# Hazard Control Plan

## CRYOGENIC LIQUIDS

University of California, San Diego
Environment, Health & Safety, 0090
Phone: (858) 534-3660
http://blink.ucsd.edu/ehs

The following Hazard Control Plan (HCP) was created and approved by the UC San Diego Chemical Safety and Surveillance Committee in order to reduce the risks of working with committee identified high hazard materials. This HCP may not be altered or relaxed in any way to ensure the safe use of this chemical. You may add additional requirements to the "Lab Specific Instructions" section in support of your specific research protocol. To promote a safe and productive research environment, it is your responsibility to ensure all work with this material rigorously adheres to the HCP at all times.

UC San Diego Chemical Safety and Surveillance Committee http://blink.ucsd.edu/sponsor/VCRMP/chemical.html

EH&S Chemical Hygiene Officer ehschem@ucsd.edu

## CRYOGENIC LIQUIDS

This Hazard Control Plan (HCP) is intended to provide a comprehensive framework for working safely with cryogenic liquids. This HCP may not be altered or relaxed in any way. If you have questions regarding the content of this HCP, contact the Principal Investigator (PI) of your laboratory, or Environment, Health and Safety.

It is the Principal Investigator's responsibility to ensure that activity-specific laboratory procedures and/or processes are thoroughly documented within the Laboratory Specific Instructions section of this HCP. A short summary on why or how you are using this material, equipment, or process must be included in the Summary section. For detailed information go to the "Hazard Control Plan" Blink web page:
> https://blink.ucsd.edu/safety/research-lab/chemical/hcp/index.html#Hazard-Control-Plan

The word "cryogenic" means "producing, or related to, low temperatures.". All cryogenic liquids are extremely cold. Liquid nitrogen has a boiling point of about −195.8 °C (−320 °F; 77 K). Cryogenic liquids commonly used at UC San Diego include: liquid air, liquid argon, liquid helium, liquid nitrogen, liquid oxygen, slush mixtures of dry ice with isopropanol. All cryogenic liquids are gases at normal temperatures and pressures. These gases must be cooled below room temperature before an increase in pressure can liquefy them. Different cryogens become liquids under different conditions of temperature and pressure, but all have two properties in common: they are extremely cold, and small amounts of liquid can expand into very large volumes of gas. The vapors and gases released from cryogenic liquids also remain very cold. They often condense the moisture in air, creating a highly visible fog. In poorly insulated containers, some cryogenic liquids actually condense the surrounding air, forming a liquid air mixture.

Each cryogenic liquid has its own specific properties, but most cryogenic liquids can be placed into one of three groups:
- Inert Gases: Inert gases do not react chemically to any great extent. They do not burn or support combustion. Examples are nitrogen, helium, neon, argon and krypton.
- Flammable Gases: Some cryogenic liquids produce a gas that can burn in air. The most common examples are hydrogen, methane and liquefied natural gas.

- Oxygen: Many materials considered non-combustible can burn in the presence of liquid oxygen. Organic materials can react explosively with liquid oxygen. The hazards and handling precautions of liquid oxygen must therefore be considered separately from other cryogenic liquids.

Hazards associated with cryogenic liquids include fire, explosion, embrittlement, pressure buildup, frostbite and asphyxiation. There are three primary hazards associated with cryogenic liquids: extreme cold, asphyxiation, vaporization.

1) Extreme Cold Hazard
Cryogenic liquids, and their associated cold vapors and gases, can produce effects on the skin similar to a thermal burn. The cold boil-off vapor of cryogenic liquids rapidly freezes human tissue. Brief exposures that would not affect skin on the face or hands can damage delicate tissues such as the eyes. Prolonged exposure of the skin or contact with cold surfaces can cause frostbite. Symptoms of frostbite include cold skin and a prickling feeling, followed by numbness and inflamed or discolored skin. As frostbite worsens, skin may become hard or waxy-looking. There is no initial pain, but there is intense pain when frozen tissue thaws. Unprotected skin can stick to metal that is cooled by cryogenic liquids. The skin can then tear when pulled away. Even non-metallic materials are dangerous to touch at low temperatures. Prolonged breathing of extremely cold air may damage the lungs. Most metals become stronger upon exposure to cold temperatures, but materials such as carbon steel, plastics and rubber become brittle or even fracture under stress at these temperatures. Proper material selection is important.

