

## Level 1 Event Review Report NH3 Shipping and Storage Incident

<b>Date of Event:</b>	1/12/23-1/25/23
<b>Time of Event:</b>	Duration
<b>Type of Event</b> (first aid or recordable injury/illness, Informational ORPS, unexpected outcome):	Unexpected outcome
<b>Location where event occurred:</b>	Shipping/Receiving, Spinquest, Meson Assembly Bldg (MAB)
<b>Date report closed:</b>	

### Personnel on review team:

<b>Name</b>	<b>ID number</b>	<b>Title/Organization</b>
Rick Ford	06409N	Assoc. Head/PPD
Matt Spaw	35888N	IH Grp Ldr/ESH
Evan Niner	31970N	App. Phys/Test Beam/PPD
Jon Ylinen	15897N	DSO/ESH
Lisa Reger	15155N	DSS/ESH

### Personnel Interviewed:

<b>Name</b>	<b>Role</b> (involved, witness)	<b>ID Number</b>
Dustin Keller	Sender/receiver of NH3	13081V
Raymond Lewis	ESH point person on arrival	07927N
Jim Cyko/Tim Herren	Shipper/Receiver	13939N / 41796N
Rick Tesarek	Project Mgr	12680N

**Description of event** (Describe the event sequence immediately prior to, all the way to immediately after the event. As appropriate, provide dates and times of key activities, decisions, process steps, and events leading up to and immediately after the event.):

On 1/4/23 the Co-spokesperson for the SpinQuest Experiment (experimenter) made contact with ESH (PPD) DSO's about his desire to have a dewar containing 12 g of frozen ammonia kept cool by LN2 shipped to Fermilab. Email below:

Hello,

I intend to bring frozen NH<sub>3</sub> (~12 g) onsite to FNAL this Friday (Jan 6th). This will be the primary target material for SpinQuest (E1039) which we hope will begin running very soon. We do not intend to handle it until after our formal target material review and ORC but we really need to have it onsite. We have a designated area in NM4 that is well ventilated and the dewar that it will be stored in is a 30-day LN<sub>2</sub> dewar (meaning once filled it last 30 days before needed refilling). We will refill the dewar every week on the same day once it holds the material.

Please let me know if there is any issue with this plan.

ESH expressed concern about the proposed shipping method (private vehicle) and procedure and referred the experimenter to an expert from the Shipping/Receiving Dept. It appears there was initially no discussion of on-site storage as ESH assumed the words "designated area" in the email above meant approved area, so the issue of storage was not raised at that time. Therefore, assuming he had addressed the shipping issue raised by using a contracted shipper, the experimenter proceeded to ship the dewar to Fermilab. According to Shipping/Receiving, the shipment did not constitute "Hazardous Materials" according to DOT standards due to the small quantities of NH<sub>3</sub> and LN<sub>2</sub>.

For background, SpinQuest submitted an NH<sub>3</sub> target handling procedure years (2018?) earlier which included the proposal to use a specific location in NM4 for storage but it was never approved. According to Raymond, there was discussion of the target handling procedure at that time but very little, if any, discussion of whether the storage location was appropriate. It appears the experimenter assumed that absence of rejection of this proposal meant approval.

On the morning of 1/12/23 the experimenter notified ESH that the shipment was due to arrive the next day, however the shipment actually arrived at Fermilab Receiving that afternoon which forced the ESH PPD DSO's to try to quickly deal with the situation. Upon realizing that the NM4 storage area had not been approved, ESH tried to come up with a suitable temporary location outside. Below is the email from Raymond Lewis describing what he arranged after that:

*Hi, Rick, Otto, and Dave. As discussed with Rick and Otto, we moved a dewar to the yard behind MAB today. Attached are photos showing the location and the signage. There is a vented dewar inside the blue plastic drum shown in the photos. The drum is vented via several holes drilled into the side of the drum. The dewar contains 25 grams of solid (frozen) ammonia and approximately 20 liters of liquid nitrogen. The liquid nitrogen will need to be replenished periodically to keep the ammonia frozen. Dustin (copied) will need a procedure (HA) on how to do that; I believe it will need to next be done early next week. It will take some time to arrange the proper approvals for this dewar to be moved into the NM4 hall. Thanks for letting us use the MAB yard as a safe storage place for it in the meantime. -Raymond*  
*PS: Attached is the conversion that shows that 25 grams of ammonia is approximately 1.15 cubic feet of gas at standard temperature and pressure.*



Second email from ESH:

*Hello. After looking at the MAB yard and discussing the dewar storage location with fire safety and IH personnel, the drum with the dewar in it has been moved to the fence line. It is secured to the fence with elastic cords. Photos attached. In consultation with Jake Kintner, the 4 holes ventilating the drum were drilled out to provide four 3/8" holes.*

It was unclear to ESH whether the plastic barrel would pose a hazard in the event of catastrophic failure of the dewar even though there were very small holes on the top of barrel originally, so the barrel was moved away from the bldg. and a PPD engineer (Jake Kintner) was requested to calculate the required hole size needed as indicated in the email above.



