Nitrogen use and Hazard Controls in the Tank Truck Industry

By design, transportation equipment is handled by multiple people working for different organizations with different equipment and work rules. Transportation workers are often the members of the supply chain community who have the most physical contact with materials shipped and the containers in which they are transported. Common activities include

- Loading product into and out of containers
- Cleaning and inspecting containers
- Performing maintenance on containers

Transportation workers must always assume that any confined space (such as a tank trailer or rail car) may contain nitrogen or chemical vapors from the product being hauled, and the tanker’s interior cannot be entered and/or the plane of the access door or hatch should not be entered without specific training, approved work processes, evaluations of the atmosphere have been completed/documented, appropriate equipment is provided based on the tasks and management has a process to verify the program and policies are being followed and equipment is being used as intended and designed by the manufacturer.

Employers should:

- Have formal programs to address the exposures to nitrogen used when transporting food grade, chemical or other products
- Have awareness training for those that work around tankers to understand the potential risks even if you do not use, haul, load or unload tankers with nitrogen blankets
- Apply the same confined space practices to tankers that you do other confined spaces
- Know and comply with regulations and best practices for confined space entry
- Have a confined space rescue program as part of your confined space entry program and practice the entry and rescue protocols to verify management and employees will respond as they should in the event of an emergency
- Audit your programs and practices to verify your policies are enforced by management and you have maintained documentation of your programs, policies, training, audits and enforcement efforts

Workers should:

- Understand and comply with your company policies on confined space entry
- Assume the atmosphere within the tanker is hazardous until atmospheric testing proves it is safe to enter
- Never lean into a tanker (i.e. break the plane of any access hatch or door) for inspection assuming entering the tanker and just leaning in are different acts.
your head enters the space, you could become incapacitated because of an inert or hazardous environment inside the tanker.

- Know and follow confined space rescue protocols if a rescue is needed

**What is Nitrogen and why is it a Hazard?**

Nitrogen is a colorless, odorless and tasteless gas that makes up around 78% of the earth’s atmosphere. Nitrogen is not typically hazardous but must be mixed with the proper concentration of oxygen to be safe to breath. When nitrogen concentrations become too high, such as in environments that are enriched with nitrogen, insufficient oxygen is available to support life. These two gases cannot be detected by the sense of smell. A nitrogen enriched environment, which depletes oxygen, can be detected only with special instruments. If the concentration of nitrogen is too high (and oxygen too low), the body becomes oxygen deprived and asphyxiation occurs.

**Why is nitrogen used in the tank truck industry?**

*Moisture Control*- Many liquid chemical products are negatively affected by moisture. Some products are considered contaminated if they are exposed to moisture. Some trailers loaded with liquid chemicals sensitive to moisture are padded with a “nitrogen blanket” after loading. Nitrogen blankets (a layer of nitrogen gas) sits on top of liquid product in the tanker. Nitrogen blankets are used to control dew point and reduce the load’s exposure to moisture.

*Reducing the risks associated with flammable or combustible materials*- In most cases, three elements are required to have a fire: a heat source, fuel and oxygen. Nitrogen is used to replace oxygen inside transportation containers to reduce the risk of fire or an explosion. Some flammable/combustible materials are unloaded with nitrogen. The following methods may be used to get product out of a tank trailer by pumping, pressure (air, nitrogen or other inert gas) and possibly a combination of two or more gases.

Trailers are commonly pressurized with nitrogen, to be sure the trailer does not have any leaks. This may be done for flammable or non-flammable materials. Trailers may be pressurized with nitrogen before, during or after loading.

A nitrogen blanket may also be used to eliminate oxygen from the head space in a tanker or rail car to prevent oxidation or reaction of the chemical contents with the oxygen normally present in air.

*Transloading of product from rail to truck or truck to truck*- Transloading occurs when product is transferred from one transportation container to another. This most commonly occurs from rail cars to highway tank trailers or vice versa. Product may be transferred (transloaded) from one tank trailer to another, or one rail car to another rail car. Transloading can also occur with intermodal containers. Nitrogen may be used to pressurize (move) product from one transportation container to another. Therefore, nitrogen may be present in a tank truck or rail car involved in transloading activities.

**Why is nitrogen a Hazard to Workers?**

Nitrogen is a significant hazard for multiple reasons. The physical properties as discussed previously do not allow a worker to sense the presence of elevated levels of nitrogen (or the absence of oxygen). This is one of the reasons workers have entered areas with low oxygen concentrations resulting from elevated nitrogen levels. This entry into a potentially hazardous atmosphere has happened as part of routine work or exceptions to normal activities when workers had an awareness of nitrogen hazards but did not expect a tanker to contain it.
When we breathe, humans inhale air containing oxygen and exhale air laden with carbon dioxide. Respiration (the act of breathing) is mainly controlled by carbon dioxide concentrations in the brain and arterial blood. Therefore, breathing is stimulated and controlled by carbon dioxide levels in the body. As the carbon dioxide levels increase the brain triggers an increase in respiration. When carbon dioxide levels drop the brain sends a signal to decrease respiration. Without adequate oxygen intake into the lungs, carbon dioxide is not generated to trigger the brain to have the body breathe normally and breathing can slow dramatically or stop. This is why workers that believed they could “hold their breath” and attempt a rescue can sustain fatal injuries. Without the stimulus to breathe, which is based on oxygen and carbon dioxide levels in the body, breathing stops. Without adequate oxygen levels in the body, a worker could lose consciousness and die.

