NIOSH ALERT: January (1986)

REQUEST FOR ASSISTANCE IN PREVENTING OCCUPATIONAL FATALITIES IN CONFINED SPACES

SUMMARY

This Alert requests the assistance of managers, supervisors, and workers in the prevention of deaths that occur in confined spaces. Confined spaces may be encountered in virtually any occupation; therefore, their recognition is the first step in preventing fatalities. Since deaths in confined spaces often occur because the atmosphere is oxygen deficient or toxic, confined spaces should be tested prior to entry and continually monitored. More than 60% of confined space fatalities occur among would-be rescuers; therefore, a well-designed and properly executed rescue plan is a must. This Alert describes 16 deaths that occurred in a variety of confined spaces. Had these spaces been properly evaluated prior to entry and continuously monitored while the work was being performed and had appropriate rescue procedures been in effect, none of the 16 deaths would have occurred. There are no specific OSHA rules that apply to all confined spaces. Recommendations for Recognition, Testing, Evaluation, and Monitoring, and Rescue of Workers are presented. Other National Institute for Occupational Safety and Health (NIOSH) publications on this subject as well as a source for additional information and assistance are also presented.

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BACKGROUND

The deaths of workers in confined spaces constitute a recurring occupational tragedy; approximately 60% of these fatalities have involved would-be rescuers. If you are required to work in a:

SEPTIC TANK	SILO	REACTION VESSEL
SEWAGE DIGESTER	VAT	BOILER
PUMPING/LIFT STATION	DUCT	PIPELINE
SEWAGE DISTRIBUTION or HOLDING TANK	UTILITY VAULT	PIT

or similar type of structure or enclosure, you are working in a CONFINED SPACE. The Occupational Safety and Health Administration (OSHA) defines a confined space in 29 CFR 1926.21 as "any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere." The NIOSH ***Criteria for a Recommended Standard .... Working in Confined Spaces*** dated December, 1979, defines a confined space as:

> ...a space which by design has limited openings for entry and exit; unfavorable natural ventilation which could contain or produce dangerous air contaminants, and which is not intended for continuous employee occupancy. Confined spaces include but are not limited to storage tanks, compartments of ships, process vessels, pits, silos, vats, degreasers,

reaction vessels, boilers, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines.

CASE REPORTS OF FATAL INCIDENTS

Case #1 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 1 RESCUER)

On December 29, 1983, a 54-year-old worker died inside a floating cover of a sewage digester while attempting to restart a propane heater that was being used to warm the outside of the sewage digester cover prior to painting it Workers had wired the safety valve open so that the flow of propane would be constant, even if the flame went out. The heater was located near an opening in the cover of the digester. When the worker attempted to restart the heater, an explosion occurred that vented through the opening. The worker crawled away from the heater into an area that was oxygen deficient and died. A co-worker attempted a rescue and also died.

Case #2 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 1 RESCUER)

On March 8, 1984, a 20-year-old construction worker died while attempting to refuel a gasoline engine powered pump used to remove waste water from a 66 inch diameter sewer line that was under construction. The pump was approximately 3,000 feet from where the worker had entered the line. The worker was overcome by carbon monoxide. A co-worker, who had also entered the sewer line, escaped. A 28-year-old state inspector entered from another point along the sewer line and died in a rescue attempt. Both deaths were due to carbon monoxide intoxication. In addition to the fatalities, 30 firefighters and 8 construction workers were treated for carbon monoxide exposure.

Case #3 - RECOGNITION AND RESCUE (FATALITIES = 2 RESCUERS)

On October 4, 1984, two workers (26 and 27 years old) were overcome by gas vapors and drowned after rescuing a third worker from a fracturing tank at a natural gas well. The tank contained a mixture of mud, water, and natural gas. The first worker had been attempting to move a hose from the tank to another tank. The hose was secured by a chain and when the worker moved the hose, the chain fell into the tank. The worker entered the tank to retrieve the chain and was overcome.

