**THIS IS A TEMPLATE/BASIC STARTING POINT. CUSTOMIZE THIS TEMPLATE WITH INFORMATION PERTINENT TO YOUR SETUP AND THE PROCEDURE YOU WILL BE USING/YOUR GROUP’S PERSONAL USE.**

STANDARD OPERATING PROCEDURE

Use this form to document the Health & Safety information associated with the procedure.

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| **Procedure Title:** | | Handling of Cryogenics Materials | | | | | | |
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| **Dept:** |  | |  | **Bldg/Rm:** |  |  | **Supervisor:** |  |

**Procedure Overview:**

**Cryogenic Materials** are generally defined as any material that has a boiling point -153°C (120K). The most commonly encountered cryogens are liquid nitrogen, liquid argon, liquid helium, liquid hydrogen, and liquid oxygen. At ISU, liquid nitrogen is the most frequently used cryogen.

Always read and understand the safety data sheet (SDS) for a chemical before use or storage.

**WARNING**

* Severe skin burns can result from even brief contact with these cryogenic liquids and solids or surfaces cooled by these materials.
* Cryogenic liquids can create an asphyxiation hazard by displacing oxygen from the room. Work only in a well-ventilated area.

**Hazard Control Measures:**

(Lab coat, eye and hand protection, and fully enclosed shoes must be selected as required by Section D of the ISU Laboratory Safety Manual.)

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|  | Latex gloves |  | Insulated gloves |  | Face shield |  | Respirator |
|  | Nitrile gloves |  | Safety glasses |  | Lab coat |  | Fume hood |
|  | Neoprene gloves |  | Vented goggles |  | Apron |  | Biosafety cabinet |
|  | Vinyl gloves |  | Splash goggles |  | Dust mask |  | Glove box |
|  | Fully enclosed shoes | | |  | Flame resistant lab coat | | |

**Handling Procedure:**

* When cryogenic liquids are transferred to containers located above waist-height of the operator, the liquid must first be poured from the storage Dewar into a small, easily-handled, insulated container (such as a glass Dewar flask) and then poured into the final container.
* All containers with evacuated wall space (Dewar flasks) and evacuated round-bottom flasks that have volume of greater than 500 mL must be wrapped with tape or surrounded by protective net to contain flying glass in case the container should break while being cooled with cryogenic liquid.
* If using cryogenic liquid to freeze a flask of liquid, only use round-bottomed flasks (never flat-bottomed). Evacuated flasks containing liquids frozen at cryogenic temperatures must be kept in secondary containment at all times.

**Transportation:**

Special precautions must be taken to prevent a spill while transporting cryogens in addition to minimizing exposures from liquids and vapors. The high liquid to vapor expansion ratio could rapidly displace all oxygen in a room and result in asphyxiation. Implement the following procedures to minimize exposures:

Transport within the laboratory or lab building:

* Wear all required PPE
* Always have two personnel present to transport cryogenic liquids
* Use handcarts equipped with brakes for large Dewars and cylinders
* Never transport an open container of cryogenic liquid, no matter how small.
* Plan the route of transport. If using an elevator, send a co-worker to the receiving floor. Then load the Dewar and place a warning sign on the Dewar warning anyone who may want to use the elevator to wait until the transport process is complete. **NEVER RIDE IN AN ELEVATOR WITH CRYOGENIC LIQUIDS**
* Always use care when handling equipment. Damage to Dewars could result in the loss of vacuum and increased evaporation.
* When at all possible, do not hand-carry cryogenic liquids. For larger Dewars use a stable wheeled base designed for the Dewar transport. Check to ensure stability before commencing transport.
* When carrying a Dewar, make sure it is the only item you are carrying. Hold the Dewar as far away from the face as possible. Be on the lookout for other people who may run into you or bump you.
* Take care to avoid crushing hands or fingers between the vessel or cart and walls or door frames.
* If there is any risk of tipping, a cart should be used. Wheeled trolleys may not be used if the vessel must pass over elevator thresholds or other slots/crevasses wider than 25% of the wheel width.

Transport between buildings:

Follow the guidelines above, in addition to the subsequent guidelines:

* While in route exercise great care stay completely clear of sewer grates, large cracks, and/or uneven portions of the pavement, and any other hazards which could catch a cart wheel and cause tipping.
* For transport of large nitrogen Dewars outside -- over pavement, sidewalks, wheelchair curb-cuts, a 4-wheel tipcart should be used. The casters welded to the tank, and/or the casters on the trollies in common use, are not meant for transport over pavement and concrete.

Vehicular transport

Before transporting cryogens, ensure that the following have been addressed:

* A risk assessment has been conducted.
* The container of the cryogenic material is labeled with the name of its contents and a danger hazard warning sign.
* The driver has been fully informed as to what is being carried and its associated hazards.
* The appropriate Personal Protective Equipment has been provided.
* An information sheet is carried within the vehicle to provide emergency response services with specific data about the material in the event of an accident.
* The quantity to be transported is consistent with DOT regulations.
* **NEVER** take liquid nitrogen or other cryogenic fluids in a car or a van where the driver's compartment is not segregated and sealed from the load. The load compartment of the van must be ventilated. Where a specimen needs to be transported frozen, consider whether dry ice would be suitable since it reduces the risks.

