Confined Spaces

Texas Department of Insurance
Division of Workers' Compensation
Workplace & Medical Services, Outreach & Education HS99-146D

Goal

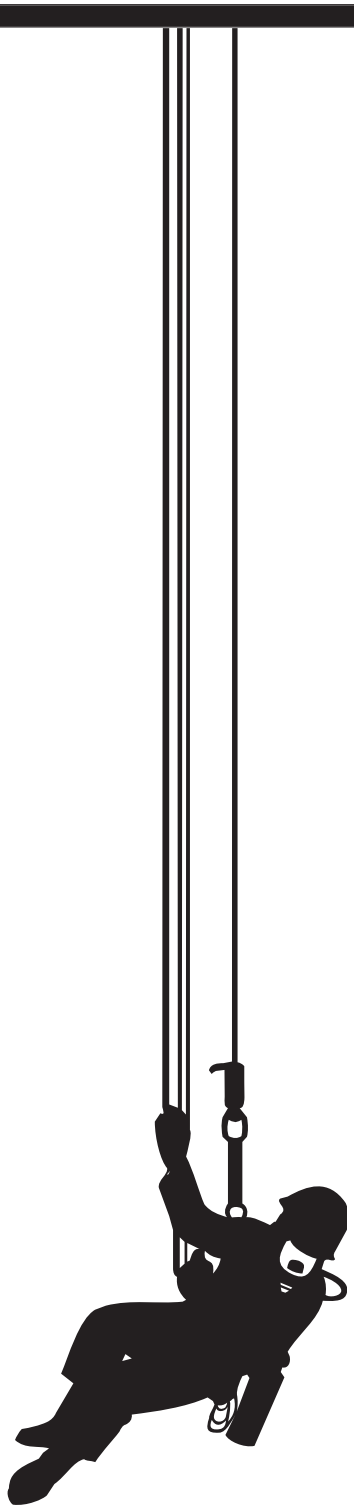
This program is designed to aid in developing a training program on confined spaces.

Objective

At the end of this program, you should be able to demonstrate general knowledge of the hazards of working in confined spaces and appropriate measures to take in preventing accidents.

Definitions

1. A confined space meets all of the following conditions:
   a. is large enough and so configured that a worker can bodily enter and perform assigned work
   b. has limited or restricted means for entry or exit (for example: tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry) and
   c. is not designed for continuous worker occupancy
2. A permit required confined space has one or more of the following characteristics:
   a. contains or has a potential to contain a hazardous atmosphere
   b. contains a material that has the potential for engulfing an entrant
   c. 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 or
   d. contains any other recognized serious safety or health hazard.



Atmospheric Hazards

Oxygen-deficient atmospheres have less than 19.5 percent available oxygen by volume while normal air contains approximately 21 percent oxygen. Deviations from normal concentrations are a major concern in confined spaces. Oxygen levels decrease as a result of:

1. welding, cutting or brazing;
2. chemical reactions (rusting);
3. bacterial action (fermentation); or
4. displacement by other gases such as carbon dioxide or nitrogen.

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

Toxic atmospheres can be caused by any of the following:

1. products stored in the space that have been absorbed into the walls that will give off toxic gases during removal;
2. work being performed in the space such as welding, sanding, degreasing, etc.; or
3. toxicants produced in areas adjacent to the confined space can enter the space and accumulate.

Substances such as liquids, vapors, mists, solid materials and dusts should be considered hazardous in a confined space. 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:

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

Atmospheric Testing

Hazardous gases, which can be found at the top, middle or bottom of a confined space, can vary in density. Therefore, to accurately determine which gases are present, atmospheric test-ing must be performed at all levels.

If a toxic or combustible gas or an oxygen deficient or enriched atmosphere is present, you must ventilate and retest the confined space before permitting entry. If ventilation is impossible and

entry is necessary, you 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 exhausted, and the source of makeup 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 them until they are within the explosive range. 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 workers to breathe safely without inhaling toxic gases or particles:

1. **Air-purifying respirators** (APRs) use a filter or sorbent to remove airborne contaminants from the air before it is inhaled. However, some disadvantages exist to using APRs:
   a. they become saturated with particles and other contaminants through normal use and can cause breathing difficulty. Use only when there is a sufficient supply of oxygen.
   b. they do not supply oxygen; therefore, they cannot be used in oxygen deficient atmospheres.
   c. they must be used only with gases or vapors that can be detected by odor, taste, or irritation.
2. **Supplied-air respirators** (SARs) supply air to the user from a source such as a compressor or compressed air cylinders. The following are disadvantages to using SARs:
   a. they have a maximum allowable hose length of 300 feet.
   b. the airline can become twisted and tangled.
   c. the wearer has only one path of entry and exit.
3. **The self-contained breathing apparatus** (SCBA) uses a source of breathable air carried by the wearer. Although the SCBA has a limited wear time and possible weight disadvantage, it provides the highest level of respiratory protection available and allows the worker greater mobility while performing the job. This is the best type of respirator to use in a confined space.

