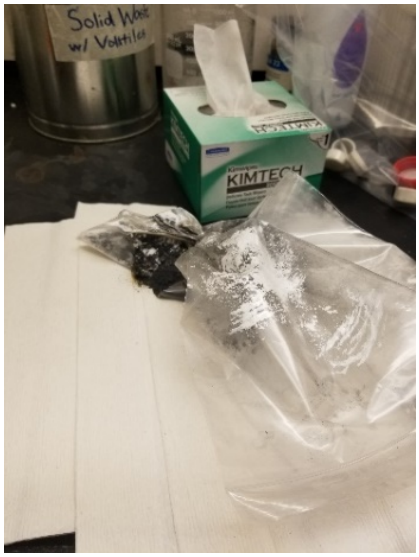
March 18, 2021

Hello Everyone,

I would like to share with you two safety incidents reported to me from the start of 2021 year. Near misses reported, such as laboratory broken vessel or small, incidental spills are not mentioned in this document. However, please use caution and don't rush through tasks while working in the lab, as this can easily lead to more serious safety incidents. As we get up to speed with lab work after the winter recess, it is important that we revisit the ChE safety page (https://engineering.purdue.edu/ChE/aboutus/safety) often and review all the important information in the safety documents posted there.

1. **February 17, 2021: Use of fire extinguisher to stop a potential fire caused by a smoldering plastic bag with chemical powders**

Description: As part of routine glovebox cleaning, samples were removed from the glove box and placed in the fume hood to await sorting and discarding. During this discarding process, several powders containing carbon and lithium samples were combined in a plastic bag. The samples began to react and self-heat, resulting in melting of the plastic bag and smoldering.



Immediate Action: As the bag started to smoke, the researchers used the fire extinguisher available in the lab to stop the reaction and smoldering, and to prevent a potential fire. The powders were then placed in an empty glass container in the fume hood, and this was filled with water to prevent further reaction.

Recommendations:

a. **Never mix incompatible waste streams**, as chemicals (even if they are in solid form) can react (sometimes violently) and lead to a safety incident (e.g.: fire, over pressurized vessels, explosion, etc.). If you are unsure whether your waste streams are compatible or not, treat the streams as incompatible and dispose of them separately.

b. Use appropriate containers to collect waste (inert to the waste stream), as plastic bags are not compatible with all chemicals.

c. As lithium was involved in this incident, it was recommended that waste powders containing lithium metal (which can react violently with traces of water and even with the humidity in the air), are covered with mineral oil while still in the glove box, before being taken out for disposal.

d. Although the researchers were confident that they can manage the smoldering using the fire extinguisher, in case of a fire (or smoldering in this case), **the proper procedure is to call 911 to report the incident, and only after that use the fire extinguisher**. Alternatively, call 911 while someone else is using the extinguisher. In any case, the fire department needs to be informed that a fire extinguisher was used in the lab.

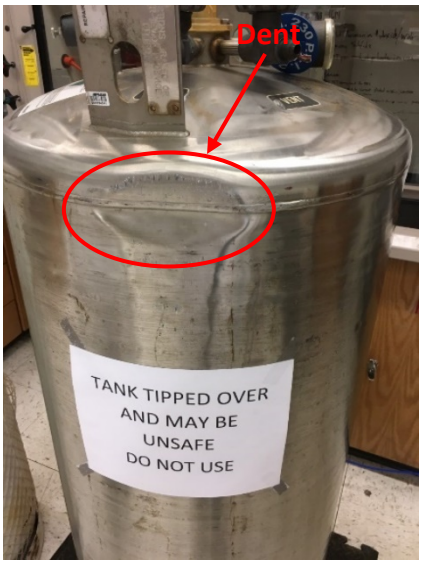
e. The group will develop Standard Operating Procedure (SOP) for safe disposal of Li metal containing samples and train the whole group on safe procedures.

2. **March 13, 2021: Full Liquid Nitrogen Tank Tipped When Moving Down Ramp Outside Forney**

Description: On Saturday, March 13, two researchers attempted to bring inside the FRNY building a full 180 L liquid nitrogen (LN2) tank from the Physics Loading Dock, using a four-wheel LN2 cart that secures the tank in place with the latch located at the upper part of the cart. One researcher pushed the loaded cart down the ramp, while the second researcher took the sidewalk and intended to take the stairs to help with bringing the LN2 tank inside FRNY through the door facing Physics building.

While the researcher was pushing the loaded cart down the ramp outside Forney, he lost control of the cart as it went over a "bump" located midway down the ramp. The bump, which is a small drop-off between two concrete slabs, caused the front wheels of the cart to drop unexpectedly, shifting the weight of the cart and

tipping it forward. This caused the cart and tank to flip forward and crash down on the ramp. Fortunately, no one was in the path of the falling LN2 tank, so no one was injured. The tank did not start to vent.



Immediate Action: Due to the heavy weight of the full tank, which can weigh between 600-800 lbs., the researchers were not able to bring the tank to upright position on their own, thus called two other members of the group to assist with this task. When the tank was in upright position, the four researchers inspected the tank visually and noted that the pressure in the tank was 90 psi (the pressure relief valve vents at 230 psi), and there was a large dent (~6" x ~3") on the upper corner of the tank (see picture to the left). The extent of the internal damage to the tank is unknown, but it was assumed that the tank was no longer safe to use. It was also assumed that the liquid nitrogen in the now-damaged tank possibly represented a hazard if allowed to build pressure over time. Therefore, the researchers slowly vented the contents of the tank outdoors, periodically pausing to ensure that nitrogen had a chance to dissipate. The tank was then brought into the lab and decommissioned, and it will be returned to Praxair.
The incident was reported the same day and was investigated during the following days to determine the root cause of the safety incident and make pertinent recommendations to prevent future occurrences.

