

CONFINED SPACE

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INTRODUCTION

1. Confined spaces exist in many workplaces and can pose a deadly hazard to anyone assigned to work in one. An *entry* into a confined space occurs when any part of an entrant's body breaks the plane of the opening into the space.

2. Overseers must be aware of the various hazards associated with entering a confined space and must ensure that measures are put in place to protect workers. They must also provide training to help workers understand the risks and how to keep themselves safe. Overseers should be aware of and follow all local laws related to confined space entries. However, higher standards may be required by organizational guidelines.

3. All workers who must enter a confined space should have a knowledge of the potential hazards and the proper training and equipment required to work there safely. Atmospheric hazards pose the greatest risk and are more likely to result in worker fatalities. These hazards should be carefully assessed prior to commencing work.

4. If a permit is required to work in a particular confined space, the permit must be filled out by an overseer trained to care for and oversee confined space work. The overseer must have a working knowledge of the space and the hazards, as well as an understanding of what precautions must be taken for those entering the space.

5. Each branch office or facility should have someone who is responsible for overseeing confined space permits. Depending on the size of the branch office, facility, or project, the size of the confined space permit structure will vary as per oversight approval. The roles described in this document may not apply to all branch offices or facilities. However, the care to plan, approve work, and complete work in these hazardous locations should never be compromised.

DEFINITIONS

6. A confined space is defined as:

- (1) A space large enough for a person to enter and perform assigned work.
- (2) A space that has a limited or restricted means of entry or exit.
- (3) A space that is not designed for continuous human occupancy.

7. Confined spaces may include:

- Boilers
- Furnaces
- Ovens
- Sewers
- Septic tanks
- Tunnels
- Manholes
- Vessels
- Silos
- Wells
- Cisterns
- Pits
- Diked Areas
- Pumping Stations
- Storage Bins
- Hoppers
- Vaults
- Digesters
- Crawl spaces

RECORD KEEPING

8. All the confined spaces for any site should be identified and cataloged. The catalog should list each space, the location, the known or potential hazards, and requirements for eliminating or mitigating them. This catalog should be available to each supervisor so that he can serve as a supervisor of a space that he may personally not be acquainted with.

9. A department or individual at each branch office or facility should be assigned to care for the maintenance of these records. As construction or renovation projects add, remove, or modify the hazards of confined spaces, the catalog should be updated accordingly.

ATMOSPHERIC HAZARDS

10. Most hazardous atmospheres are invisible and can kill without warning. A hazardous atmosphere is defined as an atmosphere that exposes individuals to a risk of death, incapacitation, injury, or acute illness from one or more of the following causes:

- (1) A flammable gas, vapor, or mist in excess of 10% of its Lower Flammable Limit (LFL) or Lower Explosive Limit (LEL).
- (2) An airborne combustible dust at a concentration that obscures vision at a distance of 2 meters (6 feet).
- (3) An atmospheric oxygen concentration below 19.5% or above 23.5%.
- (4) An atmospheric concentration where a worker could be exposed to a substance with a published permissible exposure limit that could be exceeded.
- (5) Any atmospheric condition recognized as immediately dangerous to life and health (IDLH).

11. **Oxygen Deficient:** An oxygen deficient atmosphere has less than 19.5% oxygen by volume. No one should be permitted to work in an oxygen deficient space. An oxygen deficient atmosphere can be caused by combustion (burning), rusting, normal breathing, or displacement of oxygen by another gas.

Oxygen Percent by Volume	Effects and Symptoms
19.5%	Minimum permissible level.
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; pulse increases; impaired coordination, perception, and judgment.
10-12%*	Respiration further increases in rate and depth; poor judgment; blueness of lips.
8-10%*	Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea, and vomiting.
6-8%*	100% fatal at 8 minutes; 50% fatal at 6 minutes; recovery with treatment possible between 4 and 5 minutes.
4-6%*	Coma in 40 seconds; convulsions; respiration ceases; death.

