

CONFINED SPACE EMERGENCIES

This portion of the Fire Continuing education is based upon the International Association of Fire Chiefs (IAFC) request that Fire Departments conduct confined space training, due to several recent confined space emergencies that took the lives of firefighters or required their hospitalization.

The information provided will cover the following:

- What is a confined space?
- Basic OSHA confined space definitions
- What are the hazards of a confined space?
- Recent examples of confined space emergencies
- Applicable NFPA and OSHA Standards
- Emergency response to a confined space emergency
- Non-entry Rescue Procedures

What is a confined space?

- A SPACE LARGE ENOUGH AND SO CONFIGURED THAT AN EMPLOYEE CAN BODILY ENTER AND PERFORM ASSIGNED WORK
- HAS LIMITED OR RESTRICTED MEANS FOR ENTRY AND EXIT
- IS NOT DESIGNED FOR CONTINUOUS OCCUPANCY
- A CONFINED SPACE IS NOT NECESARRILY SMALL

A confined space can represent a risk for the health and safety of anyone who enters, due to one or more of the following factors:

- Design, construction, location or atmosphere
- Materials or substances in the confined space
- Work activities in the confined space
- Mechanical processing and safety hazards present

Confined spaces can be found in almost any workplace they exist below or above ground. (I.e. silos, vats, hoppers, utility vaults, tanks, sewers, pipes, access shafts, elevator shafts, truck or rail tank cars, aircraft wings, ditches and trenches where access or egress is limited)

Illustrations of Confined Spaces:



Occupational Safety and Health Agency (OSHA) 1910.146 Confined Space Definitions:

The following definitions are the basic common terms used in the private sector and rescue service for confined space.

- **Attendant:** Individual stationed outside one or more permit required confined spaces that monitors the authorized entrants and who performs all attendant duties assigned in the employer's permit space program
- **Emergency:** Any event to the permit space that could endanger the entrants including failure of monitoring equipment and hazard controls
- **Entrant:** an employee or rescuer authorized to enter a confined space
- **Entry:** When a person or any part of the entrants body passes through an opening into a permit-required confined space.
- **Entry permit:** written or printed document provided by the employer to allow and control entry into a permit space.

- **Entry supervisor:** person (such as the employer, foreman, or crew chief) and is responsible for determining if allowable conditions are present to enter the space, authorizes entry and oversees entry operations, and can terminate entry.
 - **NOTE:** Entry supervisor also may serve as an attendant or as an authorized entrant, as long as that person is trained and equipped. Also, the duties of entry supervisor may be passed from one individual to another during the course of an entry operation.
- **Hot Work (permit):** employer's written authorization to perform operations (capable of providing a source of ignition. (I.e., riveting, welding, cutting, burning, and heating)
- **Immediately Dangerous to Life or Health (IDLH):** Any condition that poses an immediate or delayed threat to life, cause irreversible adverse health effects, or that would interfere with an individual's ability to escape unaided from a permit space.
- **NOTE:** Some materials -- hydrogen fluoride gas and cadmium vapor, for example -- may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12-72 hours after exposure. The victim "feels normal" from recovery from transient effects until collapse.
- **Non-permit confined space:** a confined space that does not contain atmospheric hazards, or have the potential to contain any hazard capable of causing death or serious physical harm.
- **Oxygen deficient atmosphere:** atmosphere containing less than 19.5 percent oxygen by volume.
- **Oxygen enriched atmosphere:** atmosphere containing more than 23.5 percent oxygen by volume.
- **Permit-required confined space (permit space):** Employer's overall program for controlling, regulating employee entry into permit spaces and protecting employees from the hazards of a confined space. A permit required confined space has one or more of the following:
 - 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
- **Rescue service:** personnel designated to rescue employees from permit spaces.
- **Retrieval system:** equipment (including a retrieval line, chest or full-body harness, wristlets, lifting device or anchor) **used for non-entry rescue** of persons from permit spaces.
- **Testing:** Identifying hazards that may confront entrants of a permit required confined space. (Air testing, combustible and flammable gas testing, oxygen content, LEL/UEL, Carbon Monoxide, Radiation, etc)

What are the hazards in a confined space?