Results of investigation: During the incident investigation it was determined that:

- The researcher acted correctly by not trying to stop the falling LN2 tank.
- Even though the so called "bump" was repaired during fall 2020 (the concrete slab was grinded to the level at which it did not pose a safety concern anymore), a close visual inspection of the revealed that the concrete swelled during the cold weather this winter, and now there is an uneven transition between the two adjacent concrete slabs, which is a safety hazard.
- The researchers were not aware of the procedures set by the ChE Safety Committee which state that full LN2 tanks should only be brought in the building via the lifting platform at the receiving area (during normal business hours), and the ramp should not be used for this purpose AT ALL, due to the heavy weight of a full LN2 tank.
- The researchers were not aware of the "Gas Cylinder Handling Procedures for FRNY Building" document posted on our website (https://engineering.purdue.edu/ChE/aboutus/safety). Direct link: https://engineering.purdue.edu/ChE/aboutus/safety/documents/Gas_Cylinder_Handling_Procedures%20(July%205%202020).pdf. This document (see page 3) has all the relevant guidelines that would have prevented this incident, if followed.

  Specifically, bullet points #7 and #9 on page 3:
  - ❖ *Use the lifting platform at the receiving area to bring full liquid nitrogen tanks into the building. Due to the heavy weight of a full liquid nitrogen tank, it is not safe to bring it inside the building via the ramp on the NE of FRNY.*
  - ❖ *Liquid nitrogen tanks should always be handled by two people during transportation*

  Although theoretically there were 2 people present during the transportation of the LN2 tank, one person took the stairs, thus practically only one person was handling the full LN2 tank on the ramp, which is the most dangerous part of the trip. However, upon closer inspection, it was determined that the LN2 cart could not be handled safely by two people due to the size of the cart and width of the ramp.

Actions taken to prevent similar situations:

- The ChE safety committee will discuss this incident in the upcoming meeting in March and will update the "Gas Cylinder Handling Procedures for FRNY Building" document to include updated verbiage regarding timing of transportation of LN2 tanks into the building.

- Reviewing the information in the "Gas Cylinder Handling Procedures for FRNY Building" document will be an integral part of the mandatory initial safety training and of the annual safety refresher training.
- Updated schedule will be posted on the door of the receiving area, to clarify that the lifting platform at the FRNY Dock can be used Monday through Friday between 9 am-12 noon and 1:30 – 3:30 pm. While currently Jason Davenport is available to assist with using the platform in the morning, Jeff Valley and/or Nick Humphrey are available in the afternoon. Please send an email and coordinate the transportation of LN2 tanks from the filling station (at Physics building).
- The Physical Facilities department was asked to grind the raised concrete slab in the ramp at a smaller slope, to ensure a smooth transition between the two adjacent slabs.
- Actions taken by the research group involved in the incident:
  - ❖ As using the lifting platform at the receiving area to bring in the building full LN2 tanks requires coordination, the group has set up a group Slack channel to make coordination easier.
  - ❖ The remailing LN2 tanks requiring the use of a cart for transportation will be returned to Praxair, soon.
  - ❖ Only the existing wide, short 230L LN2 tanks with attached wheels will be kept for in-house filling (at Physics LN2 farm). These tanks can be easily handled by two people, unlike the one-person cart used during the safety incident.
  - ❖ The group is considering transitioning to renting LN2 tanks from Indiana Oxygen, which also offers delivery of full LN2 tanks to the lab; this would eliminate the need for researchers to handle full tanks.
  - ❖ All departmental safety policy updates will be added to the group safety meeting discussions to ensure that policies like the ones in the "Gas Cylinder Handling Procedures for FRNY Building" are not overlooked.

Some lessons learned and *general* recommendations:

1. Visit the ChE Safety website (https://engineering.purdue.edu/ChE/aboutus/safety) often and review regularly the information in the safety documents posted. Discuss these in your safety group meetings on a regular basis.
2. Never attempt to stop a falling gas cylinder, or LN2 tank.
3. Collect waste in sturdy containers, compatible with the waste stream collected.
4. Never mix incompatible waste streams, as chemicals can react (sometimes violently) and lead to safety incidents (e.g.: fire, over pressurized vessels, explosion, etc.). If you are unsure whether your waste streams are compatible or not, treat the streams as incompatible and dispose of them separately.
5. If a fire develops in your lab, call 911 and ask for help. Fire extinguishers are to be used by emergency responders. Only attempt to use a fire extinguisher if you are trained on how to use it, and you already called for help.
6. Ensure everyone in your group knows and follows the incident report protocol. The first bullet point under the "Workplace Injury Information" on ChE safety website (https://engineering.purdue.edu/ChE/aboutus/safety) has useful information on the proper safety incident/near miss reporting procedure.
7. Report any safety incidents or near misses to the group safety officer and to the safety committee chair, and discuss them in your group meetings. Sharing this type of information is key in increasing safety awareness.

Incidents and near misses are great tools to learn from previous situations/events. Please continue to report any safety incidents and near misses that occur in your work area; sharing them with everyone in our School will raise the safety awareness and prevent similar situations from happening.

Sincerely,

Gabriela
On behalf of the ChE Safety Committee