* Exposure to atmospheres containing 12% or less oxygen can bring about unconsciousness without warning so quickly that the individual cannot help or protect themselves.

12. **Oxygen Enriched:** An oxygen enriched atmosphere has more than 23.5% oxygen by volume and exposes individuals to an extreme fire hazard. An oxygen enriched atmosphere can be caused by oxygen tanks, such as those used with cutting torches

13. **Flammable/Explosive:** There are two factors that make an atmosphere flammable or explosive:

- (1) The amount of oxygen in the air.
- (2) A flammable gas, vapor, or combustible dust in the proper mixture.

14. An oxygen-enriched atmosphere (above 23.5% by volume) will cause flammable materials, such as clothing and hair, to burn violently if ignited.

15. The lowest concentration in the air at which a gas or vapor can ignite is called the Lower Explosive Limit (LEL). Concentrations below this limit are too weak to ignite.

16. **Toxic:** Chemicals or gases that exist in, are taken in, or could enter a confined space must be known or anticipated and controlled. A Safety Data Sheet (SDS), formerly known as Material Safety Data Sheets (MSDS), must be on hand and available for any chemical or gas taken into a confined space.

17. Hydrogen Sulfide is a common yet deadly gas that is found in many confined spaces. It is colorless and has an odor similar to rotten eggs. It is a by-product of processing petroleum and of the decay of organic matter containing sulfur. Hydrogen Sulfide is often found in sewers, sewage treatment facilities, and grease traps. Although it has strong odor notification at low concentrations, olfactory fatigue can quickly set in, causing the person to lose his ability to smell the gas even though it is still present.

Hydrogen Sulfide (H ₂ S) Level in PPM	Effects and Symptoms
0.13	Minimal perceptible odor.
4.60	Easily detectable, moderate odor.
10.0	Eye irritation begins.
27.0	Strong and unpleasant odor.
100	Coughing, eye irritation, loss of sense of smell after 2 to 5 minutes.
200	Eye inflammation and respiratory tract irritation after 1 hour of exposure.
300	Immediately dangerous to life and health (IDLH).
500 - 700	Loss of consciousness and possibly death in 30 to 60 minutes.
700 - 1000	Rapid unconsciousness, cessation of respiration, and death.

1000 – 2000	Immediate unconsciousness, with early cessation of respiration and death in a few minutes. Death may occur even if the individual is moved immediately to fresh air.
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18. Carbon Monoxide also is a common yet deadly gas that is found in many confined spaces. It is colorless, odorless, and very toxic. Since it is very similar in weight to air, it usually mixes in with the surrounding air, neither rising nor falling. It is a product of incomplete combustion. It often comes from gasoline- or diesel-powered internal combustion engines. Carbon monoxide has a high affinity for the hemoglobin in blood and can quickly replace oxygen. In high concentrations, carbon monoxide can cause chemical asphyxiation.