2) Asphyxiation Hazard
When cryogenic liquids form a gas, the gas is very cold and usually heavier than air. This cold heavy gas does not disperse very well and can accumulate near the floor. Even if the gas is non-toxic, it displaces air. "Human beings must breathe oxygen . . . to survive, and begin to suffer adverse health effects when the oxygen level of their breathing air drops below [19.5 percent oxygen]." OSHA

3) Vaporization - All cryogenic liquids produce large volumes of gas when they vaporize. Liquid nitrogen will expand 696 times (696:1) the liquid volume as it vaporizes. The expansion ratio of argon is 847:1, hydrogen is 851:1 and oxygen is 862:1. If these liquids vaporize in a sealed container, they can produce enormous pressures that could rupture the vessel. For this reason, pressurized cryogenic containers are usually protected with multiple pressure relief devices. Vaporization of cryogenic liquids (except oxygen) in an enclosed area can cause asphyxiation. Vaporization of liquid oxygen can produce an oxygen-rich atmosphere, which will support and accelerate the combustion of other materials. Vaporization of liquid hydrogen can form an extremely flammable mixture with air.

*Definitions:
- Refrigerated Liquefied Gases are gases that are refrigerated below their normal boiling point in order to store the gas in liquid phase.
- Cryogenic Liquids are defined as refrigerated liquefied gases with a normal boiling point less than -90C (-130F), e.g., liquid nitrogen, liquid argon, liquid helium, liquid oxygen and liquid hydrogen.
- Liquid Cylinders are portable containers designed for long term storage and use of refrigerated liquefied gases. These containers consist of an insulated inner container inside a larger secondary container, separated by a

vacuum jacket. LN2 cylinders vary in capacity from about 80 to 450 liters. All liquid cylinders are provided with a vent valve (VENT) and a liquid valve (LIQUID), and/or gas valve (GAS, USE). Cylinders provided with high pressure also have a pressure building valve.

- Liquid Valve is used to withdrawal liquid nitrogen from the cylinder and marked LIQUID on the cylinder. It is provided with a CGA 295 connection.
- Vent Valve is used to manually control pressure in the head space of the cylinder and usually marked VENT on the cylinder. It is also provided with a CGA 295 connection.
- Gas Valve is used to withdraw gas-phase nitrogen from an LN2 cylinder and usually marked GAS or USE on the cylinder. It is provided with a CGA 580 connection.
- Pressure Building Valve is used to increase headspace pressure for gas withdrawal by vaporizing liquid nitrogen and transferring it to the headspace.
- Outlet Restraints are plastic tags sometimes placed on valve outlets, which must be removed to change outlet fittings. These restraints should NEVER be removed by laboratory personnel.
- Pressure Gauge gives readout of pressure in the head space of the cylinder.
- Liquid Dewars are non-pressurized, vacuum jacketed vessels used for storage or transfer of small amounts (2-50L) of LN2. These dewars may be used to transfer (pour) liquid cryogen directly into dewar flasks or devices containing small amounts of liquid cryogen (≤5L) such as cold traps, small cryostats, crystal mounting baths or to replenish larger dewars that cannot be moved.
- Dewar Flasks are small (<5L) open-mouthed vacuum jacketed steel or glass storage devices used to contain LN2.
- Dry Shippers are containers designed to maintain liquid nitrogen temperatures for up to several days yet do not have any free LN2 and do not present any risk of LN2 release. Non-regulated samples shipped in dry shippers are exempt from DOT and IATA requirements.
- LN2 Freezers are dewars designed specifically to store biological samples for preservation. Samples can be stored in liquid or vapor/gas phase nitrogen by means of racks and containers. LN2 capacity can vary from a few liters to more than 1,600 liters. Medium and large capacity LN2 Freezers will be provided with automatic LN2 fill systems either from liquid cylinders or centralized LN2 storage tanks; while smaller to medium systems may be manual fill.
- Liquid Withdrawal Devices (LWD) are designed to be attached to larger portable dewars so that liquid content can be withdrawn under low-pressure. They are provided with a liquid withdrawal valve, vent valve and usually a pressure relief device. They can be attached to manufacturer-designated dewars by means of a ring clamp and safety cable or chain.
- Transfer Hose Flexible are usually stainless steel hoses designed for service with cryogenic liquids. Connection will have CGA 295 female threads for inert gases (LN2, LAr). Hoses for intermittent use are often not insulated, while hoses for continuous service usually are insulated. Hoses come in several lengths.
- Phase Separator is a device that is attached to the end of a transfer hose that minimizes splashing from boil-off when transferring LN2.
- Cryovials come in various sizes, usually made of plastic that are designed for the storage of biological samples in vapor-phase LN2.
- Liquid Nitrogen Tanks are fixed storage units used to supply LN2 or gas-phase nitrogen to laboratory systems.

