**CRYOGENS**

**STANDARD OPERATING PROCEDURE (SOP)**

TEMPLATE

**Type of SOP:** ☐ Process ☐ Hazardous Chemical ☒ Hazardous Class

All personnel subject to these SOP requirements must review a completed SOP and sign the associated training record. Completed SOPs must be \_\_\_\_\_\_\_\_\_\_\_\_\_ or be otherwise readily accessible to laboratory personnel. Electronic access is acceptable. SOPs must be reviewed, and revised where needed, as described in the\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Note that not all hazardous chemicals are appropriately addressed in a control-banded SOP, and some chemicals are subject to several control-banded SOPs. The unique properties of each chemical must be considered before including it into a control band.

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| Date SOP Written:  |  |  | Approval Date: |  |
| SOP Prepared by: | **REQUIRED - Insert Preparer's Name** |
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| SOP Reviewed and Approved by (name/signature): | **REQUIRED - Insert Approver's Name & Signature** |
| Department:  | **REQUIRED - Insert Department** |
| Principal Investigator/Laboratory Supervisor:  | **REQUIRED - Insert Name** | Phone:  | **REQUIRED - Insert Phone#** |
| Lab Manager/ Safety Coordinator:  | **REQUIRED - Insert Name** | Phone:  | **REQUIRED - Insert Phone#** |
| Emergency Contact(s):  | **REQUIRED - Insert Name** | Phone:  | **REQUIRED - Insert Phone#** |
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| Location(s) covered by SOP: | Building: | **REQUIRED - Insert Name** | Lab Phone: | **REQUIRED - Insert Phone#** |
| Room #(s):  | **REQUIRED - Insert Number** |

1. **HAZARD OVERVIEW**

Cryogens are liquefied or solid gases at low temperatures. These materials may be used for cooling, sample storage, or a ready source of pressurized gas. Cryogen exposure may result in tissue damage or asphyxiation due to displaced oxygen. Cryogenic materials stored in sealed containers must contain safety pressure release valves in order to avoid rapid expansion and container failure.

1. **HAZARDOUS CHEMICAL(S)/CLASS OF HAZARDOUS CHEMICAL(S)**

Cryogenic liquids are defined as liquids with a normal boiling point below -150 oC (-240 oF). Some examples include: liquid N2, O2, He, etc., which have typical gas:liquid expansion volumes of 650-1500:1. Cryogenic solids are defined as solids with a sublimation range of -78.5 oC to -109.3 oC (-109.3 °F to -164.7 °F). An example of this would be solid CO2 (dry ice). Finally, some mixtures of cryogenic materials and a solvent (*e.g.*, dry ice/acetone) may have flammability or other hazards in addition to cryogenic hazards.

REQUIRED - List (or attach) the applicable chemical(s) for your laboratory, and describe important properties and signs/symptoms of exposure.

1. **ENGINEERING/VENTILATION CONTROLS**
2. Cryogens should only be used in well-ventilated areas. Cryogenic material should never be stored in a refrigerator or freezer, as pressure can build up within the closed/sealed unit. Using cryogens within small rooms or unventilated areas (*e.g.*, cold rooms) may cause a buildup of gas as the cryogen evaporates or sublimes, displacing oxygen creating an asphyxiation hazard. If the use of cryogens is required in a small or unventilated room contact \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for alternative respiratory and/or ventilation options.

How not to do it: [Texas Dewar Accident Summary](http://www.tdi.texas.gov/fire/documents/fmred022206.pdf)

REQUIRED - Insert descriptions of lab-specific ventilation controls and equipment safety features utilized to reduce the risk of cryogen hazards.

1. **ADMINISTRATIVE CONTROLS**

The following elements are required:

1. Complete the Laboratory Safety Fundamentals training (UCLC) (or approved equivalent) training prior to working in the laboratory;
2. Complete laboratory-specific safety orientation and training on laboratory-specific safety equipment, procedures, and techniques to be used, including any applicable laboratory-specific Laboratory Safety Plan(s), prior to receiving unescorted access to the laboratory;
3. Demonstrate competency to perform the procedures to the Principal Investigator (PI), Laboratory Supervisor, laboratory-specific Safety Officer, and/or trainer;
4. Be familiar with the location and content of any applicable Safety Data Sheets (SDSs) for the chemicals to be used (SDS can be accessed online);
5. Implement good laboratory practices, including good workspace hygiene;
6. Inspect all equipment and experimental setups prior to use;
7. Follow best practices for the movement, handling, and storage of hazardous chemicals (see Chapters 5 and 6 of [Prudent Practices in the Laboratory](http://ucanr.edu/sites/ucehs/files/133892.pdf) for more detail). An appropriate spill cleanup kit must be located in the laboratory. Chemical and hazardous waste storage must follow an appropriate segregation scheme and include appropriate labeling. Hazardous chemical waste must be properly labelled, stored in closed containers, in secondary containment, and in a designated location;
8. Do not deviate from the instructions described in this SOP without prior discussion and approval from the PI and/or Laboratory Supervisor.
9. Notify the PI and/or Laboratory Supervisor of any accidents, incidents, near-misses, or upset condition (*e.g.,* unexpected rise or drop in temperature, color or phase change, evolution of gas) involving cryogens described in this SOP; and
10. Abide by the laboratory-specific working alone SOP, if applicable.