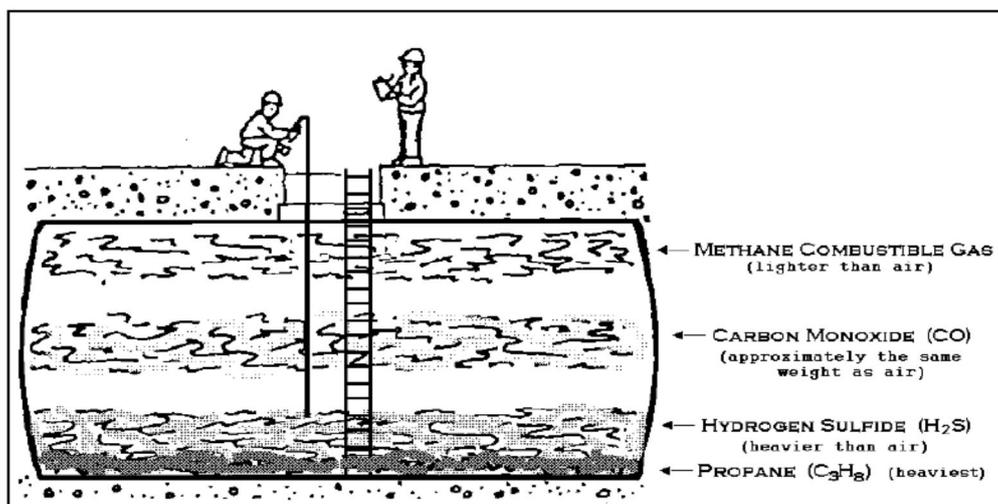
Carbon Monoxide (CO) Level in PPM	Effects and Symptoms
50	Permissible exposure level over an 8-hour time period.
200	Possible mild frontal headache in 2 to 3 hours.
400	Frontal headache and nausea after 1 to 2 hours.
800	Headache, dizziness, and nausea in 45 minutes. Collapse and possible death in 2 hours.
1500	Immediately dangerous to life and health (IDLH).
1600	Headache, dizziness, and nausea in 20 minutes. Collapse and possible death in 1 hour.
3200	Headache and dizziness in 5 to 10 minutes. Unconsciousness and danger of death in 10 to 15 minutes.
12800	Immediate unconsciousness. Danger of death in 1 to 3 minutes.

ATMOSPHERIC CONTROLS

19. **Testing:** Testing the atmosphere should always be done from outside the space by a person who is trained in confined space procedures and in calibrating the testing monitor.

20. An air monitor, such as a 4-gas meter, should be used to test for oxygen content, flammable gas and vapors, hydrogen sulfide, and carbon monoxide.

21. Since gases have different densities and can stratify, the space must be checked in 1-meter (3-foot) intervals vertically.



22. If gas meters are not readily available in the country where work is being done, complete a simple check for diminished oxygen by confirming whether a protected candle or butane lighter will

burn normally. A well-qualified overseer should review and approve this alternate method if no other options are available. The following chart shows the oxygen content levels consistent with flames from a match, candle, and flint wheel butane lighter:

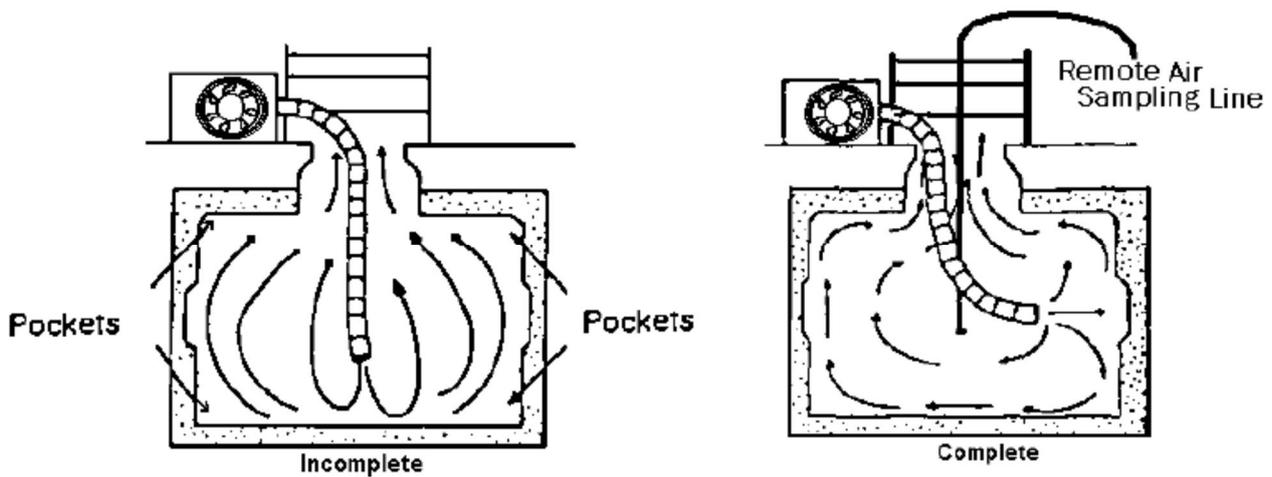
Match	Candle	Flint Wheel Butane Lighter
18%-21%: Easily burns all of match.	>19%: Normal flame.	
17.5%: Burns head, and flame transfers down to wooden splint on most occasions.	16.5%-17%: Burns with a flame that is thinner than normal.	
16.5%-17%: Burns head, and on nearly every occasion burns down onto paraffin coating, and then extinguishes.	16%-16.5%: Flame becomes smaller, but candle remains lit.	
15.5%-16%: The burning head only ignites the paraffin coating on the splint.	16%: Candle burns slowly with small flame.	
15%: The head burns briefly with a flickered flame and goes out.	<15.0%: A burning paraffin candle is extinguished.	>15%: The lighter can easily be lit and will stay lit.
		14.5%: The lighter produces a weak blue flame with orange top.
		14.25%: Flame will extinguish.
14%: Head burns very briefly and then goes out. (The head burns because of the small amount of oxygen in the potassium chlorate contained in the head.)		13%-14%: The lighter will produce large flashes of flame but will not stay lit.
<13%: Head flares and extinguishes immediately (less than 0.5 seconds).		12.5%: Sparks with partial ignition.
		<10%: No ignition. Only hot sparks from the flint are produced.

