

Procedure for Handling NH3/ND3

SEAQUEST-10360-v24

Revisions

Revision Date	December 15, 2023
Rev. No.	V24
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Changes in this revision	1. Made the training list consistent with other procedures involving ammonia
Changes in previous revision	1. Added ammonia-related training to the required training list 2. More details in the evacuation and rescue plans
Changes in v22	1. Removed the NM3 part in the evacuation plan 2. Person C can wear either leather or cryo glove on the other hand 3. Slightly updated the PPE requirement 4. Added a step to verify the HVAC is on
Changes in v19	1. Added one sentence to address power outage in the evacuation and rescue plan
Changes in v18	1. Updated rescue plan
Changes in v12	1. Updated the Evacuation and Rescue Plan according to ES&H.

Condition

- This procedure should be conducted at the one approved target material handling area which is the north end of the NM4 experiment hall within 3 meters of the HVAC intake ventilation system.
- The work area is fenced with yellow warning tape, or rope with signs.
- Target material is stored in a special dewar filled with LN2.
- Portable handheld dewar has been filled with LN2 following the procedure SEAQUEST-10358-v13.
- The target insert has been removed from the target and transported to the handling area, with the target cups in the small transfer dewar. The handling and transportation of the target insert are covered in another procedure, SEAQUEST-10355.
- Three workers are required to perform this procedure.
- At least one person in the team must be trained by the target group and determined to be qualified by the target group leader in order to perform the procedure.

Training requirements

- Cryogenic Safety (FN000115)
- General Employee Radiation Training (GERT: FN000241)
- Radworker Classroom (FN000470)
- Radworker Practical Factors (FN000471)
- Controlled Access (FN000311)
- NM4 Experimental Enclosure Hazard Awareness Training (PDNM4001)
- ODH training [FN000029/CR/02]
- SpinQuest Ammonia Target Handling [FN000761/RR/01]
- SpinQuest Ammonia Target Handling On the Job Training [FN000762/OJ/01]

Equipment and Tools

Equipment:

- NH3/ND3 dewar.
- LN2 tub wrapped with foam (made from high density polyethylene, 21x17x7 inches).
- Portable handheld dewar with LN2.
- Target insert with its small transfer dewar.
- Large table to place the LN2 tub.
- Small table to place the tools.

Tools:

- Paper towels
- Crucible tong
- Long tweezer
- Long screwdriver
- Long Q-tip (two shorter Q-tips joined together)
- Funnel

PPE:

- Cryo-gloves (both person A and B will wear cryo-gloves on both hands, person C will only wear cryo-glove on one hand)
- Leather glove (Person C will wear either safety-approved leather glove or cryo glove on the other hand)
- Vented chemical goggles (needed for all three workers)
- Tyvek suit (only for person A)
- Cryo-apron (only for person A)
- Tyvek lab coat or Tyvek suit (needed for person B and C)
- Face shield (needed for person A while filling LN2 to the tub, and dumping target bottles into the tub)
- Closed-toe non-permeable shoes, and long pants (needed for all three workers)

Evacuation and Rescue Plan

Scenario 1: Spill of Liquid Nitrogen

- In the event of spill or splash of LN2 (liquid nitrogen, cryogenic) only, all workers are to evacuate immediately and call emergency at ext. 3131 **from a Fermilab phone or 630-840-3131 from a cell phone**. Provide details of the spill or splash to the dispatcher to determine the necessary level of emergency response. Emergency response will provide immediate care for exposure or injury. After treatment Fermilab Occupational Medical Office (FOMO) will need to be notified of the injury. Follow up care can be provided by FOMO.

Scenario 2: Spill of Anhydrous Ammonia onto ground

- If in the NM4 Hall an anhydrous ammonia spill onto the ground occurs, all workers are to evacuate immediately.
- After evacuating the chemical spill area, call emergency at ext. 3131 **from a Fermilab phone or 630-840-3131 from a cell phone**. Provide details of the spill or splash to the dispatcher to determine the necessary level of emergency response. Emergency response will provide immediate care for exposure or injury. After treatment Fermilab Occupational Medical Office (FOMO) will need to be notified of the injury. Follow up care can be provided by FOMO.
- Note: Contaminated clothing and shoes should be removed and cleaned for residual chemicals before reusing them.

Scenario 3: Spill of Anhydrous Ammonia into Liquid Nitrogen Bath

- If ammonia beads are spilled into the liquid nitrogen bath while loading/unloading the target insert, beads floating in the bath will be recovered with tongs and placed in the target insert or storage canister.
- Beads that have sunk into the liquid nitrogen bath will be left in place. When the procedure is complete the liquid nitrogen bath will be moved in front of the HVAC ventilation system to evaporate. Personnel will leave the roped work area and not return until evaporation is complete.

Scenario 4: Building Fire, ODH or Ammonia alarms

- While working on procure 10360 in the back of NM4 it is possible unrelated alarms could go off. This would include the building fire alarm, an ODH alarm (audible and with red warning light) for the NM4 cryogenic platform, or alarms for ODH and ammonia (audible with blue warning light) in the NM3 target cave.
- In the case of these alarms the workers should immediately stop the work, leave the equipment in the immediate work area, and evacuate the building.
- Then call ext. 3131 from a Fermilab phone or 630-840-3131 from a cell phone to report the event and the state of anhydrous ammonia and liquid nitrogen in NM4 to emergency response when they respond to the other alarm.

