# Safety Snippet: Nitrogen Asphyxiation Safety

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## Overview

*Nitrogen under standard conditions is a colorless, odorless, inert gas. It is frequently used in manufacturing and industrial processes to purge them of any contaminants, such as corrosives, toxic chemicals, or flammables. While nitrogen gas itself is non-toxic and abundant in the atmosphere, it can pose particular risks to personnel safety. Areas where nitrogen is in use can quickly become deprived of oxygen due to its ability to displace the existing air. Once oxygen levels decrease the human body suffers various debilitating effects, making response difficult. The chart below depicts the effects of different oxygen concentrations in the body.*

| Atmospheric Oxygen Concentration | Possible Effects |
|---|---|
| 20.9 | Normal |
| 19.0 | Unnoticeable physiological effects. |
| 16.0 | Raised pulse, breathing rate. Impaired thinking, attention, and coordination. |
| 14.0 | Poor judgment and coordination, Irritability, and heavy fatigue. |
| 12.5 | Nausea, vomiting with heavily impaired coordination, judgement and respiration. Possibility for permanent heart damage. |
| <10 | Loss of consciousness, convulsions, death. |

Source: Compressed Gas Association, 2001

While confined spaces are easier to deprive of oxygen than larger enclosures or open environments, the hazards of nitrogen asphyxiation are not limited to confined spaces. Often times, the area near the openings of confined spaces can be at risk of developing a lower oxygen environment. Incidents of nitrogen asphyxiation have also occurred inside of buildings or even outdoor near equipment where nitrogen is used.

**Causes of Incidents:**
A number of causes have been isolated by the U.S. Chemical Safety Board (CSB) as being common to nitrogen asphyxiation events.

1. **Failure to detect oxygen deficient environments.** Over 60% of CSB recorded nitrogen asphyxiation events involved a failure to detect a deficiency of oxygen in or near an enclosed space.

## In This Issue

Hazards associated with nitrogen asphyxiation are discussed along with recommended practices for safe confined space entry and safe work practices.

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https://www.NebulaSafety.com

**Causes of Incidents:**

2. **Using nitrogen in place of breathing air.** Nitrogen has been mistakenly used in place of breathable air in a number of asphyxiation incidents, often due to confusing the supply lines because they have interchangeable couplings and poor labeling.

3. **Inadequate rescue preparation.** Around 10% of observed cases of nitrogen asphyxiation fatalities occurred due to improper rescue practices. It is important to have rescue training practices in place to prevent further incidents during rescue attempts.


**Valero Refinery Delaware City**

On November 5th, 2005, a fatal incident occurred when two workers entered a reactor vessel filled with nitrogen gas. Maintenance was being performed on the vessel and as a part of this work, a pipe elbow was removed from the top of the reactor vessel. The resulting opening was covered with plywood and plastic and surrounded by steel bolts wrapped with red tape. One worker noticed a roll of duct tape had fallen into the open reactor and, in an attempt to save time, likely either sat on the edge of the opening or entered the reactor without obtaining the required confined work permit. He then succumbed to the nitrogen rich environment and lost consciousness. The foreman then entered the reactor in an attempt to help the employee, but he also suffered asphyxiation upon entry.

The following recommendations were made by the CSB:

- Warning signs and barriers should be used to designate confined spaces
- Any personnel attempting rescue must be trained in and follow confined space entry procedures
- API should revise their guidelines for safe work in inert confined spaces to highlight the ability for oxygen deficient environments to form outside the opening of confined spaces

## Chemical Safety Board Good Practices for Safe Handling of Nitrogen:

**Monitoring and Alerts**
Continuous monitoring systems should be in place to detect toxic, explosive, or oxygen-deficient atmospheres, and adequate alarms, including flashing lights and unique audible alarms. Personnel oxygen monitors can help ensure safety throughout a facility as atmospheres are prone to change over time.

**Ventilation in Enclosed Areas**
A properly designed and sized ventilation system should be in place to provide continuous, forced fresh air during any operation requiring entry into an enclosed space. The ventilation system should also include an alarm system to alert personnel upon failure.

**Safe Retrieval/Rescue Plan**
Adequate training and equipment should be provided to all personnel performing work in enclosed spaces that allows for the rescue or retrieval of the individual in the event of an emergency. This equipment includes a lifeline along with a body harness, wristlet, or anklets. Any work that requires this equipment should be monitored by personnel trained in and equipped for rescue.

# Chemical Safety Board Good Practices for Safe Handling of Nitrogen:

**Uninterrupted Flow of Breathable Air**
Breathable air supply should be constantly monitored for flow and composition, with backup systems in place to account for loss of power or failures in the air supply line. Personnel should also carry an emergency escape breathing apparatus

**Prevent Mixing of Cylinders**
Personnel should be trained on the different cylinders stored and handled at a facility. This includes the difference in fittings and adaptors, and the reasons for their differences, along with the labeling and color-coding systems used for identifying cylinders.

**Training**
Employers should provide good hazard communication to affected personnel and all personnel involved in confined work should be trained in the proper use of ventilation, air monitoring and supply systems, safe practices for entering and retrieval in confined space, and the dangers of nitrogen enriched environments.

Figure 1: LIFE SoftPac Emergency Portable Oxygen Unit.


**Additional Resources:**

American Petroleum Institute
API RP 2217A – Provides best practices for working safely in inert confined spaces within the petroleum and petrochemical industries.

Compressed Gas Association
CGA G-10.1: Commodity Specification for Nitrogen - Contains data for sampling, analytical procedure, monitoring, typical uses, and other specifications for nitrogen.

Reach out to the Nebula Safety & Environmental Team at NebulaSafety.com for additional information.
Additionally, Nebula Safety can conduct a gap analysis for your facility to identify applicable deficiencies and opportunities for improvement.

References:

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