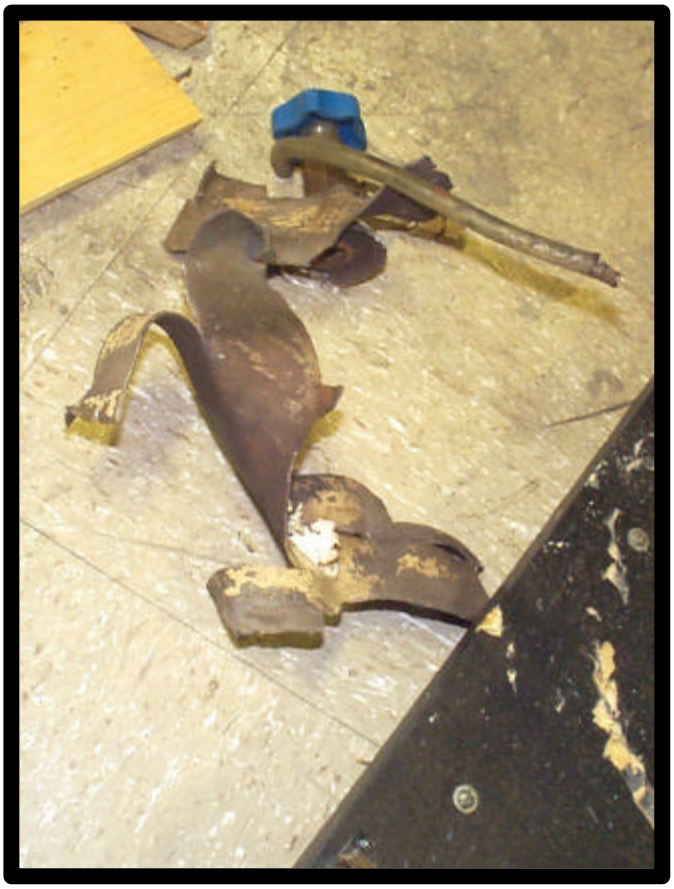
Ruptured Gas Cylinder Destroys Laboratory Hood at the University of Nevada

The Incident:

In September 2000, a steel lecture bottle located within a hood in a UNR laboratory ruptured with explosive force. The explosion occurred at night and no one was present in the laboratory at the time of the incident. There was, however, significant damage to the lab hood.

The gas cylinder contained methyl nitrite (CH_3ONO), which had been synthesized and transferred to the cylinder by a postdoctoral researcher who had left the lab approximately 45 minutes prior to the explosion. After the methyl nitrite was transferred to the cylinder it was left at room temperature in the hood. Although methyl nitrite is known to be explosive when heated or exposed to flame, these conditions were not encountered during the synthesis or storage. The cylinder had originally been used to ship iodotrifluoromethane (CF_3I) from the gas vendor, and most recently had been used to store nitrosyl chloride (ClNO).

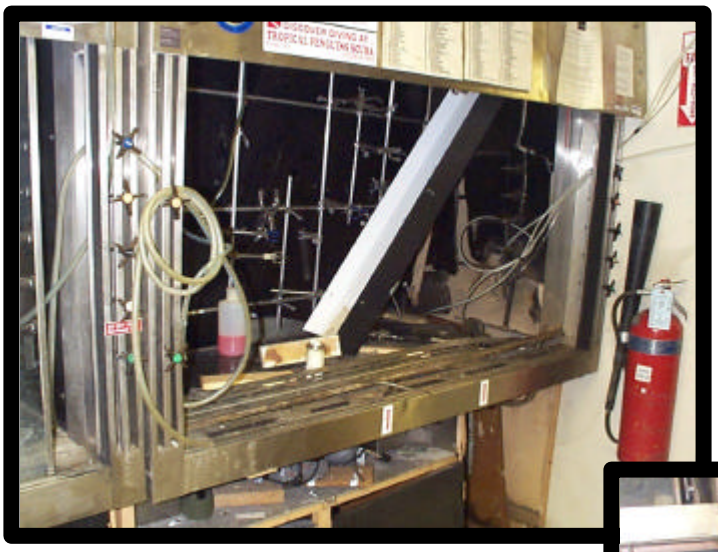


Ruptured Gas Cylinder

The Damage:

The gas cylinder containing the methyl nitrite ruptured violently, blowing the top cylinder cap off at the weld seam, and twisting the body of the steel cylinder. The cylinder was blown through the front sill of the lab hood, while the blast from the explosion shattered the hood sash, blew off the cabinet doors located underneath the hood, and destroyed the back and top of the hood. The force of the explosion even bent a metal support bracket used to secure utility lines located above the hood. Additionally, the blast produced a crack in an adjacent wall, just outside of the hood opening.