Case #4 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 1 RESCUER)

On December 5, 1984, a 22-year-old worker died inside a toluene storage tank that was 10 feet in diameter and 20 feet high while attempting to clean the tank. The worker entered the tank through the 16 inch diameter top opening using a 1/2 inch rope for descent. Although a self-contained breathing apparatus was present, the worker was not wearing it when he entered the tank. The worker was overcome and collapsed onto the floor the tank. In an attempt to rescue the worker, fire department personnel began cutting an opening into the side of the tank. The tank exploded, killing a 32-year-old firefighter and injuring 15 others.

Case #5 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 1 RESCUER)

On May 13, 1985, a 21-year-old worker died inside a waste water holding tank that was four feet in diameter and eight feet deep while attempting to clean and repair a drain line. Sulfuric acid was used to unclog a floor drain leading into the holding tank. The worker collapsed and fell face down into six inches of water in the bottom of the tank. A second 21-year-old worker attempted a rescue and was also

overcome and collapsed. The first worker was pronounced dead at the scene and the second worker died two weeks later. Cause of death was attributed to asphyxiation by methane gas. Sulfuric acid vapors may have also contributed to the cause of death.

Case #6 - RECOGNITION AND RESCUE (FATALITY = 1 RESCUER)

On June 7, 1985, a 43-year-old father died whi le attempting to rescue his 28-year-old son from a tank used to store spent acids from a metal pickling process. The tank was out of service so that sludge could be removed from the bottom. The son collapsed in the tank. The father attempted a rescue and also collapsed. The two were removed from the tank; the son was revived, but the father died. The cause of death is unknown.

Case #7 - RECOGNITION (FATALITY = 1 WORKER)

On July 2, 1985, a crew foreman became ill and was hospitalized after using an epoxy coating, which contained 2-nitropropane and coal tar pitch, to coat a valve on an underground waterline. The valve was located in an enclosed service vault (12' x 15' x 15'). The worker was released from the hospital on July 3, 1985, but was readmitted on July 6, 1985; he lapsed into a coma and died on July 12, 1985, as a result of acute liver failure induced by inhalation of 2-nitropropane and coal tar pitch vapors. A co-worker was also hospitalized, but did not die.

Case #8 - RECOGNITION AND RESCUE (FATALITIES = 1 WORKER + 3 RESCUERS)

On July 5, 1985, a 27-year-old sewer worker entered an underground pumping station (8' x 8' x 7') via a fixed ladder inside a three foot diameter shaft. Because the work crew was unaware of procedures to isolate the work area and ensure that the pump had been bypassed, the transfer line was still under pressure. Therefore, when the workers removed the bolts from an inspection plate that covered a check valve, the force of the waste water blew the inspection plate off, allowing sewage to flood the chamber, and trapping one of the workers. A co-worker, a supervisor, and a policeman attempted a rescue and died. The first two deaths appeared to be due to drowning and the latter two appeared to be due to asphyxiation as a result of inhalation of "sewer gas."

REGULATORY STATUS

As stated in the Regulatory Program of the United States Government (Confined Spaces [29 CFR 1910], page 282 dated August, 1985), "there are no specific OSHA rules directed toward all confined-space work, forcing OSHA compliance personnel to cite other marginally applicable standards or section 5(a)(1) in cases involving confined spaces. For this reason, OSHA field personnel have frequently and strongly recommended the promulgation of a specific standard on confined spaces." In the document ***Criteria for a Recommended Standard .... Working in Confined Spaces***, the National Institute for Occupational Safety and Health (NIOSH) has provided comprehensive recommendations for assuring the safety and well-being of persons required to work in confined spaces including a proposed classification system and checklist that may be applied to different types of confined spaces.

CONCLUSIONS

The case studies described above are summarized in Table 1:

	DEATHS

CASE	DATE	TYPE OF SPACE	TYPE OF HAZARD	WORKER	RESCUER	TOTAL		COMMENT
#1	12/29/83	Sewage digester	Oxygen deficiency	1	1	2	---	
#2	3/8/84	Sewer line construction	Toxic atmosphere; physical hazard	1	1	2	38	others injured
#3	10/4/84	Fracturing tank	Oxygen deficiency	0	2	2	2	rescuers drowned
#4	12/5/84	Toluene storage tank	Toxic atmosphere; explosion;limited entry and exit	1	1	2	15	others injured
#5	5/13/85	Waste water tank physical hazard	Toxic atmosphere;	1	1	2		Rescuer died two weeks later
#6	6/7/85	"Spent" acid storage tank	Toxic atmosphere	0	1	1		Rescuer was father of worker
#7	7/2/85	Underground waterline, valve area	Toxic atmosphere	1	0	1		Worker died of acute liver failure; an other worker ill bu t recovered
#8	7/2/85	Sewage pumping station	Physical hazard; toxic atmosphere	1	3	4	2 2	died of drowning; of asphyxiation
			TOTALS	6	10	16	53	OTHERS INJURED

