

WORKING SAFELY IN CONFINED SPACES

Introduction:

- Confined Space :

OSHA defines a Confined Space, as one that has limited or restricted means of entry or exit, is large enough for employees to enter and perform their work, and is not designed for continuous occupancy.

- Permit-Required Confined Space (PRCS):

Is a space that has one or more of the following characteristics:

- Contains or could contain hazardous atmosphere.
- Contains materials that have the potential for engulfing the entrant.
- Has an internal configuration such as that an entrant could be trapped or asphyxiated.
- Any other recognized safety hazards.

The following types of facilities are designated as confined spaces:

1. Manholes
2. Sewer lines or tunnels.
3. Storage tanks
4. Silos
5. Underground utility vaults and storage.
6. Boilers
7. Pipelines.
8. Pits
9. Wells.

There are two types of confined spaces:

- Class I confined space:

This is a permit-required confined space (PRCS) which, because of the nature of hazards or the location of the space, it is not feasible or possible to render the space safe to enter without proper respiratory protection. Authorized personnel entering this type of space must wear appropriate supplied air respiratory equipment.

- Class II Confined space:

This is a permit-required confined space, which, due to the nature of the potential hazard(s) or the location of the space, can be rendered safe for an employee to enter without wearing respiratory protection.

This can be accomplished through work practice such as continuous ventilation and air monitoring of the space.

The following are some of the general categories of hazards, which may be encountered in confined space :

- Atmospheric hazards.
- Mechanical and Electrical hazards.
- General Safety (means of access / egress, trips, slips falls, hot, cold, etc.)
- Engulfment hazard.

- Atmospheric Hazard:

Atmospheric hazards cause the most confined-space related deaths and injuries .

Atmospheric hazards generally cannot be seen, in most cases, it is too dangerous to assume that the sense of smell will serve as a “early warning system” air monitoring is usually required if atmospheric hazards are suspected.

There are three general classes of atmospheric hazards:

- Oxygen deficiency
- Combustible / flammable materials
- Toxic gases

A. Oxygen Deficiency :

1. Humans can survive for weeks without food, days without water, but only few minutes without air.
2. Air contains a mixture of gases but is composed primarily of nitrogen (78%) and oxygen (21%).
3. When levels of oxygen are reduced below 19.5%, serious health problem begins to occur very quickly.
4. Oxygen is consumed by a variety of chemical processes:
 - Aerobic bacterial growth. (consume oxygen to live)

- Oxidation of rusting of metals
- Combustion and displacement by other gases. (welding and cutting torches)

Effect of Oxygen Deficiency

Oxygen Content	Symptoms	Physical Effects
18 – 23 %	None	None
12 – 16 %	Increased Pulse Rate	Lack of “fine” co-ordination in fingers and hands
10 – 12 %	Rapid Pulse Rate, Nausea, Headache	Breathing defficulties, lack of co-ordination
6 – 10 %	-	Complete lack of co-ordination, inability to react to danger, loss of consciousness
0 – 6 %	-	Death

Flammable/Combustible Materials:

1. Flammable and combustible materials are of an important concern with regards to fires and explosions in confined spaces.
(Hydrogen Sulfide, Carbon Monoxide, acetylene, and Methane).
2. The proper mixture of fuel and oxygen varies from gas to gas, but explosion range is defined as the area between the lower explosive limits (LEL) and the upper explosive limits (UEL).
3. When the mixture is above the upper explosive limits, it can readily move into flammable range with the addition of dilution air.
4. Potential source of ignition that could be found in confined spaces include : open flames, arcs from electrical equipment, hot surfaces, static electricity and frictional sparks.

Toxic Gas Hazards:

- Toxic or poisons gases present two kinds of risks in a confined space:
- Irritation
- Asphyxiation

- Irritation:
- Many gases, existing in low concentration in the air, are irritating to the body's respiratory and nervous system.

- Asphyxiants:
Any gases which when present in high enough concentration, causes displacement of oxygen in the body.

- Carbon Monoxide:
- Carbon Monoxide is one of the most common asphyxiants. It is produced by incomplete combustion of carbon fuels.
- Carbon Monoxide kills by chemically combining with the hemoglobin in red blood cells. This greatly reduces the ability of the blood to carry oxygen to the body tissues and brain cells.

Carbon Monoxide Exposure Effects

35 ppm	Permissible Exposure Limit Over 8 hour shift.
500 ppm	Slight Headache
1000 ppm	Confusion, nausea, discomfort.
2000 ppm	Tendency to stagger.
2500 ppm	Unconsciousness after 30 minute exposure.
4000 ppm	Fatal in less than one hour.

- Hydrogen Sulfide:
- This gas even more toxic than Carbon Monoxide. It is produced through the decay of organisms and natural materials.
- This colorless gas has a characteristic rotten-egg odor at first smell; however after a short time the gas renders the olfactory nerve (which controls the sense of smell) ineffective, and the worker are no longer smells the substance, and yet it causes serious bodily harm in higher concentrations.