23. **Ventilation:** If a confined space is known to contain or has the potential to contain a hazardous atmosphere, then the space must be ventilated before anyone is allowed to enter it. Ventilation can be accomplished by either natural or mechanical means in order to control the atmospheric contaminants, prevent fire and explosion hazards, and control heat and humidity.

24. Natural ventilation is performed by removing covers, roofs, hatches, or similar elements to allow natural air currents to remove gases and vapors. The configuration of some spaces and the unpredictability of wind currents and thermal effects can make natural ventilation unreliable as a primary method.

25. Mechanical ventilation can be accomplished by blowing clean air into a space. This will agitate and help evaporate or disperse contaminants. Additionally, since the space is pressurized by the clean air being blown into it, the pressure will eventually expel the contaminant through the openings. Air should be blown into a space rather than exhausting it, since air blows a distance of 30 times farther than it can be exhausted. Ventilation machines should be set up in such a way that they take in clean air. The blowing duct should be positioned to have uniform dilution of the space and eliminate any gas pockets.

26. The following illustrations show examples of complete and incomplete ventilation of man-holes:



27. **Respirators:** In certain hazardous atmospheres, respirators may be used to reduce the risk of the hazard.

28. Air-purifying respirators filter the air in the space. With the proper cartridges, the respirator can protect the worker against dust, vapors, and toxic fumes. However, air-purifying respirators do not protect workers from oxygen-deficient atmospheres.

29. Supplied-air respirators supply air to the worker through a hose from a pump outside of the confined space. The pump or compressor must be located in a clean and safe ambient-air atmosphere.

NON-ATMOSPHERIC HAZARDS

30. Although atmospheric hazards are the most common and generally the most deadly, there are many other potential hazards that can exist in confined spaces. Some examples are as follows:

Type	Examples
Physical	Poor lighting, falling objects, slippery surfaces, engulfment by liquids, granular solids, or dust, and fluids under pressure that could enter the space.
Electrical	Electrical conductors, electrical panels, and static electricity.
Mechanical	Agitators, augers, stirrers, machinery with moving parts, and equipment that could start up on stored energy.
Chemical	Liquid hazardous materials, such as acids or corrosives.
Biological	Infectious microorganisms, waste in sludge pits, sewers, blood-borne pathogens, hazardous waste, and animal feces.
Radiation	Ultraviolet, microwave, infrared, and X-ray waves.
Temperature	Extreme hot or cold.
Structural	Tight quarters, insecure footing, fall hazard, and obstructions.
Noise	Exhaust fans or motors.
Fire	Hot work in the confined space. (A <i>Job Hazard Analysis</i> [DC-83] form must be completed for any hot work performed in a confined space, which must be reviewed and approved by the local safety contact.)