There were very few chemicals located either in the hood or in the cabinet underneath the hood, a fact that surely prevented a fire or significant chemical spill. Although it appears that there was a flash fire associated with the explosion, a sustained fire was probably prevented by the use of a flammable storage cabinet located away from the hood. The only chemical spill was an unknown quantity of ammonium hydroxide from a container that was broken by the blast. There was no free liquid remaining, indicating that the ammonium hydroxide volatilized and was captured by the hood, or surrounding cabinet materials absorbed the liquid. See additional photos of damage to the lab hood.



Damage to the lab hood and cabinet

The Cause:

Although the cause of the cylinder rupture is not known for sure, several contributing factors have been considered. The major suspicion is potential reaction between methyl nitrite and reactive residues in the cylinder. Although the cylinder was evacuated prior to introduction of the methyl nitrite, the cylinder had previously stored iodotrifluoromethane and nitrosyl chloride, both of which could have potentially caused internal corrosion of the cylinder. Another possibility is that small leaks in the cryogenic transfer system may have allowed liquid oxygen to be deposited in the cylinder. Mechanical failure of the cylinder simply due to the pressure of the methyl nitrite is not thought to be likely since the maximum expected pressure was calculated and found to be within the range commonly stored in these type of cylinders. The deformed condition of the cylinder remains also seem to indicate a more violent explosion than would be expected from a simple mechanical failure.

Lessons Learned and Recommendations:

Several lessons learned and recommendations were identified by the Principal Investigator, the Department Safety Committee, and EH&S.

1. The gas cylinder had been refilled with potentially corrosive gases.

Although steps were taken to evacuate the used gas cylinder, and high heat or pressure was not present, apparently the cylinder contained residues and reactive surfaces that initiated the chemical reaction that led to the explosion. *Never refill gas cylinders with highly reactive or corrosive compounds, including the original compound contained in the cylinder.*

2. The amount of methyl nitrite synthesized was far in excess of that required for the planned experiments.

Only a few grams of the methyl nitrite were required for the planned experiments; however, approximately 100 grams were synthesized. *Limit the amount of highly reactive, toxic, or flammable chemicals to the quantity necessary for planned experiments, or that will be used within a few months. Avoid the use of these compounds whenever possible.*

3. The procedure used to synthesize the methyl nitrite was modified slightly from the original published procedure.

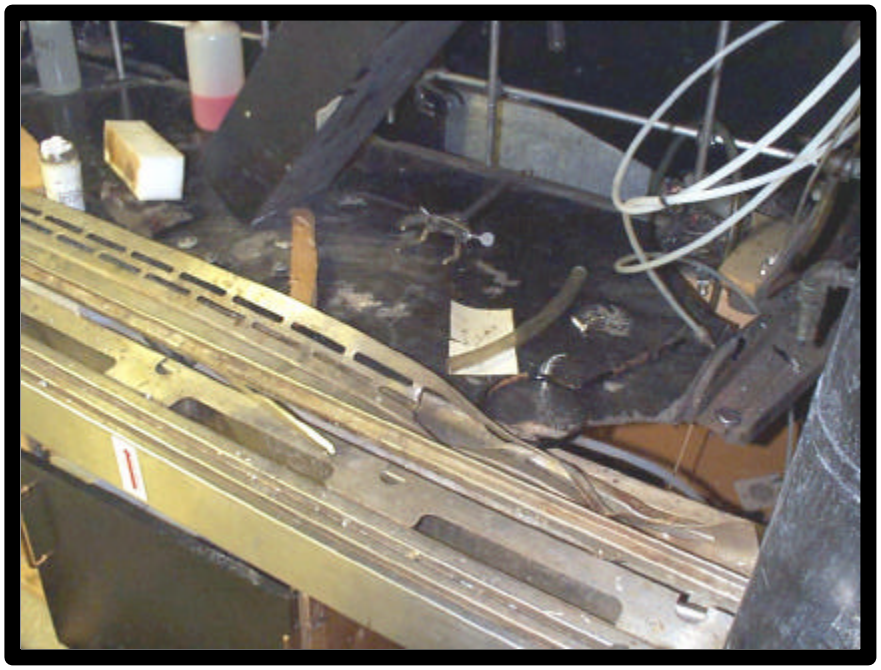
Calcium chloride was used as a drying agent instead of the sodium sulfate used in the published procedure; however, this is not thought to have contributed to the incident. Probably more importantly, the reaction was run in a closed reaction

vessel, while the published procedures that provide sufficient detail mention using a dry nitrogen purge of the reaction vessel. This purge could serve to prevent accumulation of liquid oxygen in the cryogenic system in which the methyl nitrite solid was collected. *Do not modify literature procedures (especially those involving highly reactive compounds) without proper technical review by other scientists.*