Scenario 5: Building Power Outage

In case of power outage, the workers should immediately stop the work, leave the equipment in the immediate work area, and evacuate the building. Then call ext. 3131 from a Fermilab phone or 630-840-3131 from a cell phone to report the event and the state of anhydrous ammonia and liquid nitrogen in NM4.

Procedure

Three persons are needed for this procedure; they are denoted as A, B, and C in the following procedure:

- Person A is the primary loader/unloader.
- Person B handles the target insert.
- Person C is the assistant to Person A.

Two general rules need to be followed to maintain the paramagnetic center in the target material:

- The target material should not be out of LN2 for more than 10 seconds.
- Everything in contact with the target material should be pre-cooled in the LN2.

Setting up the work area

1. Bring all the equipment and tools to the work area.
2. Verify that the HVAC in NM4 target prep area is on.
3. Put LN2 tub on the table. Make sure the long side of the table is perpendicular to the HVAC.
4. Arrange the tools and target material dewar so they are close and easily accessible.
5. Rope off the work area with yellow warning tape.
6. (Person A) Fill the LN2 tub with LN2 until the level reaches the marked black line (1 inch below maximum, see Fig. 4). Throughout the procedure, if the LN2 level drops to below the marked red line (see Fig. 4), we will refill the LN2 back to the marked level. (**Hazard: cryogenic, Mitigation: Person A is wearing Tyvek suit, cryo-apron, cryo-gloves and face-shield, Person B and C stays away from the work area**).

Loading materials to the target insert

1. (Person A) Remove the target canister from the target material dewar, remove the paper stopper using the tweezers and dump the target bottles into the LN2 tub (**Hazard: ammonia spill, Mitigation: Immediately evacuate according to emergency plan if ammonia spills on ground**).
2. (Person A) Pick up the unwanted bottles with the crucible tong, put them back into the target canister, put back the paper stopper, and insert the canister back into the target material dewar. Person A can now remove the face-shield, Person B and C can now approach the work area (**Hazard: cryogenic splash, Mitigation: Person A is wearing Tyvek suit, cryo-apron, cryo-gloves and face-shield, Person B and C stays away from the work area**).
3. (Person B) Move the target insert and put the end with target cups into the LN2 tub. Person B will hold the target insert in this position through the remaining steps.
4. If materials are in the target cup, follow steps 3-6 in the unloading procedure to unload the material.
5. (Person A) Pick up the target bottle we intend to use with the crucible tong and tap the lid to push down the material into the bottle. Then remove the cap while keeping the bottle soaked in LN2.

6. (Person C) Unscrew the target cover screws and use a tweezer and Q-tip to push the target cup cover to the side. Be careful not to fully unthread. Tighten the screw again to keep the target cup cover on the side. See Fig. 1 and Fig. 2 for the different target cup cover configurations. (**Hazard: cryogenic splash, Mitigation: Person C handles this step using long tools wearing leather or cryo glove**)
7. (Person A) Dump a small amount of the target material from the bottle to the target cup, then soak the target bottle back in the LN2. Repeat this step until the target cup is full (**Hazard: ammonia spill, Mitigation: Immediately evacuate according to emergency plan if ammonia spills on ground**).
8. (Person C) Use Q-tip to help move the target material pellets into the target cup if necessary. (**Hazard: cryogenic splash, Mitigation: Person C handles this step using long tools wearing leather or cryo glove**)
9. (Person A) Put the cap back on the target bottle and leave the target bottle in the LN2 tub.
10. (Person C) Use a tweezer and Q-tip to push the target cup cover back in place and tighten the screws. (**Hazard: cryogenic splash, Mitigation: Person C handles this step using long tools wearing leather or cryo glove**)
11. Repeat steps 5-10 until all the target cups are filled.
12. (Person B) Move the target insert back to the target transfer dewar.
13. (Person A) Remove the target canister from the target material dewar, remove the paper stopper, put the target bottles back in the canister, put the paper stopper back in, and put the canister back in the target material dewar.
14. Document the number of bottles used for this fill.
15. Leave the LN2 tub in the area until all LN2 evaporates (it takes about 30-40 minutes). Keep the no-entry fence tape until the LN2 is completely gone.

