



# Environment, Safety and Health Bulletin

## Hazards of Nitrogen Asphyxiation in Confined Spaces

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**Special Operations Reports** are issued to initiate management actions in response to events whose subject matter represents significant Departmental safety concerns.

**Environment, Safety and Health Alerts** are issued to initiate immediate action on potentially significant safety issues.

**Environment, Safety and Health Bulletins** are issued to share information and recommend actions on potential safety issues.

**Safety Advisories** are issued to provide information to the DOE Complex on potentially significant safety or health issues.

### PURPOSE

This Safety Bulletin is being issued to alert readers to the potential hazard of nitrogen asphyxiation following the November 6, 2005, fatality of two contractor maintenance workers at the Valero Energy Corporation's Delaware City, Delaware refinery.

Nitrogen gas, inert under most conditions, is widely used as a barrier to prevent unwanted reactions with oxygen or water. Most people are aware that breathing air contains about 78 percent nitrogen. However, higher concentrations of nitrogen in air replace necessary oxygen, and can cause physiological problems, coma, and death.

Section 146 of the OSHA Standard for General Industry (29 CFR 1910) requires employers to evaluate workplaces to determine if any spaces in which their employees will be working are confined spaces necessitating a permit. Examples of atmospheres that require a permit include:

- those having an oxygen concentration equal to or less than 19.5 percent;
- those having an oxygen concentration equal to or greater than 23.5 percent;
- the presence of toxic gases in concentrations equal to or less than the 8-hour time-weighted average for the gas; or
- the presence of explosive or flammable gases equal to or greater than 10 percent of the lower flammable limit.

### BACKGROUND

The U.S. Chemical Safety Board (CSB) is investigating the accident at the Valero refinery. Preliminary information indicates that the two workers were reattaching piping to a process vessel while performing maintenance activities.

Because the vessel contained a catalyst that is sensitive to oxygen and moisture, the vessel was filled with a nitrogen blanket to prevent moisture from reaching the catalyst.

Investigators believe that one of the workers became disoriented, passed out, and fell into the vessel after he breathed nitrogen near the manhole on top of the vessel. Witnesses stated that one worker appeared to fall into the vessel while reaching inside. The second worker then entered the vessel, most likely trying to save his coworker. Both workers died from nitrogen asphyxiation. At this time, it is not known whether or not the two workers were aware that the vessel contained nitrogen. A Valero spokesperson stated that the workers were authorized to work near, but not in, the vessel, explaining that personal protective equipment, including breathing apparatus, would have been required.

In June 2003, the CSB issued a [Safety Bulletin](#) on the hazards of nitrogen asphyxiation. The Board's study identified 85 incidents involving nitrogen in the United States between 1992 and 2002 that resulted in 80 deaths and 50 injuries. Almost half of the incidents involved contractors, who accounted for more than 60 percent of the fatalities. The main causes were failure to detect nitrogen-enriched atmospheres, mistaking nitrogen gas for breathing air, and being inadequately prepared for rescue efforts.

### IMPLICATIONS

Breathing oxygen-deficient air can have immediate, life-threatening effects. Rescuers should never attempt to rush into an oxygen-deficient space to retrieve fallen workers without first connecting to a supplied breathing air source.

### RECOMMENDED ACTIONS

Facility managers should ensure that their personnel know how to work safely in the presence of nitrogen, particularly in confined spaces where they can be quickly overcome.

Questions concerning this Safety Bulletin should be directed to Tom Williams by telephone at (301) 903-4859 or by e-mail at [thomas.e.williams@eh.doe.gov](mailto:thomas.e.williams@eh.doe.gov).

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# PREVENT EVENTS

## Learning from Industry Experience

**PREVENT EVENTS is intended for use by personnel during morning meetings, pre-job briefings, and work unit meetings to communicate key industry experience.**

### Management

1. In areas where liquid or gaseous nitrogen are used, are there processes for continuously monitoring oxygen levels and alerting workers of oxygen levels less than 19.5 percent?
2. Does our process for work in confined spaces include a provision for placing a trained, equipped worker nearby to observe, communicate with, and, if necessary, retrieve overcome workers?
3. Do we flow down our safety expectations for working in confined spaces or potential oxygen-deficient atmospheres to subcontractors?
4. Do we have positive controls in place to prevent other workers from inadvertently coming into confined or oxygen-deficient spaces?
5. Are our existing confined spaces appropriately placarded?

### Training

1. Are our training programs for the correct usage of personal protective equipment and ventilating work areas sufficiently comprehensive?
2. Does our training program for confined spaces include a discussion about how temporary confined spaces can be inadvertently established by, for example, hanging a temporary barrier over an opening?
3. Is there a provision for annual refresher training for confined-space workers?

### Individual Worker

1. Do I understand what constitutes a confined space, and do I know how to work safely in one?
2. Do I use appropriate PPE (self-contained breathing apparatus, backup breathing air supplies) when working around nitrogen gas?
3. Do I use the "buddy system" when entering a confined space?
4. Do I know to stop work if I see a potentially dangerous situation?
5. Do I understand the procedures for worker retrieval should a worker lose consciousness while working in a confined space?