## Required Training / Approvals

All research involving cryogenic liquids requires the following prior to beginning work:
1. Must be trained and approved by the PI, and all training must be well documented.
a. Training must include the use of pressurized vessels and laboratory dewars.
2. Follow this mentor method until proficiency is demonstrated:
a. The first time observe. This includes operating a pressurized vessel.
b. The second time work cooperatively.
c. The third time conduct the experiment in the presence of a mentor.
d. The fourth time become a mentor - provide feedback to your PI regarding this HCP.
3. Must be familiar with, and know how to access, the UC San Diego "Chemical Hygiene Plan":
> http://blink.ucsd.edu/go/chemicalhygiene

4. Must have the following documented safety training BEFORE beginning work in a laboratory facility:
a. UC Laboratory Safety Fundamentals - Required for all UC San Diego laboratory personnel before beginning work in a laboratory facility, with refresher training required every 3 years. Introduces staff to fundamentals of laboratory and chemical safety, general safety, and their rights and responsibilities. Go to UC Learning Center and take the UC Laboratory Safety Fundamentals eCourse. Search keyword: laboratory.
b. Annual Laboratory Hazards Training - Required for all UC San Diego laboratory personnel before beginning work in a laboratory facility, with refresher training required annually. Hazardous materials handling, waste disposal, and emergency response are covered. Go to UC Learning Center and take the Annual Laboratory Hazards Training eCourse. Search keyword: annual.
5. Must always follow this HCP.
6. Must read the relevant manufacturer specific Safety Data Sheets. To locate and evaluate Safety Data Sheets go to the "Safety Data Sheet Sources" Blink web page:
> https://blink.ucsd.edu/safety/resources/SDS/sources/index.html

7. Complete all the necessary additional laboratory specific training that is required to safely work with this material/equipment/process including experimental procedures, journal article reviews, and other technical or scholastic references/reviews. This laboratory specific training must be referenced in the 'Laboratory Specific Instructions' section and made available for review by EH&S.
8. Watch the Liquid Cylinder Operation YouTube video from Chart Industries for a useful overview:
> https://youtu.be/Ha3_MFZ_MaM

## Administrative Controls

Definition: Administrative controls are changes in work procedures with the goal of reducing the duration, frequency, and severity of exposure. Review the UC San Diego "Chemical Hygiene Plan" Blink web page for further information:
> https://blink.ucsd.edu/safety/research-lab/chemical/hygiene.html#Exposure-control-practices

1. Never work alone. At least one other person must be present in the same laboratory.
2. Review the UC San Diego "Emergency Guide" in its entirety prior to beginning work with hazardous materials.