The hazard found in a regular work space can also be found in a confined space. However, the hazards encountered in a confined space can often be more dangerous than those in a regular worksite for the employees and rescuers. Anytime someone enters a work space they should determine if the work space is a permit required confined space or non-permit confined space. In the private sector and rescue service before entering any confined space, a trained and experienced person should also identify and evaluate all the potential hazards within the confined space. Listed below are the common hazards of a confined space, the common gases encountered and the vapor density of the common gases.

Confined Space Hazards Include:

- Hazardous air conditions (such as flammable gas, too little oxygen, too much oxygen, airborne combustion dust, radiation, biological hazards, etc.)
- FLAMMABLE GAS, Combustible gas MIST, OR VAPOR IN EXCESS OF 10% OF ITS LEL, AIRBOURNE COMBUSTIBLE DUST THAT MEETS OR EXCEEDS ITS LEL
- Liquid or solid materials that can engulf an entrant (such as sand, grain, etc.)
- Chemical exposures due to: ABSORPTION, INHALATION, INGESTION, INJECTION
- Conditions that can trap or suffocate an entrant (such as inwardly converging walls, floors which slope downward, etc.)
- Fire Hazard: explosive/flammable atmosphere due to flammable liquids and gases and combustible dusts which if ignited would lead to fire or explosion.
- Mechanical hazards (such as gears, conveyors, mulchers, etc.)
- Electrical hazards
- Temperature extremes, poor visibility (LESS THAN 5 FT VISIBILITY), lack of lighting, falling objects, tripping, insecure footing

Gases Found In a Confined Space:

Air testing is a critical step in determining the hazards in a confined space. Before entering a confined space the internal atmosphere shall be tested, with a calibrated instrument, for oxygen content, for flammable gases and vapors, and for potential toxic air contaminants, **in that order. Various levels of the confined space must be tested due to the vapor density of the common gases.**

- Methane (CH₄),
- Carbon Monoxide (CO)
- Carbon Dioxide (CO₂)
- Hydrogen Sulfide (H₂S)
- Sulfur Dioxide (SO₂)

VAPOR DENSITIES of Gases (AIR 1.0)

- | | | |
|--------------------|------------------|--------|
| • CARBON DIOXIDE | CO ₂ | 1.5270 |
| • CARBON MONOXIDE | CO | .9680 |
| • HYDROGEN SULFIDE | H ₂ S | 1.1912 |

- METHANE CH4 .5540
- SULFUR DIOXIDE SO2 2.2638

RECENT CONFINED SPACE EMERGENCIES:

Daily construction workers, industrial personnel and public employees enter more than 250,000 confined spaces. Per OSHA, 95% of victims in a confined space incident did not have confined space training. Another alarming statistic published by the National Safety Council and the National Institute of Occupational Safety Health (NIOSH) stated that 50% to 60% of confined space deaths resulted from secondary personnel attempting to rescue the initial entrants of the confined space.

Federal and State officials of the Occupational Safety and Health Administration (OSHA) have established written rules that govern the safe operating procedures for a confined space entry. However, accidents do occur and safety procedures are not always followed. The following two examples of confined space rescue incidents created very difficult and dangerous rescue situation for the Fire Departments involved. In both incidents civilians were killed and firefighters were injured.

Middletown, OH Confined Space Incident - FF's Down

Friday, May 7, 2010 a 32-year-old city worker is dead after being overcome by fumes this morning while checking a sewer outside of a business on Yankee Road, according to police.

Meanwhile, two firefighters who attempted to rescue the public works employee were hospitalized after the accident about 8 a.m. today, May 7, in front of Air Products and Chemicals Inc., 2500 Yankee Road, according to police.

Jabin Lakes died after falling into a manhole during an inspection, according to Police Maj. Mark Hoffman.

Firefighters went into rescue Lakes and were overcome with something in the shaft, he said. It is not clear what the substance is, according to Hoffman.

