Technical Information Bulletin

U.S. Department of Labor
Occupational Safety and Health Administration

Exposure to Hazards Associated with Temporary Enclosures

TIB 02-05-30

Preface

The U.S. Chemical Safety and Hazard Investigation Board (CSB) reported[1] an incident involving the asphyxiation death of one employee and injury of another while working in a temporary enclosure. The enclosure was created by employees temporarily covering an open piping system that contained hazardous concentrations of nitrogen. Among other recommendations, the CSB recommended that the Occupational Safety and Health Administration (OSHA) "issue a safety alert that addresses the hazards and provides safety guidelines for the use of temporary enclosures that are erected around equipment containing hazardous substances."

The Occupational Safety and Health Administration (OSHA) issues Technical Information Bulletins (TIBs) to provide information about occupational hazards and/or to provide information about noteworthy, innovative, or specialized procedures, practices, and research that relate to occupational safety and health. These bulletins are not standards or regulations and they create no independent legal obligations. They are advisory in nature, informational in content, and are intended to assist employers in providing a safe and healthful workplace.

Further information about this bulletin may be obtained by contacting OSHA's Directorate of Technical Support at 202-693-2095.

Purpose

The purpose of this Technical Information Bulletin is:

- To alert users that hazardous substances may be contained inside enclosures that are in contact with, or proximate to, equipment that has the potential to contain or generate hazardous atmospheres. Employers and employees should be aware of, and manage, hazards related to temporary enclosures;
- To provide guidance with respect to identifying and managing the hazards of such temporary enclosures;
- To provide recommendations for all employers that use such temporary enclosures; and
- To provide a link to the OSHA website for an electronic presentation related to this Technical Information Bulletin.[2]

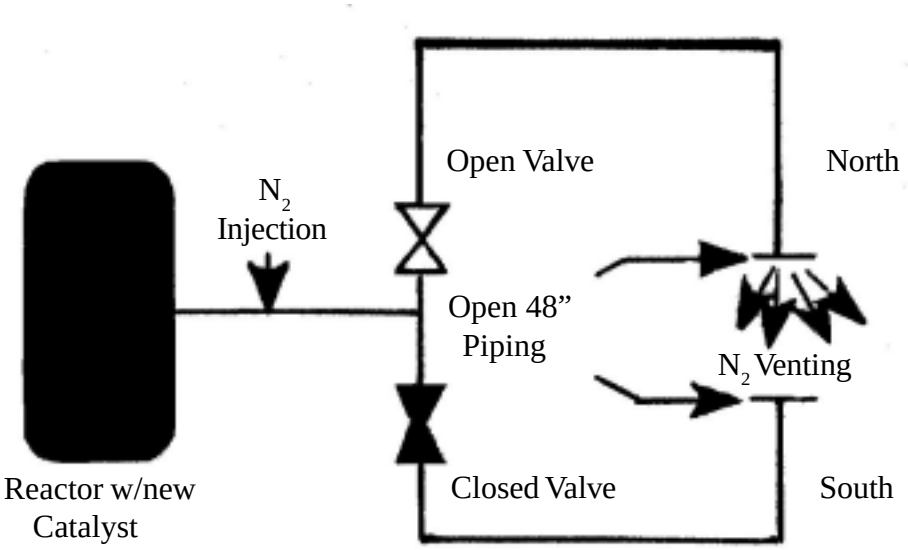
Background

During a turnaround[3] operation at a chemical process facility, two workers were overcome by nitrogen gas (N_2). The employees were inspecting the flange surfaces of an open 48-inch pipe system (Figure 1) around which a temporary enclosure had been built by the workers to facilitate the inspection. A piece of process equipment had been removed from the pipe system for cleaning,

[1] CSB report, *Summary Report, Nitrogen Asphyxiation (1 Death, 1 Injury), Union Carbide Corporation, Hanville, Louisiana, March 27, 1998, Report No. 98-05-I-LA*, issued March 1999. Those wishing to obtain a copy of the CSB report may access the following website: http://www.csb.gov/reports/1998/union_carbide/98005lafr.htm.

[2] There are two different links to this presentation. The shorter version of the presentation does not include electronic photos of the incident scene. It will download faster. The second link allows access to the complete presentation, including a photo of the incident scene. There is no other difference between the presentation files. The short presentation is designed to be used as a training tool for employees and first-line supervisors who may be exposed to the hazards of confined spaces in relation to temporary enclosures. It contains informational "notes" to aid the speaker during the presentation to employees.

[3] A "turnaround" is a major planned shutdown for maintenance and inspection activities at chemical/refining facilities.



Note: Actual process/piping significantly more complex. N_2 injection point 150' and several stories in elevation from pipe opening.

Figure 1- Process Piping System

leaving the 48-inch piping system with two flanged openings. Upstream from both sides of the open pipe, N_2 was injected into the pipe system to protect a newly installed catalyst from moisture-containing air and to protect the process piping from the corrosive effects of moisture (see diagram above). The gas collected in the temporary enclosure, and the employees were overcome when they were performing inspection of the pipe flange inside the enclosure.

The addition of N_2 to the process occurred the night before the two employees began the inspection of the two open 48-inch pipe flanges. The piping and valve configuration were such that the N_2 was venting through the north end of the open 48-inch pipe; there was no N_2 flowing through the south end of the opening because the valves upstream from that opening were closed.

The injection of N_2 and its movement into the opening in the piping system was not as simple as is shown in the diagram. Like many chemical/refinery processes, this process consisted of a complex interconnected piping system. In this instance, the N_2 injection point was approximately 150 feet from, and several stories above, the open pipe. Even though one of the workers involved in the incident reportedly directed operations to inject the N_2 into the system on the evening before the incident, the complexity of the piping system may have produced a situation in which (1) the worker inadvertently failed to close the valve to the north end of the open 48-inch pipe; (2) the worker failed to recognize that the process configuration would allow N_2 to reach the open pipe location; (3) the worker may have forgotten that N_2 was in the process; or (4) failed to recognize the hazard associated with a N_2 atmosphere.