Proactive review is essential to a safe laboratory environment:
> https://blink.ucsd.edu/safety/emergencies/preparedness/guide.html

a. Know where every copy of the Emergency Guide is located within each laboratory space.
b. Cover the details of the Emergency Guide in regularly scheduled laboratory meetings.
c. Contact EH&S if you need additional copies of the Emergency Guide.
3. Eliminate or substitute for a less hazardous material when possible.
4. Design your experiment to use the least amount of material possible to achieve the desired result.
5. Verify your experimental set-up and procedure prior to use.
6. Inform colleagues when using large quantities or when use presents a higher degree of risk. Any attempt to scale up the reaction, or change the parameters beyond the scope of the equipment or experiment, MUST be preapproved by the PI.

## Engineering Controls

1. Make sure cryogenic materials are used in rooms with sufficient ventilation. General laboratory room ventilation is usually adequate.
2. Do not store or use in unventilated closets and/or small rooms with poor ventilation. This can be a serious asphyxiation risk.
a. If you are unsure if the space in which you plan to store or use cryogenic liquids has sufficient ventilation, contact EHS for an evaluation. An oxygen sensing device may be required.
3. All cryogenic systems, including piping, must be fitted with pressure relief devices that are directed to a safe location.
a. Liquid cylinders have multiple pressure relief devices built-in to the cylinder. Do not alter or defeat these devices in any way.
4. Use seismic restraints (chain) to secure large pressurized cylinders using the top-ring tether or double restrain with non-combustible material (e.g. chain) - like compressed gas cylinder restraints.

## Personal Protective Equipment

Definition: Personal protective equipment (PPE) controls hazards that cannot be eliminated through engineering and administrative controls. PPE includes all clothing and accessories designed to protect against safety and health hazards. For more information regarding PPE visit the UC San Diego Blink web page "Personal Protective Equipment (PPE)":
> https://blink.ucsd.edu/safety/occupational/PPE/

NOTE: Ensure that you have completed your Laboratory Hazard Assessment Tool (LHAT) to account for the required PPE listed below.

IMPORTANT: You must wear appropriate PPE when dispensing from liquid cylinders! It has been observed that researchers frequently dispense materials without eye protection, lab coats, and even cryo gloves - this is a foolish practice and will eventually result in serious injury.

At a minimum, the following PPE must be worn at all times:
1. Eye Protection
a. Safety glasses that meet the ANSI Z87.1 Standard.
i. Ordinary prescription glasses will NOT provide adequate protection unless they also meet this Standard.
b. When there is the potential for splashes (dispensing or transferring cryogenic liquids), safety glasses and a face shield must be worn.

2. Skin Protection
a. Lab coat.
i. Fully extended sleeves that cover the wrists. Do not cuff your sleeves - cuffed sleeves can trap cryogenic material and lead to cold burns
ii. Buttoned at all times.
iii. Additional protective clothing (e.g. sleeve protectors, chemical apron, etc) may be necessary when handling larger quantities or when activities present increased risk of exposure.
b. Gloves - Cryogenically rated, loose-fitting gloves.
i. Must be loose fitting so that they can be quickly removed.
ii. Cryogenic gloves are not rated for immersion into cryogenic liquids or for prolonged handling of cryogenically chilled materials
iii. Cryogenic gloves are required when dispensing or when there is a risk exposure to hands.
iv. For proper selection of glove material, review the chemical Safety Data Sheet as well as the glove selection guidance on the Environment, Health and Safety "Gloves Overview" Blink web page:
> http://blink.ucsd.edu/safety/occupational/PPE/gloves/index.html

v. Thoroughly decontaminate reusable gloves before and after every use.
vi. Never reuse disposable gloves.
c. Close toed shoes.
d. Covered legs. Do not wear pants with cuffs - cryogenic liquids can get trapped in cuffs and lead to cold burns.

3. Respiratory protection. EH&S must be consulted if there is a risk of inhalation exposure.

NOTE: Additional PPE may be required if procedures or processes present additional risk. It is the responsibility of the PI to ensure that any additional PPE requirements are identified and communicated to research staff.

## Handling / Storage / Purchasing

Cryogenic liquids are shipped and used in thermally insulated containers. These cryogenic liquid containers are specifically designed to withstand rapid temperature changes and extreme differences in temperature.

