***STANDARD OPERATING PROCEDURE – C005***

**Handling cryogenics including liquid nitrogen**

1. **Objectives**

The objective of this document is to establish standard operating procedures (SOP) for handling cryogenics including liquid nitrogen, liquid argon and liquid helium ensuring the safety of laboratory personnel by mitigating potential risks associated with hazardous materials, and related injuries. In addition, this SOP aims to enhance the efficiency of experimental workflows.

1. **Personal Protective Equipment**

To ensure safety when handling cryogenics, appropriate personal protective equipment (PPE) must be worn. This includes:

* Long pants and closed-toe shoes to protect against spills and splashes.
* A long-sleeved, buttoned lab coat to minimize skin exposure.
* Safety glasses with side shields to protect against splashes and flying debris.
* Face shield when handling large volumes or during high-risk operations.
* Disposable nitrile or latex gloves to prevent direct contact with hazardous materials.
* Cryogenic gloves for handling ultra-low-temperature materials.
* Avoid wearing loose clothing or jewelry that could become entangled or contaminated.
* If the user has long hair, it should be tied back.

1. **Potential Hazards**

Handling cryogenics, including liquid nitrogen, can result in potential hazards that must be managed to maintain a safe working environment. These hazards include:

* **Frostbite and Cold Burns:** Direct contact with liquid nitrogen or cold surfaces can cause severe skin and tissue damage.
* **Asphyxiation:** Liquefied gas such as Nitrogen and Argon gas can displace oxygen in poorly ventilated areas, leading to oxygen deficiency and suffocation.
* **Pressure Buildup and Explosion:** Rapid expansion of liquid nitrogen into gas can cause pressure buildup in sealed containers, potentially leading to explosions.
* **Fire Hazard:** Condensation of oxygen from the atmosphere can create a fire risk, especially near flammable materials.
* **Physical Hazards:** Spills can create slippery surfaces, increasing the risk of falls and injuries.
* **Thermal Shock:** Rapid temperature changes can cause materials to crack or shatter, leading to potential injuries.

1. **Procedures**
2. Preparation

* Ensure that all personnel have received adequate training in cryogenic safety practices and emergency procedures.
* Read the [Risk Assessment for Storage and Use of Liquid Nitrogen](https://hseo.hkust.edu.hk/sites/default/files/2023-02/Risk%20Assessment%20for%20LN2_Mar2023-1.pdf) to understand its properties, hazards, and emergency protocols.
* Wear the appropriate PPE before engaging with cryogenics.

1. Handling Cryogenic Liquid

* Conduct all operations in a well-ventilated area or fume hood to minimize the risk of asphyxiation.
* Utilize cryogenic containers (e.g. Dewar flask) specifically designed for the storage and transportation of cryogenic liquid.
* Inspect all equipment (e.g. hoses, valves, and containers) for damage or wear before use. Avoid materials like glass that may shatter at ultra-low temperatures. Metals or plastics are preferred over glass.
* To ensure excess safe dispersal of gases, a Dewer flask may be opened and placed inside a fume hood.
* Do not fill secondary containers beyond 80% capacity to allow for expansion.
* When filling a container with liquified gases or inserting objects inside, proceed slowly to minimize boiling, splashing and thermal shock.
* Immediately re-cap any container after use to avoid atmospheric moisture from entering and forming ice plugs.
* Regularly inspect container necks and relief devices for ice plugs and remove them promptly.

1. Transporting Cryogenic Liquid

* Store and transport cryogenic materials only in Dewars or cryogenic liquid cylinders specifically designed for that purpose.
* Use a cart or trolley to move cryogenic liquid containers, minimizing the risk of spills and enhancing stability.
* Ensure all containers are securely capped during transport to prevent leaks and pressure buildup.
* Avoid moving cryogenic materials up or down stairs to reduce the risk of trips and spills.
* Transport cryogenic liquids in elevators only if the container is certified to leak a volume of less than or equal to 1 liter of liquid daily.
* The number of passengers in an elevator containing cryogenic liquids should be kept to a minimum.
* When transporting wheeled Dewars, at least two individuals should assist to ensure safety and to prevent the Dewar from tipping over.

1. Storing Cryogenic Liquid

* Store liquid nitrogen containers in cool, dry, and well-ventilated areas.
* Avoid placing them in cold rooms or other controlled environments without adequate air supply.
* Keep liquid nitrogen in designated locations, away from heat sources and incompatible materials.
* Post caution signs in the area to inform others that liquid nitrogen is being stored and used.
* Store and use liquid nitrogen away from flammable materials and ignition sources.
* Protect cryogenic storage containers from moisture to prevent the formation of ice plugs in relief devices.
* Regularly inspect cryogenic storage container necks for ice plugs and remove any that form in relief devices.
* Ensure all containers are clearly labeled with their contents and hazard warnings.

1. Waste Disposal

* Dispose of contaminated materials or equipment according to the institution’s hazardous waste disposal guidelines.
* Cryogens must never be disposed of in sinks or drains, as thermal shock can damage the sink and plumbing.
* Maintain good ventilation while cryogens are evaporating to hazardous gas concentrations from building up in the air.
* Do not store excess cryogen in a sealed container, as pressure buildup could cause an explosion.
* Purchase compressed gases only in cylinders from the Center of Laboratory Supplies and return any vessels when they are no longer needed.

**5) Spills and Incident Reporting**

* For small spills (<1 liter), ensure the area is well-ventilated and clean up using appropriate absorbent materials. Evacuation may not be necessary.
* For significant spills (>1 liter), evacuate the area immediately, notify nearby personnel, and contact the departmental safety officer or emergency response team.
* For injuries involving cold burns, rinse the affected area with warm water or submerge body part in a warm water bath for at least 15 minutes, then seek medical attention.
* Cryogenics can penetrate clothing more rapidly than water, so remove any contaminated clothing immediately.
* Avoid rubbing the skin, as this may cause further tissue damage.
* Cover the affected area with bulky, dry, sterile dressings and seek medical assistance promptly.
* Report any accidents that result in injuries to the Principal Investigator and/or the departmental safety officer immediately.
* For serious incidents, notify the Security Unit immediately by calling the 24-hour hotline on **2358 8999**.

**6) References**

* Kwan, A. (2016). *SOP\_SMB010: Using cryogens including liquid nitrogen.* Risk Assessment. The University of Sydney.
* Coleman, N. (2014). *SOP SMB010.2 (NC 0314): Cryogenics including liquid nitrogen*. The University of Sydney.
* Health, Safety and Environment Office, The Hong Kong University of Science and Technology (2025). *Risk Assessment for Storage and Use of Liquid Nitrogen.* From <https://hseo.hkust.edu.hk/sites/default/files/2023-02/Risk%20Assessment%20for%20LN2_Mar2023-1.pdf>
* Hong Kong Oxygen & Acetylene Co. Ltd., User Manual and Safety Information for Industrial Liquid Gas Containers (n.d.). From <https://hseo.hkust.edu.hk/sites/default/files/2023-02/LGC.pdf>
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