Hydrogen Sulfide Exposure Effects

10 ppm	Permissible Exposure Limit Over 8 hour shift.
50 - 100 ppm	Mild eye and respiratory irritation.
200 - 300 ppm	Marked increase in eye and lung irritation.
500 – 700 ppm	Unconsciousness/death after 30 minute exposure.
1000 ppm or more	Death within minutes.

2- Mechanical/Electrical Hazards:

- The unexpected movement of mechanical equipment or the unexpected discharge of electrical equipment in a confined space presents a very hazardous situation for anyone within the space.
- Commonly encountered equipment includes:
 - Blenders – Stirrers – mixers and agitators.

It is very important therefore to ensure that all mechanical and electrical equipment is locked out and tagged out when any work is to be performed in a confined space.

- General Safety (Physical Hazards):

- Exposure to higher environmental temperature during work activities.
- Exposure to corrosive substances which could cause irritation to unprotected skin.
- Exposure to rats and other pests living in the area.
- Poor or inadequate illumination.
- Exposure to noise from the use of hammers, hydraulic equipment.
- Slips and falls on wet surfaces or resulting from broken or oxidized ladder rungs.
- Means of access and egress.
- Improper handling of tools and equipment can result in cuts and back injury.

- Engulfment:

- ◀ The movement or shifting of material within a confined space has

- been responsible for many injuries and fatalities.
- Of particular concern are loose, granular materials which can act like quick sand.
- Silos with grain inside are prime example of this type of hazard.
- Possibility of engulfment by flooding while working in a storm sewer.



Written Entry Permit :

Before anyone can enter the permit – required confined space (PRCS) to work, there must be a written entry permit, which will list the following:

- ❑ Name/location of the Permit-Required Confined Space
- ❑ Purpose for entering the PRCS.
- ❑ Date and duration of entry.
- ❑ Names of those entering.
- ❑ Names of those attending on the outside.
- ❑ Supervisor's name.
- ❑ List of the expected hazard.
- ❑ Means by which you intend to isolate or control the hazards.
- ❑ Conditions under which you deem it acceptable to enter (level of oxygen, combustible, toxic materials etc.)
- ❑ Test results of hazards in the atmosphere in the PRCS before and during the entry.
- ❑ Provisions for rescuing someone from the PRCS.
- ❑ Communication methods such as phones, radios, hand signals etc. to allow enterant and attendants to communicate with each other.
- ❑ Equipment needed, including all the personal protective equipment, harness, alarm systems
- ❑ Other special precautions or considerations specific to the

particular space.

Monitoring for Hazards in Confined Spaces :

- Measuring and monitoring for atmospheric hazards is one of the important things to remember when doing confined space work.
 1. Oxygen :
 - According to the standard, 19.5 % is the minimum and 23.5 % is the maximum range for oxygen in PRCS.
 2. Combustibles :
 - Measure the percent of LEL and according to the standard, the acceptable level for any combustible is at or below 10% of its LEL.
 3. Toxic:
 - Measure the concentration of toxic substances which might be available and compare same with TLV.

The entrant:

- No one can enter a permit-required confined space (PRCS) unless he is authorized. That means he has to be thoroughly trained and checked out by his supervisor, so he will know:
 - The hazards present in the space.
 - How to recognize symptoms of exposure to hazards.
 - How to maintain contact with the attendants on the outside.
 - What personal protective equipment, retrieval lines, and harnesses he will need to stay safe in the space.
 - To leave the space if he thinks he is in danger or if an alarm goes off.

The Attendant:

- Work in Permit-Required Confined Space will be monitored by an attendant who has been trained to:
 - Keep constant count of every person in the space.
 - Keep in contact with the workers in the space.
 - Recognize and monitor hazards.
 - Order evacuation if anything inside or outside the space looks dangerous for the workers inside.
 - Call for help from trained emergency response team if anyone has to be rescued from the space.

Entry Procedure:

Once the initial tests are completed and determined to be within acceptable limits, work may proceed utilizing the following precautions:

- At least two, and preferably three, employees will conduct all work operations in confined space. One employee will remain outside of the space to be available in case of an emergency.
- This individual must be in direct communication with the other workers in the confined space, as well as have the capability to reach emergency response personnel.
- A portable blower must be used at all times during confined space work activities to purge the area of possible contaminated air.
- The blower intake must be located outside of the confined

space and away from any operating internal combustion engine to ensure that fresh air is being supplied.

- Continous monitoring of the atmosphere inside the confined space, and at any time the monitoring devices indicate the presence of toxic or flammable gases, or a decreased level of oxygen, employees are to evacuate the space at once.
- Each worker in the space shall wear a safety harness attached to a tripod located outside of the confined spaces.

Emergency and Rescue Procedures

- If someone has to be rescued from a confined space, that is the job of the rescue team.
- The rescue team will Know how to :
 - Close off the area
 - Remove victims with harnesses or rescue equipment.
 - Use oxygen, CPR, and other rescue and first-aid techniques and equipment.
 - They will enter the confined space wearing a SCBA respiratory system.
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