***STANDARD OPERATING PROCEDURE – R002***

**Using X-ray Cryosystems**

1. **Objectives**

The objective of this document is to establish standard operating procedures for using X-ray cryosystems, ensuring the safety of laboratory personnel by mitigating potential risks associated with hazardous materials and injuries. Additionally, this SOP aims to enhance the efficiency of experimental workflows.

1. **Personal Protective Equipment**

To ensure safety of using X-ray cryosystems, appropriate personal protective equipment (PPE) must be worn. This includes:

* Long pants and closed-toe shoes to protect against spills and cryogenic splashes.
* A long-sleeved, buttoned lab coat to minimize skin exposure.
* Safety glasses with side shields to protect against splashes and flying debris.
* Cryogenic gloves for handling ultra-low-temperature materials.
* Disposable nitrile gloves to prevent direct contact with hazardous materials.
* If the user has long hair, it should be tied back.
* A personal dosimeter must be worn by personnel working with X-ray.
1. **Potential Hazards**

Using X-ray cryosystems poses various hazards that must be managed to maintain a safe working environment. These include:

* **Cryogenic Exposure:** Contact with liquid nitrogen or surfaces cooled to cryogenic temperatures can cause severe cold burns or frostbite.
* **Asphyxiation Risk:** Large spills of liquid nitrogen can displace oxygen in enclosed spaces, leading to suffocation.
* **X-ray Radiation Exposure:** Improper use of shielding or bypassing safety interlocks may result in harmful radiation exposure.
* **Mechanical Hazards:** Moving parts, pressurized components, or equipment malfunctions pose pinch, crush, or implosion risks.
* **Electrical Hazards:** High-voltage components or faulty wiring may cause electrocution or fires.
1. **Training / Licenses**

Ensure all personnel have received proper training on their hazards and safe handling techniques. All users that will use X-ray must complete the relevant training and undergo medical surveillance and register as a radiation worker prior to start of work.

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Ensure the licenses for the apparatus, users, and workers remain valid.

1. **Procedures**
2. Pre-Operation Checks
* Ensure the licenses for the apparatus, users, and workers remain valid.
* All workers should read and understand the safety data sheet (SDS) of chemicals used for X-ray analysis. The SDS should be kept in the nearby work area.
* Examine the X-ray cryosystem for any signs of damage or leaks.
* Confirm that all safety equipment, including emergency shut-off switches are functional.
* Check the liquid nitrogen levels in the operating dewar before starting an experiment.
* Check dry air flow to the appropriate instrument.
* Ensure that the area is adequately ventilated to avoid oxygen displacement.
1. Dewar Filling
* Should there be low levels of liquid nitrogen after checking, liquid nitrogen should then be refilled.
* Appropriate PPE including face shield and cryogenc gloves should be worn when handling liquid nitrogen.
* All doors of the laboratory should be open to facilitate fresh air flow.
* The oxygen alarm installed should sound when detects oxygen levels are low. Users should leave the room immediately until oxygen levels return to normal.
* Liquid nitrogen should be filled into the dewar slowly.
* After refilling liquid nitrogen, the valve should be shut off and refilling tubes only be unplugged when it has reached room temperature.
1. Samples Preparation
* Use cryogenic gloves when handling all samples to prevent skin exposure.
* Make sure samples are correctly labeled and stored in appropriate cryogenic containers.
1. System Setting
* Adhere to the manufacturer’s guidelines for setting up the X-ray cryosystem.
1. Operation of the X-Ray Cryosystem
* Don all required PPE before initiating the system.
* Start the cryosystem and allow it 30 minutes to reach the standard operating temperature of 100K.
* Operate the X-ray cryosystem following the manufacturer's instructions, ensuring that all safety interlocks are engaged.
* Continuously monitor the temperature and pressure gauges during the operation.
1. Post-Operation Procedures
* Allow the system to return to room temperature prior to conducting any maintenance.
* Dispose of any cryogenic waste in accordance with institutional guidelines.
* Clean the workspace and ensure all equipment is powered off and stored safely.
* Equipment should be checked and maintained periodically.
1. **Spills and Incident Report**
* In the event of a large spill of liquid nitrogen, turn off all supply lines (only if it is safe to do so). **IMMEDIATELY** leave the laboratory. Notify other workers nearby to leave as well. Notify the Principal Investigator (PI) or laboratory safety officer immediately of any accidents or spills. Equipment malfunctions should be reported to the equipment custodian.
* For serious incidents, contact the Security Unit right away by calling the 24-hour hotline on **2358 8999**.
1. **References**
* Hofer, M. (2016). *SOP\_SMB035: Working with Phosphorus-32/33 radioactive isotope.* Risk Assessment. The University of Sydney.
* Guss, M. & Coleman, N. (2014). *SOP SMB037.2 (MG NC 0314): Using X-ray cryosystems.* The University of Sydney*.*
* Safety and Environmental Protection Manual *- Chapter 10: Radiation Safety | Health, Safety and Environment Office - the Hong Kong University of Science and Technology*