impossible and entry is necessary, employees must wear the proper respiratory protection for the detected contaminants.

## Ventilation

Several methods exist for ventilating a confined space. The method and equipment chosen depend on the size of the confined space openings, the gases to be removed, and the source of replacement air.

Under certain conditions where flammable gases or vapors have displaced the oxygen level but are too rich to burn, forced air ventilation may dilute the gases until they are capable of exploding. The same is true if inert gases (for example carbon dioxide, nitrogen, or argon) exist in the confined space.

Ventilate and retest the space before allowing entry. Ventilation should be continuous where possible because, in many confined spaces, the hazardous atmosphere will form again when the airflow is stopped.

# Respiratory Protection

Three types of respirators allow employees to breathe safely without inhaling toxic gases or particles:

- **Air-purifying respirators (APRs)**

APRs are best used with gases or vapors that are detected by odor, taste, or irritation. These respirators use a filter or sorbent to remove airborne contaminants from the air before they are inhaled.

However, some disadvantages exist to using APRs. These respirators require wearers to use more effort while breathing and must be medically surveilled to ensure a proper fit. In addition, the filter must be selected specifically to absorb or counteract the contaminants that are present. If overused, APRs may become saturated with particles or other contaminants. This can cause added breathing difficulties for wearers until the masks or filters are changed. Also, employers must develop regular cartridge or mask-change schedules.

If there is room inside the confined space, powered air-purifying respirators (PAPRs), which use a fan to draw air through the filters, can be used. However, they do not supply oxygen, so they cannot be used in oxygen-deficient atmospheres.



- **Supplied-air respirators (SARs)**

SARs supply air to the user from a source such as a compressor or compressed air cylinder. One of the major disadvantages of using SARs is that they have a maximum allowable hose length of 300 feet. The hose, which can become twisted and tangled, gives the employee only one path of entry and exit.

- **Self-contained breathing apparatus (SCBA)**

SCBAs use a tank of breathable air carried by the employee. Although the SCBA has a limited wear time and is often heavy and bulky, it provides the highest level of respiratory protection available. It also allows the employee greater mobility while performing the job. This is the best type of respirator for work in a confined space if there is room to use one.



## Isolation

Isolation of a confined space is a process for removing the area from service by:

- locking out electrical sources, preferably at disconnect switches away from the equipment;
- blanking and bleeding pneumatic and hydraulic lines;
- disconnecting belt and chain drives and mechanical linkages on shaft-driven equipment when possible; and
- securing with latches, chains, chocks, blocks, or other devices all mechanical moving parts in a confined space.

## General and Physical Hazards

Employers should consider the following when evaluating a confined space:

- **Temperature**  
Temperature extremes can be harmful to employees. For example, if a space has been steam-cleaned, it must cool before any employees enter.
- **Engulfment hazards**  
Loose material such as grain, sand, coal, and other materials can crust over in a bin, break loose under an employee's weight, and trap employees during entry.
- **Noise**  
Sound can become excessive in a



confined space. In addition to possibly causing hearing damage, it can affect communication and cause warnings to go unheeded.

- **Wet surfaces**  
Slick or wet surfaces can cause slips and falls. It can also increase the chances of electric shock inside a confined space.
- **Falling objects**  
Falling objects are a danger if work is being done above the entry of a confined space.
- **Falls**  
All employees working four feet or more above a lower level must wear fall protection.

## Written Program

An employer that allows employees to enter permit-required confined spaces must develop and implement a written program. The program should include:

- measures to prevent unauthorized entry;
- a review of all confined space hazards; and
- procedures and practices for safe entry into permit-required confined spaces including:
  - creating acceptable entry conditions;
  - allowing authorized personnel to observe the monitoring process;

- isolating permitted spaces;
- eliminating or controlling atmospheric hazards;
- providing barriers to protect entrants from external hazards; and
- verifying that conditions are acceptable throughout an authorized entry.
- equipment needed for a permit-required confined space such as:
  - testing and monitoring equipment;
  - ventilation equipment;
  - communications equipment;
  - personal protective equipment;
  - lighting equipment;
  - barriers or shields;
  - equipment needed for safe ingress and egress; and
  - any other needed equipment.
- explanation of how permitted spaces must be evaluated;
- assignments for attendants, supervisors, and rescuers;

**Confined Space**

Obtain authorization before entering a confined space

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

- designations and definitions of roles of attendants, supervisors, and rescuers;
- rescue procedures; and
- descriptions of the processes for issuing, using, and canceling confined space permits.