31. For many of the above hazards, isolation, lockout/tagout, blanking, blinding, double block and bleed, physical disconnection of sources, or barricading must be utilized. Before commencing work in the confined space, a detailed plan of how to manage these risks must have been created and communicated to all working in the vicinity of the confined space.

CONFINED SPACE SUPERVISOR

32. A confined space supervisor is responsible for authorizing confined space permits. He should be a responsible brother who understands the hazards associated with confined space entries, successfully completed confined space training (if available), has many years of experience working with and in confined spaces, is known for his good example and attitude toward safety, and accepts the serious responsibility of ensuring that all entries that he supervises are well-planned and set up for safe entry.

33. The supervisor will be responsible for the following:

- (1) Filling out the confined space permit.
- (2) Determining what new, existing, or potential hazards exist for the space.
- (3) Understanding the scope of work in the space.
- (4) Determining what equipment, controls, and personal protective equipment (PPE) will be needed to eliminate or mitigate the hazards.
- (5) Personally sampling the air, using the calibrated air monitor, and recording the initial readings on the permit.
- (6) Canceling the permit and terminating the work if the conditions are not acceptable.
- (7) Ensuring all entrants and attendants on the permit have received the appropriate training.
- (8) Reviewing the permit and the hazards with all the entrants and attendants listed on the permit.
- (9) Canceling the permit and ensuring the space is secure after the work is complete.
- (10) Determining if a written rescue plan is necessary for the space and entry.
- (11) Verifying that communication measures are in place and sufficient rescue personnel are available in the event of an emergency.

CONFINED SPACE ENTRANT

34. A confined space entrant performs the work in a confined space. Of all the workers, he should be the most concerned and interested in the elimination or mitigation of the hazards. The entrant must successfully complete the required "Entrant/Attendant Training" or other approved training provided by oversight at the branch office.

35. The entrant is responsible for the following:

- (1) Reviewing the permit prior to entry so that he understands all the hazards and controls.
- (2) Wearing the appropriate personal protective equipment (PPE) as outlined on the permit.
- (3) Understanding how to use the air monitor/4-gas meter.
- (4) Paying attention to his own physical reactions that could signal an unsafe condition and notifying the attendant of possible unsafe conditions immediately.
- (5) Maintaining visual or verbal contact with the attendant at all times.
- (6) Evacuating immediately if the monitor goes into alarm or if instructed to do so by the attendant.

CONFINED SPACE ATTENDANT

36. A confined space attendant ensures the safety of the entrant(s) and secures the jobsite. The attendant must successfully complete the required "Entrant/Attendant Training" or other similar approved training by oversight.

37. The attendant is responsible for the following:

- (1) Reviewing the permit prior to entry so that he understands all the hazards and controls.
- (2) Making sure the ventilation equipment is working, if such is being used.
- (3) Keeping track of who is in the space at all times.
- (4) Preventing anyone who is not approved as an entrant on the permit from entering the space.
- (5) Maintaining visual or verbal contact with the entrant at all times.
- (6) Paying attention to the monitoring equipment at all times.
- (7) Remaining alert to early symptoms of danger within the space.
- (8) Watching for hazards inside and outside the space.
- (9) Notifying the entrant to evacuate the space if conditions warrant it.
- (10) Being trained in first aid and cardiopulmonary resuscitation (CPR) or having rapid access to individuals trained to perform such.
- (11) Remaining at the entrance of the space unless relieved by another attendant, as specified on the permit.
- (12) Providing information to the rescue team in an emergency.
- (13) Performing non-entry rescue after notifying the local emergency rescue team.