**Storage:**

A cryogenic liquid storage unit left open to the atmosphere, or catastrophic failure of a storage unit, could create an oxygen deficient atmosphere. Follow these procedures to reduce the likelihood of this occurrence:

* Glass Dewars must have an exterior coating/cover/netting to minimize projectiles in the event of an explosion. Newer Dewars may have a plastic mesh over the exterior for this purpose. Older Dewars must be thoroughly taped or replaced.
* Only store Dewars in well-ventilated rooms.
* If the ventilation rate is unknown, contact EH&S and Facilities Planning & Management (FP&M) to evaluate the storage area.
* EH&S and/or FP&M may recommend the installation of oxygen detection systems and alarms for cryogenic liquid storage areas depending on location, ventilation, and quantity of material stored.
* Do not store cryogenic liquids with corrosive or flammable chemicals.
* Storage units should be placed so that valve vents and openings are oriented away from personnel and lab equipment.
* Bulk cryogenic liquid dispensing areas within buildings must be well ventilated. EH&S recommends continuous oxygen monitoring equipment in all these areas. All new installations should be designed with oxygen monitoring system and alarm.
* Storage of cryogenic liquid Dewars in hallways, unventilated closets, and stairwells is prohibited.

**Emergency Procedures and First Aid:**

* Liquid Nitrogen (LN2) is the most commonly used cryogenic liquid. Oxygen depletion resulting from nitrogen gas may occur rapidly with no warning properties. A person entering an oxygen deficient environment may become disoriented and unable to respond properly. Nitrogen gas is odorless, colorless, tasteless, and inert. The failure of a large Dewar could spill 180 L of LN2, which will completely displace all oxygen in a 21x21x10 ft room. A much smaller spill in the same room could still create a safety hazard. Simply reducing the oxygen content in a room below 19.5% is considered an oxygen deficient environment. Implement the following procedures to minimize the risk of asphyxiation:
* If ventilation in the room is less than six air changes per hour, consults with EH&S
* If a spill occurs, immediately exit the area. With adequate ventilation, it may be appropriate to return to the area after 30 minutes. For large spills, contact EH&S immediately as the area may need to be monitored for oxygen levels area and determine when it is safe to re-enter.
* If experiencing symptoms such as lightheadedness, dizziness, or confusion, immediately seek fresh air and receive medical attention.
* If researcher becomes unconscious in a cryogenic liquid storage area they should only be retrieved by emergency personnel (Immediately call **911**). Over 50% of deaths associated with asphyxiation in confined spaces occur to would-be rescuers.
* Immediately remove any clothing that has been contaminated. In the event of clothing contamination with oxygen, hydrogen, or carbon monoxide, it is important to remove clothing, evacuate personnel from the facility, and keep away from ignition sources.
* Flush or soak the area with warm water (no greater than 105 °F).
* Do not apply dry heat or rub damaged flesh or eyes.
* **All accidents and injuries occurring at work or in the course of employment must be reported to the employee's supervisor as soon as possible (even if no medical attention is required). Report incidents and exposures here:** <https://www.ehs.iastate.edu/services/occupational/accidents-injuries>

**Spill/Release Containment, Decontamination, and Clean Up Procedures:**

Small Spill

* Allow liquid to evaporate, ensuring adequate ventilation.
* Following return to room temperature, inspect area where spillage has occurred.
* If there is any damage to the floors, benches or walls, report it to Facilities Planning & Management.
* If any equipment has been damaged following the spillage, inform your Supervisor.

Large Spill

* Shut off all sources of ignition.
* Evacuate area of all personnel.
* Inform EH&S (294-5359) and your supervisor.
* DO NOT return to the area until it has been declared safe by EH&S.

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| **Written By:** |  |  | **Date:** |  |
|  |  |  |  |  |
| **Approved By:** |  |  | **Date:** |  |

(PI or Lab Supervisor)

**HAZARD ASSESSMENT**

Use the hierarchy of controls to document the hazards and the

corresponding control measure(s) involved in each step of the procedure.

Consider *elimination or substitution* of hazards, if possible.

*Engineering Control(s):* items used to isolate the hazard from the user (i.e. fume hood, biosafety cabinet).

*Administrative Control(s):* policies/programs to limit the exposure to the hazard (i.e. authorizations, designated areas, time restrictions, training).

*Required PPE*: indicate PPE including specific material requirements if applicable (i.e. flame resistant lab coat, type of respirator or cartridge).

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| --- | --- | --- | --- |
| **Hazard** | **Engineering Control(s)** | **Administrative Control(s)** | **Required PPE** |
| Oxygen Deficiency – dizziness, nausea, vomiting, convulsions, loss of consciousness, death | Fume hood, ventilated gas cabinet (optional), ventilation in room, oxygen sensors (optional) | Ensure adequate ventilation in the room |  |
| Cold burns, Frostbite and Hypothermia |  | Training | Thermal gloves, long pants, lab coat, fully enclosed shoes |
| Oxygen enrichment – explosion risk, dizziness, convulsions, vision changes, loss of consciousness | Fume hood, ventilated gas cabinet (optional), ventilation in room, oxygen sensors (optional) | Never pull vacuum on an open flask submerged in cryogenic liquid – can condense oxygen in the flask |  |
| Flammable gas – fire, explosion | Fume hood, ventilated gas cabinet (optional), ventilation in room, hydrogen sensors (optional), flashback arrester | Do not use any sparking tools or heat/ignition sources near the flammable gas. |  |
| **INSERT SPECIFIC HAZARDS/CONTROLS HERE** |  |  |  |
|  |  |  |  |

**Training Record**

Use the following table to record the training associated with this Standard Operating Procedure.

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| --- | --- | --- |
| **Print Name** | **Signature** | **Date** |
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