For Cryogens, the following are also required:

1. Successful completion of the Cryogen Safety training course; (Link to training in UCLC)
2. Read (insert supplemental material here, e.g., safety precautions, fact sheets)
3. Do not alter or disable the pressure-relief mechanisms/valves as installed by the manufacturer;
4. Do not alter/modify the cryogen containers as received from the vendor;
5. Do not store solid cryogens in a refrigerator or freezer, as pressure can build up within the closed/sealed unit;
6. Use tongs or similar tools to immerse and remove objects from liquid cryogens;
7. Do not touch cryogenic materials, or tools in contact with cryogens, with bare skin or disposable gloves (see PPE requirements below);
8. Cryogen handling insulated gloves shall be inspected before each use or at least annually. If any surface holes or non-uniform insulation materials are observed, the gloves must be replaced and the compromised gloves discarded;
9. Do not lubricate equipment for cryogenic oxygen use; and
10. Cryogenic dewars and/or delivery lines should be inspected for leaks and must be composed of compatible materials.

INSERT IF APPLICABLE - Describe any additional administrative controls (*e.g.,* restrictions on procedure/work equipment/work locations/unattended operations). Include any chemical-specific administrative controls (*e.g.,* peroxide formers).

REQUIRED - Descriptions of lab-specific handling, storage and transport procedures. This includes bulk materials and samples cryogenically preserved.

1. **PERSONAL PROTECTIVE EQUIPMENT (PPE)**

At a minimum, long pants (covered legs) and closed toe/closed heel shoes (covered feet) are required to enter a laboratory or technical area where hazardous chemicals are used or stored.

In addition to the minimum attire required upon entering a laboratory, the following PPE are required for work with cryogens:

1. Eye Protection: Eye protection is required for all work with cryogens.
	1. At a minimum ANSI Z87.1-compliant safety glasses are necessary.
	2. Splash goggles may be substituted for safety glasses and are required for processes where splashes are foreseeable or when generating aerosols.
	3. In addition to safety glasses/goggles, a face shield, in good condition, is **required** for transferring from any pressurized container, and should be considered for large volume transfers.
	4. Ordinary prescription glasses will NOT provide adequate protection unless they also meet the Z87.1 standard and have compliant side shields.
2. Body Protection: At a minimum a chemically compatible laboratory coat that fully extends to the wrist is necessary.
	1. If a risk of fire exists, a flame-resistant laboratory coat that is NFPA 2112-compliant should be worn.
	2. For chemicals that are corrosive and/or toxic by skin contact/absorption additional protective clothing (*e.g.,* face shield, chemically-resistant apron, disposable sleeves, etc.) are required where splashes or skin contact is foreseeable.
	3. Pants should not have cuffs, which could catch the liquid cryogen causing dermal burns.
	4. Shoes should be made of non-porous materials or have impermeable uppers.
3. Hand Protection: When hand protection is needed for the activities described in this SOP define the type of glove to be used based on: A) the chemical(s) being used, B) the anticipated chemical contact (*e.g.*, incidental, immersion, etc.), C) the manufacturers’ permeation/compatibility data, and D) whether a combination of different gloves is needed for any specific procedural step or task.
	1. Loose-fitting, thermal-insulated gloves that are meant for incidental contact (not intended for full immersion purposes) **must** be available to all personnel using cryogens. These gloves shall be inspected before each use or at least annually and replaced [as directed in the Administrative Controls](#GloveInspectionReplacement). No metal jewelry, watches, or rings should be worn while handing cryogens.

REQUIRED - Insert descriptions of PPE and hygiene practices used with each process, hazardous chemical(s), or hazardous chemical class, including any specialized PPE needed for a procedural step/task.