Unloading material from the target insert

1. (Person A) Remove the target canister from the target material dewar, remove the paper stopper using the tweezer, and dump the target bottles into the LN2 tub. Person A can now remove the face-shield, Person B and C can now approach the work area. (**Hazard: cryogenic splash, Mitigation: Person A is wearing Tyvek suit, cryo-gloves and face-shield, Person B and C stays away from the work area**)
2. (Person A) Pick up the unwanted bottles with the crucible tong, put them back into the target canister, put back the paper stopper, and insert the canister back into the target material dewar.
3. (Person A) Remove the cap and screw the funnel on the empty target bottle. See Fig. 3 for the illustration of the target bottle and the funnel.
4. (Person B) Move the target insert and put the end with target cups into the LN2 tub.
5. (Person C) Unscrew the target cover screws and use a tweezer and Q-tip to push the target cup cover to the side. Be careful not to fully unthread. Tighten the screw again to keep the target cup cover on the side. See Fig. 1 and Fig. 2 for the different target cup cover configurations. (**Hazard: cryogenic splash, Mitigation: Person C handles this step using long tools wearing leather or cryo glove**)
6. Dump the target material from the target cups back to the target bottle through the funnel
 - a. (Person A) Hold the target bottle with a funnel in LN2 using the crucible tong.
 - b. (Person B) Dump a small amount of material from the target cup to the target bottle, then put the target cup back in the LN2. Repeat until all materials are moved to the target bottle.
 - c. (Person C) Use a Q-tip to push the target material through the funnel if necessary. (**Hazard: cryogenic splash, Mitigation: Person C handles this step using long tools wearing leather or**

cryo glove) **(Hazard: ammonia spill, Mitigation: Immediately evacuate according to emergency plan if ammonia spills on ground).**

7. (Person A) Remove the funnel and install the cap of the target material bottle.
8. Repeat steps 3-7 until all the target cups have been emptied.
9. (Person B) Move the target insert back to the small transfer dewar.
10. (Person A) Remove the target canister from the target material dewar, remove the paper stopper, put the target bottles back in the canister, put the paper stopper back in, and put the canister back in the target material dewar. **(Hazard: ammonia spill, Mitigation: Immediately evacuate according to emergency plan if ammonia spills on ground).**
16. Leave the LN2 tub in the area until all LN2 evaporates (it takes about 30-40 minutes). Keep the no-entry fence tape until the LN2 is completely gone.

Attachment

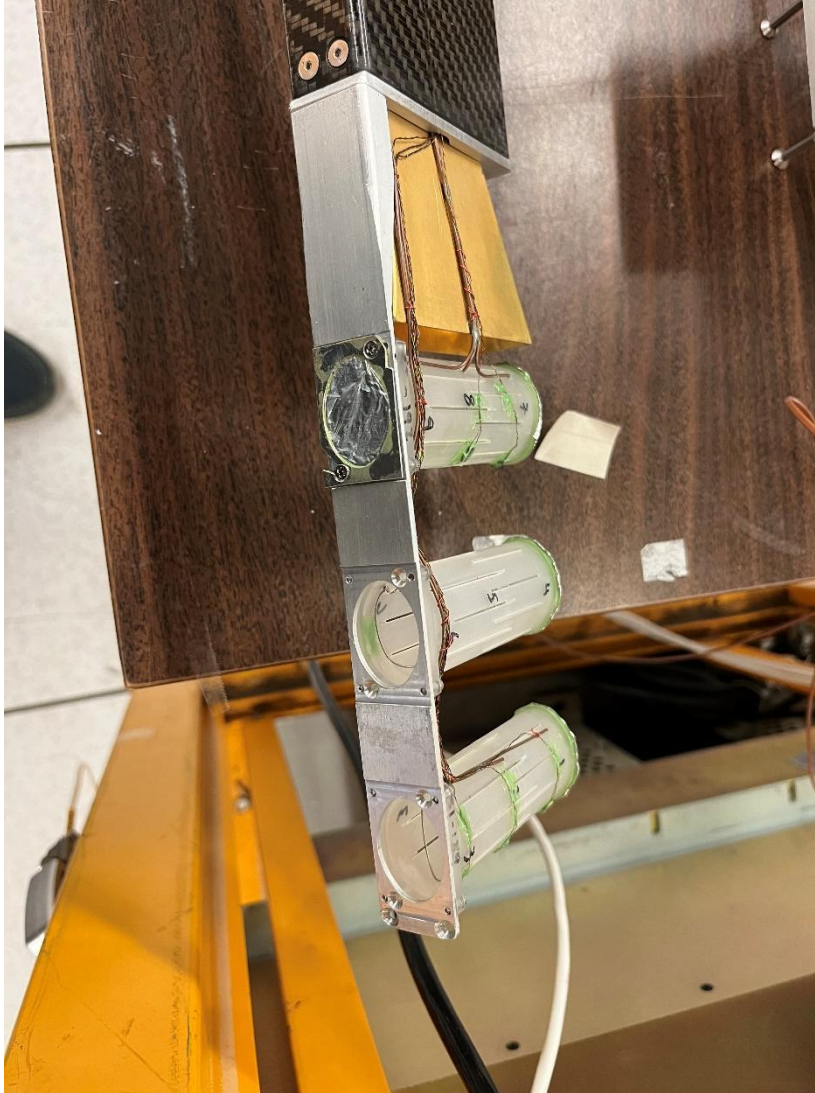


Figure 1 Target cup with the cover closed. In the picture only one cup cover is shown, but all three cups will have covers.



Figure 2 Target cut with cover opened. In the picture only one cup cover is shown, but all three cups will have covers.



Figure 3 Target bottle with the cap and special-made funnel



Figure 4 New LN2 tub sitting on top of the work desk. The black line indicates the fill level, the red line indicates the minimum level.