Vessel Types:
- Liquid Dewar Flasks
Liquid dewar flasks are non-pressurized, vacuum-jacketed vessels, somewhat like a "Thermos bottle". They should have a loose fitting cap or plug that prevents air and moisture from entering, yet allows excess pressure to

vent. Flasks containing helium, hydrogen and other low- boiling liquids have an outer vessel of liquid nitrogen for insulation.

- Laboratory Liquid Dewar Flasks
Laboratory liquid dewars have wide-mouthed openings and do not have lids or covers. These small containers are primarily used in laboratories for temporary storage.

- Liquid Cylinders
Liquid Cylinders are portable containers designed for long term storage and use of refrigerated liquefied gases. These cylinders consist of an insulated inner container inside a larger secondary container, separated by a vacuum jacket. LN2 cylinders vary in capacity from about 80 to 450 liters. Some liquid cylinders have rollers attached while others do not. All liquid cylinders are provided with a vent valve (VENT), a liquid valve (LIQUID), and/or gas valve (GAS, USE), and a pressure building valve. --- IMPORTANT SAFETY FEATURE --- These vessels have Pressure Relief Devices (PRD) installed to prevent excess pressure and rupture of equipment. PRDs in liquid cylinders include a spring-loaded relief valve, a rupture disk for the head space of the internal container, and a rupture disk for the vacuum jacket. Cylinders may have a low-pressure relief valve set at 22 psi, a high-pressure relief set at 230 or 350 psi, or both. Liquid phase nitrogen is withdrawn at 22 psi and gas phase is usually withdrawn under higher pressures. The pressure relief valve should be marked with a pressure setting. When using cryogenic liquid cylinders, users should ensure that all valves and pressure relief devices are in place and in good condition. If pressure relief devices fail or are defeated, catastrophic failure may result. ***See the State Fire Marshals Alert dated February 22, 2006 in the reference section of this HCP regarding a liquid cylinder that failed due to defeated PRDs.

NOTE: Liquid cylinders routinely relieve their internal pressure through the PRD - you may observe a sudden hissing sound and the appearance of a fog. This is completely normal. Occasionally, the PRD will freeze in the open position allowing the hissing sound to continue indefinitely. If this happens, contact EHS and we will resolve the issue.

>>> SPECIAL NOTE ON LIQUID NITROGEN FREEZERS AND CRYOPRESERVATION OF SAMPLES <<<

- Follow manufacturer recommendations at all times when using liquid nitrogen freezers. Keep the operators manual with the equipment.
- Do not lean into freezer units when accessing samples.
- Do not breath in the cold vapors. It could lead to lung tissue damage.
- Guard against oxygen depletion by limiting access times to liquid nitrogen freezers and keeping your breathing zone as far as is practical from the freezer opening.
- Do not create freezer farms of liquid nitrogen freezers without EH&S approval. Rooms need to be designed to handle the ventilation and oxygen monitoring requirements that liquid nitrogen freezers demand.
- Wear appropriate cryogenic materials PPE at all times. See PPE section of this HCP.
- Do not overfill cryovials beyond the designated fill line. This will increase the risk of cracking and possible release of contents.
- If at all possible, store cryovials in the vapor phase of liquid nitrogen freezers. Most manufacturers of cryovials do not recommend liquid-phase storage.
- When liquid-phase storage is required or necessary, specialized cryoflex tubing or other safety enclosures that

can be heat sealed to prevent the entry of liquid nitrogen into cryovials should be used. However, if these items are used inappropriately, the risk of violent rupture is still possible.
- For cryovials immersed in liquid-phase storage, it is recommended that tubes are placed in a sealed, unbreakable, plastic container immediately after removal from storage and prior to thawing. Tubes can also be moved from the liquid-phase to the vapor-phase for at least 24-48 hours prior to removing from the storage container. When vials are stored within the liquid-phase of liquid nitrogen, liquid nitrogen can leak into the vials during immersion and rapidly expand when removed from storage and warmed to room temperature. A rupture can cause both flying debris and exposure to the contents. Cryovials containing human cells or other potentially infectious materials should be handled or thawed in a biosafety cabinet. This will contain aerosols if over pressurization or rupture occurs.