1. **SPILL AND EMERGENCY PROCEDURES**

Follow the guidance for chemical spill cleanup from \_\_\_\_\_\_\_\_\_\_ and/or the \_\_\_\_\_\_\_\_\_\_\_ unless specialized cleanup procedures are described below. Emergency procedure instructions for the UC \_\_\_\_\_\_\_\_\_ campus and/or UC Health System are contained in the UC \_\_\_\_\_\_\_\_\_\_\_ Laboratory Safety Manual, campus Emergency Response Guide (ERG), and UC Health System ERG. The applicable ERG must be posted in the laboratory. All other locations must describe detailed emergency procedure instructions below.

1. **Tank/dewar failures/any uncontrolled release of cryogenic material, including solids,**

**OR**

**If the cryogenic material spilled is anything but inert (Flammable/Combustible/Oxidizer):**

* + 1. Turn off sources of ignition if the cryogenic material is flammable or an oxidizer, if it is safe and feasible to do so;
		2. Evacuate the area; and
		3. Call **9-1-1**.
1. **Spills of inert cryogenic material (liquids or solids) more than 1 Liter in volume:**
2. Evacuate the area;
3. Allow ventilation to dissipate the gas; and
4. Contact EH&S at **(xxx) xxx-xxxx** for oxygen deficiency monitoring prior to reentry.
5. **Spills less than 1 Liter in volume of inert cryogenic material:**
6. Purge the room by raising the fume hood sash until the cryogenic material has completely evaporated/sublimed.
7. **Suspected slow and continuous leaks from a cryogen dewar or delivery line/system:**
	1. Discontinue use immediately. If it is safe and feasible, move the leaking dewar to a safe location: contact EH&S at **(xxx) xxx- xxxx** if unable to do so; and
	2. Contact the vendor immediately.

Care should be taken to prevent the accidental accumulation of **liquid oxygen**. Laboratory activities where liquid nitrogen or helium are used for cooling (*e.g.*, vacuum traps) have increased potential for liquid oxygen enrichment or entrapment. If a pale blue liquid is observed in a closed system, evacuate, and call **9-1-1**.

INSERT IF APPLICABLE - Descriptions of any specialized emergency procedures for locations outside of the UC main campus and/or the UC Medical Center campus.

Contaminated clothing or PPE should not be worn outside the lab. Soiled lab coats should be sent for professional laundering. Grossly contaminated clothing/PPE and disposable gloves must not be reused.

1. **WASTE MANAGEMENT**

Specific waste concerns for cryogens:

1. Do not put unneeded cryogens into a sealed container. Ensure good ventilation while the unneeded cryogen evaporates/sublimates;
2. If cryogen has been mixed with a liquid (*e.g.*, dry ice/acetone) that would normally be disposed of as hazardous waste, follow waste disposal procedures for that liquid once the cryogen has completely dissipated; and
3. Do not dispose of cryogens into sinks, as thermal shock or gaseous expansion may damage the sink and/or plumbing.

INSERT IF APPLICABLE - Descriptions of laboratory-specific information on the waste streams generated, storage location, and any special handling/storage requirements.

INSERT IF APPLICABLE - Descriptions of decontamination procedures for equipment, glassware, and controlled areas (*e.g.*, glove boxes, restricted access hoods, perchloric/hot acid fume hoods, or designated portions of the laboratory).

1. **DESIGNATED AREA**

INSERT IF APPLICABLE - Description(s) of the designated area(s) in your laboratory. Designated areas are required for "Particularly Hazardous Substances". The entire laboratory, a portion of the laboratory, a fume hood, etc. can be designated.

1. **DETAILED PROTOCOL**

REQUIRED - Insert or attach detailed laboratory-specific procedures for the process, hazardous chemical(s), or hazard class. You may also include any relevant supporting resources such as SafetyNets, journal citations, etc. that are applicable.

**TEMPLATE REVISION HISTORY**

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| --- | --- | --- | --- |
| **Version** | **Date Approved** | **Author** | **Revision Notes:** |
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**LAB-SPECIFIC REVISION HISTORY**

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| **Version** | **Date Approved** | **Author** | **Revision Notes:** |
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**Documentation of Standard Operating Procedure Training**

*(Signature of all users is required)*

* Prior to using **Cryogens**, laboratory personnel must be trained on the hazards described in this SOP, how to protect themselves from these hazards, and emergency procedures.

* Ready access to this SOP and to a Safety Data Sheet for each hazardous material described in the SOP must be made available.
* The Principal Investigator (PI), or the Laboratory Supervisor if the activity does not involve a PI, must ensure that their laboratory personnel have attended appropriate laboratory safety training or refresher training within the last three years.
* Training must be repeated following any revision to the content of this SOP.

**Designated Trainer:** *(signature is required)*

I have read and acknowledge the contents, requirements, and responsibilities outlined in this SOP:

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| **Name** | **Signature** | **Trainer Initials** | **Date** |
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