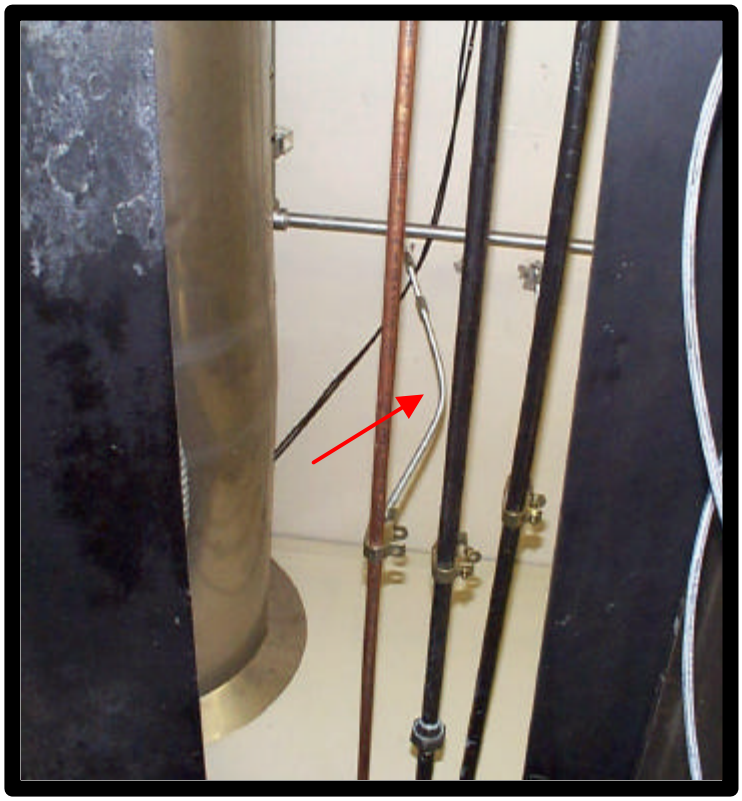
4. Implement good laboratory safety procedures and emergency response preplanning.

Several general laboratory safety items were identified as either being related to the actual incident, or the response to the incident. These items included: posting of high hazard areas ("designated areas"), prior approval or review of laboratory experiments, proper chemical storage and availability of flammable storage cabinets, and emergency response procedures and training. These are all basic laboratory safety issues. *Implementation of the good laboratory practices contained in the UNR Chemical Hygiene Plan, Biosafety Manual, Radiation Safety Manual, and other laboratory safety references will reduce risks to laboratory personnel.*

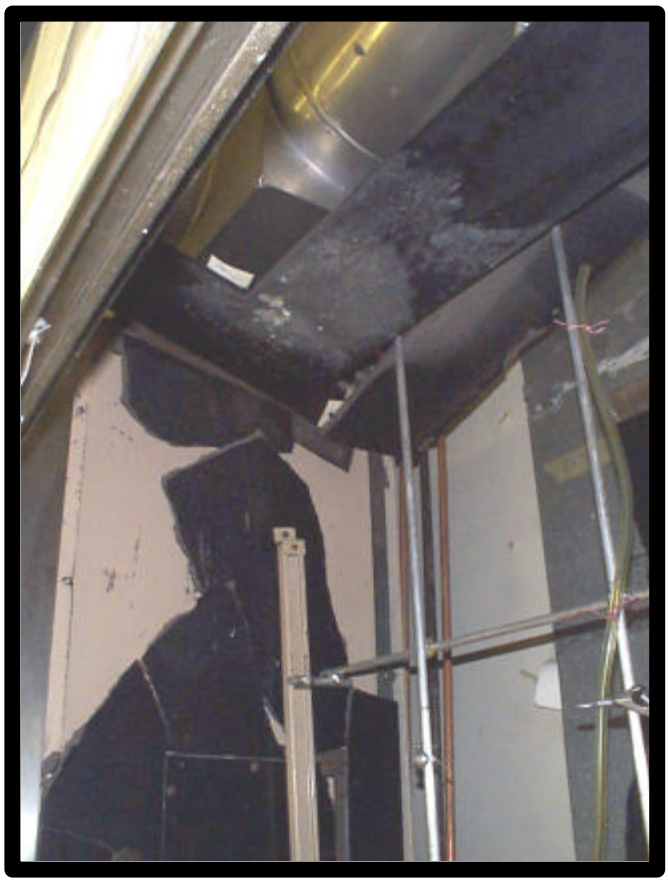
Additional Photos



Gas cylinder was propelled through hood airfoil



Damaged utility line support above hood (see arrow)



Damage to top and rear of hood

Damage to wall (crack) adjacent to hood