Fire Marshal Bob Hess was taken to Atrium Medical Center in Middletown and Capt. Todd Wissemier was taken to Miami Valley Hospital in Dayton, according to Hoffman.

The manhole is estimated to be about 20 to 30 feet deep and 20 to 22 inches wide, Hoffman said.

Mayor Larry Mulligan could not discuss details of the incident but said the city will hold a press conference today at 2 p.m. in council chambers, One Donham Plaza.

A coroner's investigator is at the scene as well as fire rescue units from West Chester Twp., Fairfield and Franklin. The deceased man is still in the hole at 9:55 a.m.

Shortly before 10 a.m., crews were performing air quality tests on the manhole, Hoffman said. He said there does not appear to be any hazard to the general public in the area. At 10:12 a.m., crews on scene were requesting a chemist from AK Steel be sent to the manhole.

Air Products officials were in a meeting regarding the incident and couldn't be reached for comment. The Allentown, Pa.-based company provides oxygen to AK Steel's Middletown Works.

Hoffman said Lakes and two other city workers were inspecting the sewer about 8 a.m. because Air Products was interested in tapping into a main line. When the manhole cover was opened, Lakes was overcome by fumes and fell into the hole, he said.

The workers called 911 and fire crews arrived shortly thereafter, Hoffman said.

AUBURN, Twp. – GEAUGA COUNTY TEENAGER DIES TRYING TO RESCUE FATHER TRAPPED IN ABOVE GROUND FUEL STORAGE TANK IN AUBURN TOWNSHIP.

Tim Haas, 17, a junior at Kenston High School, died Friday night. The Cuyahoga County Coroner's office will conduct an autopsy to determine the cause of death. Tim, along with his older brother, Paul, tried to rescue their father who was overcome by toxic fumes and a lack of oxygen while cleaning the inside of the fuel storage tank.

"The two sons were outside of the tank," said Auburn Volunteer Fire Chief, John Phillips. "They noticed that (their father) became disoriented and called for help so they entered the tank to help him," Phillips said.

Paul Haas suffered chemical burns and remains in critical condition at Metro Health Medical Center in Cleveland.

The boys' father, Bruce Haas, 49, was hired to clean the 30-foot tank behind a gas station on Washington Street in Auburn Township.

Bruce was reportedly the first one in the tank, followed by Paul. When neither came out, Tim went in and was overcome by the fumes. Friends of the Haas family told Channel 3 News that Bruce Haas was released from the hospital.

According to Chief Phillips, one of the first arriving firefighters at the scene assisted Bruce Haas from the fuel tank. That firefighter was taken to a local hospital with minor injuries.

Chief Phillips said that the confined space rescue with access through only a 24-inch diameter manhole presented challenges for firefighters.

"First thing that people want to do is rush in to help the people as the sons did," Phillips said. "And you can very quickly become a victim.

"At the (rescue Friday) people were questioning, 'Well, it took you forever to get this done and that done.' That's so we could keep the firefighters safe."

Rescuers pumped oxygen into the fuel tank. Firefighters in protective gear, and outfitted with respirators harnessed Paul and Tim Haas to baskets and lifted them from the fuel tanks.

APPLICABLE STANDARDS for FIREFIGHTERS:

Guidance on the management and safe operation of a confined space emergency can be found by referring to the following National Fire Protection Agency Standards:

- NFPA 1006 Standard for Technical Rescuer Professional Qualifications
- NFPA 1670 Standard on Operations and Training for Technical Search and Rescue Incidents

NFPA 1006 establishes the job performance requirements for the technician level rescuer. The skills include:

- Preplanning confined spaces
- Site assessment
- Hazard recognition and control
- Atmospheric monitoring
- Entry team preparation
- Victim assessment , packaging and transfer techniques
- Incident termination procedures

NFPA 1670 establishes how the fire departments can operate safely, efficiently and effectively at confined space rescue. The standard identifies the requirements for:

- Confined space site identification
- Confined space classification
- Permitting systems
- Documentation requirements
- Permissible entry conditions
- Safety procedures
- Training requirements

Federal OSHA Standard 1910.146, Permit Required Confined Spaces is the regulation for personnel (including Fire Department rescuers) that enter a confined space as part of their work requirements. The standard establishes the following:

- Confined space site identification
- Confined space classification
- Permitting systems
- Documentation requirements
- Permissible entry conditions
- Safety procedures
- Training requirements

All rescue personnel responding to a confined space emergency should be trained to NFPA 1670 awareness level. Firefighters that will make a basic confined space entry rescue must be trained to NFPA 1670 operations level. Fire/Rescue personnel

performing more difficult confined space rescues must be trained to meet the technician-level job performance requirements of NFPA 1006.