ENTRY PERMIT

38. A confined space entry permit is the backbone of the confined space safety program. A permit is required to enter a confined space if it has one or more of the following hazards:

- (1) A hazardous atmosphere or the potential of such.
- (2) A material with the potential to engulf a person who enters the space.
- (3) 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 small cross section, such as a hopper.
- (4) Any other recognized serious safety or health hazard.

39. All confined spaces that require a permit must be clearly labeled as such and must have covers, barricades, or other means to restrict access to unauthorized persons. A sign similar to what is shown below can be used.



40. The permit should be filled out and signed by an approved and trained confined space supervisor. He should review the permit and the requirements outlined for entry into the confined space with those who will serve as entrants and attendants.

41. Although requirements for the permit may vary from place to place according to local laws, the permit should contain the following information:

- (1) Identity and physical location of the space. (This should be very descriptive, in the event that emergency responders must be called.)
- (2) Scope of work inside the space.
- (3) Date and duration of the entry.
- (4) Name(s) of authorized entrants.
- (5) Name(s) of authorized attendants.
- (6) Signature and printed name of the entry supervisor who is authorizing the entry.
- (7) Known or potential hazards of the space.
- (8) Hazard control measures required for the entry.
- (9) Communication procedure between entrant and attendant.
- (10) Personal protective equipment requirements.
- (11) Air monitoring equipment, procedures, and testing results.
- (12) Emergency contact information.
- (13) On-site rescue equipment requirements.

42. The permit should always be available at the confined space and should be filled out legibly. When the work is complete, the permit should be cancelled and returned to the entry supervisor. The entry supervisor should ensure that the record of completed work is passed on to the individual responsible for maintaining records.

EMERGENCY

43. A retrieval system should be used during all work operations within a permit-required confined space unless such equipment will not contribute to a rescue or would increase the overall risk of entry.

44. The retrieval system should include a full body harness and retrieval line. The end of the retrieval line must be attached to a mechanical device that allows the attendant to rescue the entrant without entering the space.

45. For any emergency in the confined space, the attendant should immediately call the emergency number listed on the entry permit. The attendant should report the following:

- (1) Immediately state: "This is a confined space emergency."
- (2) Provide the location of the space. (He should be descriptive so that responders who are unfamiliar with the area or space can quickly locate it.)
- (3) Provide the name of the attendant and of the victim.
- (4) Provide the nature of the injury or emergency.

46. The emergency dispatcher should immediately notify the local confined space rescue team or those assigned at the location to respond to emergencies.

47. Under no circumstances should the attendant enter the confined space in a rescue attempt. Rather, he may attempt a non-entry rescue utilizing the retrieval system from outside the space.

48. When atmospheric hazards are present or if rescuers are unsure of the atmospheric conditions, the rescuers must wear a self-contained breathing apparatus (SCBA) as well as a full body harness with a lifeline.

RESCUE TEAM

49. A confined space rescue team, or those assigned to care for confined space emergencies, must be available to perform a rescue in the event of an emergency. This team may consist of brothers who have received proper training and have all the proper equipment for carrying out a rescue, including ropes, tripods, air-monitoring equipment, ventilation equipment, and personal protective equipment (PPE). Sufficient training includes annual refresher training and practicing confined space rescues a minimum of one time per year.

50. The means of communication with the rescue team must be clear and mutually agreed upon by emergency dispatch personnel and by the rescue team.

OUTSIDE CONTRACTORS

51. Prior to an outside contractor performing work at any location that may involve entering a confined space, an agreement between the contractor and our local legal entity must be made. There must be a confined space information exchange that requires the contractor to provide their written confined space safety program. The program must meet or exceed local applicable laws or standards, along with the minimum standards required by our organization, and include details of how the work will be accomplished.

52. The safety and supervision of safe work practices by the contractor, contractor's employees, subcontractors, and employees of subcontractors are the responsibility of the contractor.