## Communication

Communication is the primary key to safety in confined space work. The following personnel are involved in this process:

- **Entrant**  
An entrant is a person who enters the space to perform the work;
- **Attendant**  
An attendant is the person on duty outside the space

whose only function is to monitor the space as long as entrants are working inside. The attendant is responsible for knowing what is going on inside the space at all times to react in event of an emergency.

- **Entry Supervisor**

An entry supervisor is the person in charge of confined space entry and is responsible for all activities. To work safely in a confined space, the entrant must be able to communicate with the attendant on duty outside the space. A system of communication must be set up before beginning work.

- **Rescuers**

This personnel must be able and available to rescue the entrant by remote means (such as a winch) or to enter the space with sufficient gear (including personal protective equipment) to do the job safely.

- **Training**

Entrants, attendants, entry supervisors, and rescuers must be trained in their duties before attempting a confined space entry. The employer must ensure that all affected employees understand and can perform their tasks fully. Rescuers must be trained in the hazards they are likely to encounter in the employer's confined spaces. Additional training is required if job duties change, new permit-required confined spaces are identified, or if affected employees show a lack of understanding or proficiency. In addition, rescuers should be trained in first aid and cardiopulmonary resuscitation (CPR) and perform practical rescue exercises at least annually. All training must be documented, and records retained



for three years from the date training occurred.

## Use of Fire Department Rescue Squads

OSHA's [29 CFR 1910.146](#) standard does not prohibit an employer from using a fire department rescue team for confined space rescue. However, employers must take the following precautions:

- The employer must evaluate the fire department rescue truck and personnel to determine that the rescue squad is properly trained and equipped to undertake a confined space rescue in the employer's permit-required confined space.
- The employer must determine that the fire department rescue squad can respond and deploy promptly.
- Before beginning a permit-required confined space entry, the employer must determine that the rescue squad is available to respond if needed and prepared to abort the entry if the rescue personnel go out on another call.



## Entry Permits

The entry supervisor must sign all entry permits and post them at all entrances to the confined space, or otherwise make them available to entrants before anyone enters the space. Permits must confirm that all pre-entry preparations have been completed. The permit must contain a time limit that does not exceed the time needed to do the task inside the confined space.

Entry permits must include:

- the name of the permit-required confined space to be entered;
- the names of the entry supervisor, all entrants, and attendants involved;
- the atmospheric test results;
- the tester's initials or signature;
- the entry supervisor's signature;
- the purpose of entry;
- all known hazards;
- measures to isolate the space;

- measures to eliminate or control hazards;
- the names and phone numbers of rescue and emergency personnel;
- the date and authorized duration of entry;
- acceptable entry conditions;
- communication procedures and equipment used to ensure communication during entry;
- additional permits, such as hot work permits, that authorize specific work in the confined space;
- special equipment and procedures needed for the entry; and
- any other information needed to ensure employee safety.

The entry supervisor must cancel the permit when the work is complete or new conditions arise. New conditions must be noted on the permit and used to revise the confined space entry program. Permits must be kept on file for at least one year.



## Review Questions

1. What is the best respirator for use in confined space operations (assuming it will fit in the space)?
  - a. Supplied-air respirators (SAR)
  - b. Self-contained breathing apparatus (SCBA)
  - c. Air-purifying respirators (APR)
2. Oxygen-deficient atmospheres have less than [how much] oxygen available?
  - a. 20.6 percent
  - b. 18.7 percent
  - c. 19.5 percent
  - d. 21.7 percent
3. Carbon monoxide is colorless and odorless but leaves a distinct taste of rotten eggs in your mouth.
  - a. True
  - b. False
4. Atmospheric testing must be done at the top and bottom of the space only since gases tend to only rise to the top or sink to the bottom.
  - a. True
  - b. False
5. The attendant is the person responsible for the confined space entry and is ultimately responsible for all activities.
  - a. True
  - b. False
6. Entry permits are issued by:
  - a. Entrants
  - b. Attendants
  - c. Entry supervisor
  - d. The fire department rescue captain
7. If the designated rescuers are the fire department rescue squad members, the confined space entry must be aborted if the rescue truck leaves to respond to an emergency.
  - a. True
  - b. False

## Answers

1. b; 2. c; 3. b (false) – Hydrogen sulfide smells like rotten eggs; 4. b (false) – To accurately determine which gases are present, atmospheric testing must be performed at all levels; 5. b (false) – Entry supervisor; 6. c. 7. a (true).



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