NFPA 1670 Standard on Operations and Training for Technical Search and Rescue Incidents has three levels of competency, Awareness, Operations and Technician.

- **Awareness level: no actual rescue skills provided to all responders, emphasizes**
 - Recognizing the hazards
 - Secure the scene
 - Call for appropriate assistance (Tech Rescue, hazmat, EMS, etc)
- **Operations Level:**
 - Limited entry into a confined space with very minimal hazards
 - Firefighters could enter with a self contained breathing apparatus, no obstructions
 - The victim is scene from the entryway of a confined space
- **Technician Level:**
 - Responders are permitted to be directly involved in the rescue operation
 - Difficult and hazardous confined space entries
 - Specialized equipment training (atmospheric monitoring equipment, positive pressure ventilation fans, , intrinsically safe lighting equipment, supplied air breathing apparatus, , airlines, manifold systems, hard line communication systems, rope rescue skills
 - Victim(s) care during rescue
 - Management of the incident and personnel at the scene

EMERGENCY RESPONSE TO A CONFINED SPACE EMERGENCY

Many confined spaces are unique and have their own specific hazards. Firefighters must understand the hazards they may encounter and protect themselves and their crew from injury or death. All responders shall adhere to SOP 18 Technical Rescue Response.

After performing the Awareness level functions at a confined space incident the first arriving should attempt to gather the following information:

1. The confined space permit and locate a supervisor.
 - The confined space permit provides important safety information for all rescuers. (i.e. work being performed, atmospheric conditions, hazard controls in place, ventilation, number of entrants in the space, PPE needed, communication procedures)
2. Request onsite Material Safety Data Sheet (MSDS) of any hazardous material that may be encountered in the confined space.

3. Make verbal or visual contact with the victim from **OUTSIDE** the confined space. **DO NOT PLACE ANY PART OF YOUR BODY IN THE CONFINED SPACE.**
4. If possible determine the location of the victim. Personnel not trained to the operations or technician level or properly equipped shall not make entry into the confined space.

NON ENTRY RESCUE PROCEDURES:

Firefighters trained to the awareness level should not make entry into a confined space to initiate a rescue. However, a non-entry rescue maybe considered in specific situations.

- I.e. Victim is in utility vault, or manhole confined space has a harness on and is tethered to a tripod with a winch system. Consider having the co-workers of the victim attempt removal by using the winch or request to operate the winch by hand to remove the victim. **UNDER NO CIRCUMSTANCES SHOULD AWARENESS PERSONNEL ENTER THE CONFINED SPACE.**
- I.e. if the confined space is a horizontal tank or pipe and the victim is near the entrance. Consider reaching with a tool and pull the victim out without making entry into the horizontal opening. Be aware of utilities or other manufacturing processes that the victim could get snagged on.
- If either of these attempts is considered be aware of the fall hazards in a vertical rescue attempt, the possibility of a toxic atmosphere, fire hazard, etc.

Non-Entry Confined Space Horizontal Retrieval Steps

1. Identify a confined space incident, secure the scene and request additional resources.
2. Asses the location of victim, conduct a risk analysis and confirm that non-entry retrieval is possible. Be aware of all confined space hazards.
3. Position personnel next to the entry point and use a long reaching tool (pike pole) to reach and grab the victims clothing or harness.
4. Pull the victim toward the entry point. **AT NO TIME SHOULD ANY OF YOUR BODY ENTER THE CONFINED SPACE.**
5. Continue to pull the victim to the entry point until the victim's is removed.
6. Provide medical care

