



The University of Akron
College of Polymer Science
and Polymer Engineering

Office of Operations - Safety Office

LESSONS LEARNED

August 2019 – NMR LN₂ Fill accident

What happened?

While refilling the liquid N₂ in the magnet of the NMR, the pressure relief valve opened and N₂ gas began to encapsulate the small lab. Once the room's O₂ level decreased the O₂ alarm sounded. The researcher quickly turned off the valve to the dewar, ran out of the room and pulled the fire alarm. There is not a red emergency phone located near this lab. The N₂ gas filled the entire hallway from floor to ceiling displacing the O₂ in the area. The researcher quickly found the safety personnel and informed them of what had occurred. Safety personnel stopped access to the hallway to allow the N₂ gas to dissipate. The primary investigator arrived bypassing safety personnel's instructions and entered the potentially hazardous atmosphere and turned off the dewar completely. Full evacuation of the building was due to the fire alarm being pulled and was reset as quickly as possible to allow entry to the building. No injuries and no damage to the equipment.

Liquid N₂ gas is tasteless and odorless. It displaces O₂ which can cause humans to become unconscious in just a few breaths or asphyxiation leading to possible death.

Statistics on Nitrogen Asphyxiation from reported data for the United States, CSB identified 85 nitrogen asphyxiation incidents that occurred in the workplace between 1992 and 2002. In these incidents, 80 people were killed and 50 were injured. (*Chemical Safety Board, 2003*).



O₂ sensor monitors constant oxygen levels in the area. When O₂ drops below 19.5% the alarm is triggered along with blinking light.

What was the cause?

Accidental overfill of the NMR magnet reservoir which caused the relief valve to open dispersing the gas into the small lab. The O₂ alarm sounded and the researcher attempted to close the dewar valve without success before exiting the room. This is a procedure the researcher has performed several times. The researcher did everything correct notifying safety!

What went wrong?

- PI entered a potentially very hazardous atmosphere after being directed not to enter while the O₂ sensor was on alert.
- Researcher initially did not know what the alarm was in the lab.
- **No Standard Operating Procedures.**

What went right?

- Researcher immediately called for help via pulling the fire alarm. Did not re-enter the room for cell phone.
- Researcher was wearing cryogenic gloves during the transfer of LN₂.
- Researcher was able to provide safety pertinent information about the situation.

What corrective action was taken?

- Researcher is aware of the specific lab hazards after one on one discussion.
- A safety orientation for the lab will be developed.
- Standard Operating Procedures will be written with precautions, hazards and mitigation for LN₂ Filling of NMR.
- All new students will receive lab specific safety training prior to working with the NMR.

How can incidents like this be prevented?

- **NEVER ignore safety personnel's directions.**
- **Equipment damage NEVER supersedes life safety.**
- Lab specific safety training/orientation needs to be developed for every lab.
- Understanding the hazards of the specific lab.

References:

NASA deaths from LN₂ inhalation:

https://sma.nasa.gov/docs/default-source/safety-messages/safetymessage-2011-10-03-sts1prelaunchaccident-vits.pdf?sfvrsn=a6ae1ef8_4

NASA Lessons Learned contributing factors:

- Unclear and incomplete procedures
- Communication breakdown

Sheriff deputy death from LN₂ gas inhalation:

https://www.huffpost.com/entry/sheriff-dies-inhaling-liquid-nitrogen-at-sperm-bank_n_589958f0e4b09bd304bd468f

"Approximately 10 percent of fatalities from the CSB data were due to attempts to rescue injured persons in confined spaces." (Chemical Safety Board 2003)