Eventually it was decided to ship the dewar back to the UVa until such time that an approved SpinQuest storage location and NH3 target handling procedures were in place. This occurred on 1/25/23

**Background** (As appropriate, provide background details on facilities, work groups, and/or work processes.):

The NH3 is supposed be used for the SpinQuest polarized target. It was shipped here from UVa in order to eventually be installed into the cryo system at NM4. It was intended that the NH3 would be stored there, but the approvals were not in place at time of arrival so a temporary storage place was used at MAB until the NH3 was eventually shipped back pending appropriate procedures and approvals.

**Training and Assignment of Workers** (As appropriate, provide details on worker training, qualifications, and authorizations applicable to the work activities and/or hazards involved in the event, e.g. IMPACT documents, work order, ORC, hazard analysis.):

There were some engineering documents provided years ago but no action was taken and ORC's, or other work planning had yet occurred.

**Cause(s)** (such as direct, apparent, contributing, or root)

**Contributing Factors** (mark "yes" and provide an explanation for all items that contributed to the event. Otherwise check "no or N/A.")

Item	Yes	No or N/A	Explain
Procedures/policies – unclear, lack of understanding, not available, etc. List those applicable.	X		It seems that most potentially hazardous materials which get shipped to Fermilab are approved by ESH through the purchase requisition process. If something is shipped to the lab outside of that process such as users shipping something from their home institution it is unclear whether there are equally protective measures in place to make sure the hazardous materials are approved, especially if they are not considered hazardous by DOT rules.
Design – inadequate design/layout of facility, equipment.	X		It is unclear whether the drum containing the dewar would be an appropriate pressure vessel in the event of catastrophic failure of the dewar.
Work plan/Hazard analysis – job walkdown not performed, pre-job briefing not performed, hazard analysis not performed, hazards not identified, or hazards not adequately addressed.		N/A	
Training – personnel did not have the appropriate or updated training for the operation.	X		Even though the experimenter appropriately contacted ESH, the experimenter did not understand that the storage location was not officially approved. Also did not seem to understand that DOT shipping rules are not the same as lab rules regarding storage

Communication – hazards, safe work procedures, and/or work policies/procedures requirements not communicated to workers. Communication between work groups less than adequate.	X		There was an initial misunderstanding between the experimenter and ESH regarding the “designated area” for storage.
Personnel resources – inadequate, overstrained, not provided, etc.	X		It seems both ESH and the experiment were under pressure to solve the problem quickly
Enforcement – work rules/ requirements not enforced adequately or consistently.	X		The approval process for hazardous materials arriving on site seems inconsistent depending whether the source was an experimenter, vendor, or sub-contractor
Personnel behavior – individual was inattentive, speeding, or horseplay involved.		N/A	
Housekeeping – housekeeping not performed regularly or adequately at the work site.		N/A	
Inspections – work area or equipment inspections not performed initially, regularly, and/or thoroughly.		N/A	
Maintenance – equipment not maintained regularly, proactively, or adequately.		N/A	
Proper Equipment – the proper tools or equipment were not provided or not used for the operation.	X		The barrel may not have been appropriately configured to house the dewar
Equipment or material failure that contributed to the event.		N/A	
Personal Protective Equipment – not provided, not used, or not used properly by the individual.		N/A	
Personal physical factors – such as strength, physical condition, prior injuries were a factor.		N/A	
Environmental or chemical factors – vapors, dust, noise, glare, or heat/cold.	X		NH3 (ammonia) can be quite hazardous depending on the concentration. LN2 can boil off and create an ODH situation if it is confined indoors
Quality control process – not available, not utilized, insufficient detail, etc.	X		Procedures for moving, storage, and maintenance on site were not approved
Other:		X	
<b>List any identified cause(s) of the event:</b> Miscommunication between experimenter and ESH.			

Misunderstanding of what constitutes an approval of hazardous material storage on site.

**Immediate Actions Taken:**

Notified stakeholders, changed storage location temporarily to outside fenced area behind Meson Assembly Bldg, provided sufficient ventilation to prevent potential pressure build-up, and set-up procedures and HA to provide LN2 to keep NH3 pellets frozen. Eventually shipped dewar back to University of Virginia.

**Corrective actions recommended to reduce the probability of recurrence:**

<u>Description of Corrective Action</u>	<u>Due Date</u>	<u>iTrack number</u>
Find a better path to train users/experimenters about the lab ESH expectations. In the past there was a Procedures for Experimenters (PFX) but this could also take the form of a training class or video.		
Conduct a review to make sure that there is proper vetting at Site 38 Receiving to assure hazardous materials don't slip thru without ESH involvement regardless of DOT designation		
ESH has a designated rad materials shipping coordinator, investigate whether ESH needs a non-rad hazardous materials shipping coordinator		

**Lessons Learned and Best Practices:**

It seems experimenters/users are not as well trained with respect to hazardous materials restrictions and procedures as lab employees and it is easier for them to bring them on site without proper vetting. This is not the first occurrence of this type of event, therefore it is recommended training for users should be upgraded with many of the common issues the lab experiences such as movement of hazardous materials.  
A review of how hazardous materials are vetted at receiving is also recommended.

Add Lessons Learned and Best Practices to the iTrack Review. Lesson Learned ID # (s) _____

**Attachments** (photographs, sketches, documents reviewed, etc.)