As the pipe flanges needed to be free of grease, oils, and other organic chemicals, a black light was used because organic residue will readily shine when viewed with a black light. Because the flange inspection was to be conducted at midday and the sunlight would make it difficult to find any organic residues, the workers used a black plastic tarp to shield the pipe flanges from sunlight. The placement of the black tarp created an enclosure (the CSB termed this to be a "temporary enclosed space"). The workers successfully performed inspection on the southern portion of the pipe flange because the closed valving blocked the flow of N_2 to that flange. However, when the enclosure was moved to allow inspection of the northern portion of the pipe flange, N_2 flowed into the enclosure because the valving between the injection point and the north flange opening was open. When the two workers were conducting the inspection of the pipe flange inside the enclosure, they were overcome by oxygen deficiency. One of the workers died of asphyxiation, and the second worker was severely injured.

Description of the Hazards Related to Enclosures Around Equipment

In the chemical processing industry, many types of hazards may be present in enclosures/confined spaces. These hazards can include the following:

Oxygen deficiency	Engulfment
Toxic Atmosphere	Flammable atmosphere
Trapping/Pinch Points	Oxygen enrichment
Mechanical hazard	Temperature extremes
Electrical shock	Chemical exposure
Slips, Trips and Falls	Physical hazards
Thermal hazards	Unstable working surface
Structural failure	

Enclosures can contain hazardous atmospheres. In some instances, the enclosure might not even be in physical contact with equipment, but could be near enough to contain hazards. For example, equipment, such as piping, which is in contact with or near an enclosure, might either inadvertently, or by design, generate hazardous atmospheres inside these enclosures. According to the CSB, "temporary enclosures erected around tanks, vessels, pipes, or similar equipment that contain hazardous material may trap a dangerous atmosphere if the equipment leaks or vents substances, such as nitrogen, into the enclosure."

Enclosing equipment, which contains hazardous substances, may create hazardous confined spaces. These enclosures have the potential to be *permit-required confined spaces* as defined by OSHA's standard on *Permit-Required Confined Spaces, Title 29 of the Code of Federal Regulations* Part 1910.146. OSHA defines a *confined space* as a space that (1) is large enough and so configured that an employee can bodily enter and perform assigned work; (2) has limited or restricted means for entry or exit - e.g. tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry; and (3) is not designed for continuous employee occupancy. OSHA further defines a *permit-required confined space* as a *confined space* that has one or more of the following characteristics: (1) contains or has a potential to contain a hazardous atmosphere; (2) contains a material that has the potential for engulfing an entrant; (3) 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 (4) contains any other recognized serious safety or health hazard.

Nitrogen cannot be detected by human senses. High concentrations of N_2 become particularly dangerous because workers may not be able to recognize physical or mental symptoms of overexposure. When N_2 displaces air/oxygen in an enclosure/confined space, high concentrations of N_2 result in lower concentrations of oxygen. The table below details human responses to oxygen-deficient atmospheres.[4]

Atmospheric Oxygen Concentration [%O_2]	**Possible Results**
19.5	OSHA minimum requirements for worker protection
8 - 10	Unconsciousness without warning and so quickly that individuals cannot help or protect themselves
6 - 8	Fatal injury in less than 6 minutes
4 - 6	Coma in less than 40 seconds with subsequent death

In this case, the N_2 acted as an asphyxiant. The two workers in the enclosure did not recognize that they were in trouble and therefore, did not attempt to leave the enclosure or to seek help.

[4] Compressed Gas Association; SafetyBulletin SB-2 (1992)

Conclusions

When work is to be performed in any type of enclosure or *permit-required confined space*, the following considerations are relevant:

1. Where a *permit-required confined space* exists, employers must follow 29 *CFR* 1910.146. Among the requirements of this standard, employers must include training for supervisors, employees, contract employees and other personnel to alert them to the specific hazards that can be created during the use of these temporary enclosures.
2. Temporary *permit-required confined space*s must be addressed by the employer's *permit-required confined space program*. Temporary enclosures are most often created during maintenance and construction activities.
3. Some enclosures in general industry workplaces may not meet OSHA's regulatory definition for a "confined space." In these instances, OSHA recommends that employers follow the *permit-required confined spaces* requirements to the extent practicable whenever employees otherwise would be exposed to hazards that may cause death or serious injury. In addition, other OSHA standards, such as 29 *CFR* 1910.134, *Respiratory Protection,* may apply to confined spaces and enclosures, including temporary enclosures. As it relates to this incident, all oxygen-deficient atmospheres must be considered *immediately dangerous to life or health*, and 29 *CFR* 1910.134 applies. This standard requires the employer to develop and implement a written respiratory protection program, which must address, among other things, respirator selection and emergency rescue procedures, along with respirator-related employee training. Please see OSHA's website at:http:/www.osha-slc.gov/Osh.Std_data/1910_0134.html for the complete text of the *Respiratory Protection* standard (not including appendices).
4. Hazards such as oxygen deficiency, toxic atmospheres, and flammable atmospheres that may exist in enclosures deserve particular attention. The flow of purge gas, such as nitrogen, into a process system has the potential to create a hazardous atmosphere inside equipment/enclosures that are in contact with or near processes. The recognition and effective management of hazards associated with temporary enclosures should be conveyed through the company confined space program and other employee training programs. For enclosures that are OSHA defined *permit-required confined space*, all training must be provided to employees when mandated by applicable OSHA standards—i.e., 29 *CFR* 1910.146 and 1910.134.

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