



Union Carbide Nitrogen Asphyxiation

Hahnville, Louisiana March 27, 1998

On March 27, 1998, one worker was killed and another severely injured when they were asphyxiated by nitrogen, an odorless gas that was venting through the large open pipe where the men were working at Union Carbide's Taft/Star plant in Hahnville, Louisiana.

The Taft plant manufactures industrial chemicals, and the accident occurred in the plant's ethylene oxide production unit. The ethylene oxide unit was undergoing a major main-



Large open pipe end where the two victims were working



tenance project, in which some process equipment had been temporarily removed. The equipment removal left the pipe connected into the process unit but open to the air at one end. The two victims, both skilled and experienced workers, were inspecting the inside of the 48-inch open pipe end to gauge the effectiveness of an earlier cleaning effort. While the men worked, nitrogen gas was being used to purge air and moisture from the unit, protecting the chemicals inside.

During their inspection of the inside of the pipe, the two workers used a black light, which causes grease, oil, and other contaminants to glow in the dark. But the midday sun would make it difficult to see, so the workers asked two con-

tractors to hold a black plastic sheet over the open pipe end while they crouched just inside. Unknown to any of the workers, the plastic sheet created a dangerous enclosure where nitrogen gas could accumulate, displacing oxygen and causing asphyxiation.

The two contract workers holding the sheet became concerned when they had not heard from the workers inside for some 15 minutes. When there was no response to their calls, they pulled the sheet away and found one worker unconscious and the other in a daze. The first worker was pronounced dead on arrival at a hospital. The second man was hospitalized in critical condition but survived.

The U.S. Chemical Safety Board investigated the accident and found that inadequate confined-space warnings and entry procedures were at the root of the tragedy.

DANGERS OF TEMPORARY CONFINED SPACES

A confined space is defined by the U.S. Occupational Safety and Health Administration (OSHA) as a space that is large enough for a person to enter, has limited means for entry or exit, and is not designed for continuous occupancy. When workers temporarily enclosed the open pipe end, they in effect created a confined space. Federal regulations as well as good practice require various safety measures for entry into such spaces. There are particular requirements for those confined

DANGERS OF NITROGEN

The air we breathe normally contains 78% nitrogen and 21% oxygen. As nitrogen is added to air, it displaces oxygen. When the oxygen concentration drops from 21% to 16%, pulse and breathing rates drop, and mental functions are impaired. Below 14%, people suffer abnormal fatigue, emotional upset, poor judgment, and faulty coordination. Further reductions result in nausea, vomiting, permanent heart damage and loss of consciousness. At about 5% oxygen or below, a person will fall into a coma within 40 seconds, requiring emergency administration of oxygen to have any chance of survival.

spaces where it may be unsafe to breathe, such as air monitoring and the issuance of a written permit identifying the expected hazards and needed precautions.

Although the Union Carbide plant did have procedures for entering confined spaces, CSB found that these procedures did not generally cover temporary enclosures like the one in this case. No permit was issued prior to the workers' entry into the enclosure, nor were any precautions taken to protect the men from the risk of asphyxiation.

NITROGEN HAZARDS NOT RECOGNIZED

Even though one of the two victims had directed the nitrogen purging operation the evening before, apparently he did not realize that dangerous amounts of nitrogen were flowing through open valves to the pipe end where the incident occurred — some 150 feet and several floors away from the source of the nitrogen.

The CSB investigation report noted that it is important to look beyond an immediate task and anticipate secondary hazards that may not be obvious. In this case, operators did not evaluate the risks caused by the nitrogen purge to the workers downstream, and hazards at the open pipe end were not recognized. The investigation concluded that a hazard evaluation likely would have led operators to post warning signs at the pipe opening and prevented the accident.

After the accident, managers said they did not know that the workers were going to perform a black light inspection of the pipe, which led to the creation of a temporary enclosure. However, the CSB found that the open pipe end itself presented a hazard, and any worker who simply leaned into the open pipe could have been overcome, depending upon the wind and other conditions.

ODORLESS GAS POSES RISKS

The CSB investigation noted that humans cannot detect excess levels of nitrogen because the gas is invisible, odorless and tasteless. Natural gas and propane also lack a natural odor, but a chemical odorant is added to these gases to warn of their presence in the air. The odor warning is used along with other safety measures to prevent accidents involving these gases. In the Union Carbide case, the CSB found that if nitrogen had been odorized, the workers prob-

ably would have realized they were in danger before it was too late. Odorizing nitrogen would provide an extra measure of safety, the CSB determined, in addition to appropriate confined space procedures, hazard evaluations and warning signs.

RECOMMENDATIONS

On February 23, 1999, the CSB issued several safety recommendations designed to prevent similar accidents.

To the Union Carbide (now Dow Chemical) Taft Plant:

The CSB recommended that the plant modify its safety program to better control the hazards associated with temporary enclosures. Whenever tanks, pipes or other pieces of equipment are opened, the plant should post warning signs stating "Danger, Confined Space: Do Not Enter without Authorization." In cases where nitrogen is added to a confined space, an additional warning sign should be used.

To the National Institute for Occupational Safety and Health (NIOSH):

The Board requested that NIOSH conduct a study concerning the feasibility of odorizing nitrogen to warn personnel who work around potentially hazardous confined spaces.

To the U.S. Occupational Safety and Health Administration (OSHA):

The CSB recommended that OSHA issue a safety alert providing guidelines for temporary enclosures that are erected around equipment containing hazardous substances.

CSB STUDY FINDS MANY NITROGEN-RELATED DEATHS

In 2003, the CSB issued a Safety Bulletin drawing attention to the ongoing problem of nitrogen asphyxiation. Nitrogen asphyxiation caused 80 deaths and 50 injuries in industrial settings between 1992 and 2002, the bulletin said. Deaths and injuries occurred at chemical plants, food processing facilities, laboratories, medical facilities and other sites. The majority of incidents occurred during work in or near confined spaces, and many incidents were caused by the failure to detect an oxygen-deficient environment. The Safety Bulletin identified a number of good safety practices to prevent nitrogen-related injuries, including comprehensive worker training programs, warning systems, continuous ventilation, atmospheric monitoring and planning for emergency rescue operations. Copies of the bulletin are available from the CSB website, www.csb.gov.

NOTICE:

The CSB is an independent federal agency charged with investigating industrial chemical accidents and hazards. The CSB determines the root causes of accidents and issues safety recommendations to industry, labor, and other government agencies. CSB Investigation Digests are not intended to substitute for the official, Board-approved reports, which can be obtained from the agency's web site, www.csb.gov. The web site also has complete, up-to-date information on the implementation status of all CSB safety recommendations. Comments or suggestions, please write to info@csb.gov.