Based on the information derived from these case studies, NIOSH concludes that these fatalities occurred as a result of encountering one or more of the following potential hazards:

- lack of natural ventilation,
- oxygen deficient atmosphere,

- flammable/explosive atmosphere,
- unexpected release of hazardous energy,
- limited entry and exit,
- dangerous concentrations of air contaminants,
- physical barriers or limitations to movement, or
- instability of stored product.

In each of these cases there was a lack of RECOGNITION and TESTING, EVALUATION, and MONITORING prior to entry nor had a well-planned RESCUE been attempted.

These incident reports suggest that RECOGNITION of what is a confined space in conjunction with the proper TESTING, EVALUATION, and MONITORING of the atmosphere and development of appropriate RESCUE procedures could prevent such deaths. These three steps are discussed below.

NIOSH investigations indicate that workers usually do not RECOGNIZE that they are working in a confined space and that they may encounter unforeseen hazards. TESTING and EVALUATION of the atmosphere are typically not initiated prior to entry and MONITORING is not performed during the confined space work procedures. RESCUE is seldom planned and usually consists of spontaneous reaction in an emergency situation.

RECOMMENDATIONS

In light of findings to date regarding occupational deaths in confined spaces, NIOSH recommends that managers, supervisors, and workers be made familiar with the following three steps:

1. RECOGNITION

Worker training is essential to the RECOGNITION of what constitutes a confined space and the hazards that may be encountered in them. This training should stress that death to the worker is the likely outcome if proper precautions are not taken before entry is made.

2. TESTING, EVALUATION, AND MONITORING

All confined spaces should be TESTED by a qualified person before entry to determine whether the confined space atmosphere is safe for entry. Tests should be made for oxygen level, flammability, and known or suspected toxic substances. EVALUATION of the confined space should consider the following:

- methods for isolating the space by mechanical or electrical means (i.e., double block and bleed, lockout, etc.),
- the institution of lockout-tagout procedures,
- ventilation of the space,
- cleaning and/or purging,
- work procedures, including use of safety lines attached to the person working in the confined space and its use by a standby person if trouble develops,
- personal protective equipment required (clothing, respirator, boots, etc.),
- special tools required, and
- communications system to be used.

The confined space should be continuously MONITORED to determine whether the sphere has changed due to the work being performed.

3. RESCUE

RESCUE procedures should be established before entry and should be specific for each type of confined space. A standby person should be assigned for each entry where warranted. The standby person should be equipped with rescue equipment including a safety line attached to the worker in the confined space, self-contained breathing apparatus, protective clothing, boots, etc. The standby person should use this attached safety line to help rescue the worker. The rescue procedures should be practiced frequently enough to provide a level of proficiency that eliminates life-threatening rescue attempts and ensures an efficient and calm response to any emergency.

OTHER HELPFUL PUBLICATIONS BY NIOSH

NIOSH has published the following documents which contain further information:

Criteria for a Recommended Standard .... Working in Confined Spaces, DHEW Publication No. 80-106.

Guidelines for Controlling Hazardous Energy During Maintenance and Servicing, DHHS Publication No. 83-125.

We ask that editors of appropriate trade journals and safety and health officials (i.e., inspectors, managers, and hygienists, especially those associated with work in confined spaces) bring these recommendations to the attention of workers, supervisors, managers, and owners.

Requests for additional information on control practices or questions related to this announcement should be directed to Director, Division of Safety Research, National Institute for Occupational Safety and Health, 1095 Willowdale Road, Morgantown, West Virginia 26505,Telephone, (304) 285-5894; or call 1-800-35-NIOSH (1-800-356-4674).

We greatly appreciate your assistance.

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