**Which Types of workers are exposed to Nitrogen:**
Many workers in the tank truck industry can be exposed to nitrogen even when it is not obviously used or handled by their company. The workers include:
- Drivers
- Tank Wash Technicians
- Mechanics
- Shipper Product Loaders
- Receiver Product Unloaders
- Emergency Responders
- Transloaders

All workers should receive awareness training and have an understanding of policies related to tank entry and inspection. They must have job specific training for their regular jobs and any jobs they may assist with at a facility.

**What injuries have occurred when workers were exposed to oxygen deficient atmospheres due to high nitrogen levels:**
The U.S. Chemical Safety Board Bulletin mentioned in the resource section at the end of the paper stated the following:
Failure to detect an oxygen deficient (nitrogen-enriched) atmosphere was a significant factor in several incidents. In the data evaluated for this study, 67 of the 85 incidents involved circumstances where personnel were in or around a confined area—such as a railcar, room, process vessel, or tank (Figure 2)—and nitrogen was initially present in high levels or later collected in the area. These incidents accounted for 62 fatalities and 33 injuries. In each of the 67 incidents, personnel failed to detect elevated levels of nitrogen and take appropriate precautions.
One of the most difficult issues concerning hazardous atmosphere emergencies is the human instinct to aid someone in distress. Approximately 10 percent of fatalities from the CSB data were due to attempts to rescue injured persons in confined spaces. (OSHA and the CDC found a significantly higher % of fatalities were rescuers https://www.cdc.gov/niosh/docs/86-110/)

There have been other incidents in the tank truck industry where tank washers or mechanics entered tanks assuming it was safe and were not aware nitrogen had been used to move or transfer a previous load or as a blanket in the head space of the load. Entering the tank is an obvious hazard but drivers can also be exposed by leaning into an open dome lid when inspecting a tank. Drivers may not understand the same hazards can exist from leaning into an opening as those that exist when entering the tanker.

Is Tagging a Tank with a warning tag enough to Protect Workers
No, tags can be removed or not properly placed on a tanker that has contained nitrogen. Workers could believe a tank had not contained a nitrogen blanket and not take the proper precautions. Workers should assume a nitrogen enriched atmosphere exists until they prove entry is safe.

Why are written programs and policies related to rescue important
Many multiple death incidents involved rescuers. As discussed in the “Why is Nitrogen a Hazard to Workers” section workers cannot sense the presence of low oxygen levels caused by nitrogen displacing normal breathing air. Workers have gone into areas or confined space with the good intention of assisting a co-worker or contractor working in a facility. Because carbon dioxide triggers the brain to breath the rescuers lose conscientiousness quickly and multiple fatalities have occurred.

Written programs are just part of what a company should have in place to address confined space entry hazards in tankers. In addition to the program companies must have and document effective implementation and communication of the program. They must also verify that workers and management have and maintain a working knowledge of nitrogen hazards. The expectations for workers must address the imperative to prove an atmosphere is safe prior to entering it and that an attempt to rescue without proper training and equipment can have fatal consequences for both the incapacitated worker and the would-be rescuer.

How atmospheres should be evaluated for low oxygen levels due to excessive amounts of nitrogen:
The atmosphere inside a tanker must be evaluated prior to entering the tanker. The best practice would be multi-level evaluations of the tank prior to entry and monitoring near the workers breathing zone while in the tank. The recommended method would involve use of a four gas (oxygen, carbon monoxide, flammable vapor and toxic gas sensor, usually hydrogen sulfide) meter. Additional evaluations may be required depending on the prior contents. Tanks should only be entered after the cleaning process has occurred and the atmosphere should be considered hazardous until the evaluation proving the atmosphere is safe (i.e. completion of measurements on confirmed space entry permit and all program steps) has been completed.

What control programs should be in place to protect workers from the hazards of nitrogen use:
If your employees enter tanks for cleaning, loading, inspecting or other work you must have a formal confined space entry program. The program must meet the minimum requirements of Federal and State Department of Labor regulations. If your employees do not enter tanks for any
reason you must still have formal policies and training that clearly establish expectations that tanks will not be entered. Awareness training should be provided for drivers and others working around tanks so they understand the hazards of leaning into tankers that could potentially contain or have hauled loads with nitrogen blankets.

**Resources and Sources for Additional Information**

  [http://www.csb.gov/hazards-of-nitrogen-asphyxiation/](http://www.csb.gov/hazards-of-nitrogen-asphyxiation/) (Has a link to this report with a listing of resources and references at the end of the report)

- OSHA Confined Space Standard (other resource links on the OSHA site)  
  [https://www.osha.gov/SLTC/confinedspaces/](https://www.osha.gov/SLTC/confinedspaces/)  

- Confined space rescue teams [http://www.asse.org/assets/1/7/Thomas_Fireline.pdf](http://www.asse.org/assets/1/7/Thomas_Fireline.pdf)

- Truck Driver Dies While Cleaning Out Inside of Tanker in South Carolina – Nitrogen Blanket  
  [http://www.cdc.gov/niosh face/in-house/full8727.html](http://www.cdc.gov/niosh face/in-house/full8727.html)

- Two Railroad Repair Workers Asphyxiated in Damaged Tank Car – Nitrogen Blanket  
  [http://www.cdc.gov/niosh/stateface/ia/01ia021.html](http://www.cdc.gov/niosh/stateface/ia/01ia021.html)