Isolation

Isolation of a confined space is a process where the space is removed from service by:

1. locking out electrical sources, preferably at disconnect switches remote from the equipment
2. blanking and bleeding pneumatic and hydraulic lines
3. disconnecting belt and chain drives and mechanical linkages on shaft-driven equipment where possible
4. securing mechanical moving parts within confined spaces with latches, chains, chocks, blocks or other devices.

General and Physical Hazards

In addition to the areas previously discussed, you should also consider the following when evaluating a confined space:

1. Temperature extremes can have an adverse effect on entrants. For example, if a space has been steam-cleaned, it must cool before any entry is made.
2. Engulfment hazards such as loose material (grain, sand, coal, etc.) can crust over in a bin and break loose under your weight and trap you during entry.
3. Noise can become excessive in a confined space and can not only damage hearing but can affect communication, causing warnings to go unheeded.
4. Slick/wet surfaces can cause slips and falls and increase the chances of electric shock in a confined space.
5. Falling objects are a danger if work is being done above the entrant in a confined space.

Communication

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

A. Entrant - the person who enters the space to perform the work.
B. Attendant - the person who is on duty outside the space and whose only function is to monitor the space as long as there are entrants working inside.
C. Entry supervisor - is in charge of the confined space entry and is ultimately responsible for all activities.

To work safely in a confined space, the entrant must be able to communicate with the attendant who is on duty outside the space. A system of communication must be set up prior to beginning work. The attendant must always be aware of what is going on inside the space in order to be able to react in event of an emergency.

Review Questions:

1. What is the best respirator for use in confined space operations?
   (a) Supplied-air (SAR)
   (b) Self-contained breathing apparatus (SCBA)
   (c) Air-purifying respirators (APR)

2. Oxygen-deficient atmospheres have less than _____ 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 attendent is the person responsible for the confined space entry and is ultimately responsible for all activities.
   (a) True
   (b) False

Answer Key

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

Effects of Various Carbon Monoxide (CO) Levels

*CO Level in PPM**	*Resulting Condition/Effect on Humans*
35	Permissible exposure level, 8 hours (OSHA)
200	Possible mild frontal headache in 2 to 3 hours
400	Frontal headache and nausea after 1 to 2 hours. Occipital after 2-1/2 to 3-1/2 hours
800	Headache, dizziness, and nausea in 45 minutes. Collapse and possibly death in 2 hours
1,600	Headache, dizziness, and nausea in 20 minutes. Collapse and possibly death in 2 hours
3,200	Headache and dizziness in 5 to 10 minutes. Unconsciousness and danger of death in 30 minutes
6,400	Headache and dizziness in 1 to 2 minutes. Unconsciousness and danger of death in 10-15 minutes
12,800	Immediate effect unconsciousness. Danger of death in 1 to 3 minutes

*PPM-Parts Per Million

10,000 PPM-1% by volume

All values are approximate. The effects can vary depending on the individual's health and the type of physical activity being performed.

Source: American Industrial Hygiene Association

Potential Effects of Oxygen-Deficient Atmospheres

Oxygen	*Resulting Condition/Effect on Humans by Volume*
23.% and above	Oxygen enriched, extreme fire hazard
21.%	Oxygen concentration of "Air"
19.5%	Minimum "Safe Level": OSHA, NIOSH
15-19%	Decreased ability to work strenuously. May impair coordination and may induce early symptoms in persons with coronary, pulmonary, or circulatory problems.
12-14%	Respiration increases in exertion, pulse up, impaired coordination, perception, judgement.
10-12%	Respiration further increases in rate and depth, poor judgement, lips blue.
8-10%	Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea, and vomiting.
6-8%	8 minutes, 100% fatal; 6 minutes, 50% fatal; 4-5 minutes, recovery with treatment.
4-6%	Coma in 40 seconds, convulsions, respiration ceases, death.

These values are approximate and vary as to the individual's state of health and his physical activities. Source: NIOSH

Resources

The Texas Department of Insurance/Division of Workers' Compensation (TDI/DWC) Resource Center offers a workers' health and safety video tape library. Call (512) 804-4620 for more information or visit our web site at www.tdi.state.tx.us.

Disclaimer: Information contained in this training program is considered accurate at time of publication.