PURCHASING

- Purchase only what you need in a reasonable amount of time.
- Do not purchase liquid oxygen without consulting with EHS first. There are significant safety precautions that must be reviewed prior to beginning work with liquid oxygen.

STORAGE

- Use seismic restraints to secure large dewars and liquid cylinders. Large nitrogen cylinders must be restrained to a wall with a top-ring tether or double restrained with non-combustible material (chain).
- Keep containers clean and dry.
- Moisture, animal waste, chemicals, strong cleaning agents, and other substances can promote corrosion or clog relief valves.
- Use water or mild detergent for cleaning and dry the surface thoroughly.
- Do not use strong alkaline or acid cleaners that could damage the finish and corrode the metal shell.
- Store and use cryogenic liquids only in well-ventilated laboratory locations. If the rapid loss of containment would depress oxygen to below 19.5% you must install an O2 monitor. If you are unsure if a location has sufficient ventilation contact EHS for an evaluation of the space.
- Do not store in front or near egress points (e.g. doorways)
- Never store liquid cylinders in environmental rooms due to very limited ventilation.
- Must obtain approval to store liquid cylinders in any location other than a laboratory.

HANDLING

Wear your PPE at all times!

Risk of asphyxiation: Cryogenic liquids produce large volumes of gas upon vaporization and will displace oxygen. When cryogenic liquids form a gas, the gas is very cold and usually heavier than air. This cold heavy gas does not disperse very well and can accumulate near the floor. Even if the gas is non-toxic, it displaces air (e.g. oxygen). When there is not enough oxygen, asphyxiation and death can occur. Oxygen deficiency is a serious hazard in enclosed or confined spaces (closets, offices, small rooms). Because nitrogen makes up 79% of our breathable air, we cannot detect an increasing concentration of nitrogen and reduced concentration of oxygen, resulting in a very hazardous situation. "Human beings must breathe oxygen . . . to survive, and begin to suffer adverse health effects when the oxygen level of their breathing air drops below [19.5 percent oxygen]." OSHA

Containers:
- Use high-quality dewars with protective covers instead of standard thermos bottles.
- Check dewars regularly for damage. If damaged they must be taken out of service. Hairline cracks can be hard to detect and can lead to failure of the vessel. Be diligent in reviewing your equipment.
- Do not cover or plug container openings. Cryogenic liquid containers are generally designed to operate with little or no internal pressure. Inadequate venting can result in excessive pressure, possibly damaging or bursting the container.
- Use only the loose-fitting neck tube core supplied by the manufacturer, or one of the approved accessories for closing the neck tube.
- Check containers periodically to be sure that venting is not restricted.
- Be vigilant against ice plug formation. Because oxygen has a higher boiling point than hydrogen, helium, or nitrogen, it can be condensed out of the atmosphere with the use of those lower boiling point cryogens. Use with liquid hydrogen is particularly dangerous!
- Keep containers upright at all times, except when pouring liquid from dewars specifically designed for that purpose.
- Use a dolly or handcart when moving containers. Do not walk, roll, or drag these units across a floor. Rough handling can cause serious damage to dewars and refrigerators.

Operational hazards:
- Never permit unprotected body parts to directly contact cryogenic liquids or uninsulated vessels containing cryogenic liquids. Contact with cryogenic liquids results in painful burns.
- Boil-off vapors can rapidly freeze human tissue.
- Use caution when sealing containers that have been highly cooled. Cryogenic liquids condense room air gases and will expand, or possibly explode when allowed to warm. Sealed sample tubes removed from LN2 storage units can rapidly warm and explode if not handled correctly.
- Boil-off vapors can rapidly cause embrittlement of many common materials and cause them to shatter.
- Excessive ice buildup can result in the discharge of cold gas or structural damage to the cryogenic container or its surroundings.
- Fire or explosion from oxygen condensation in operational equipment such as cold traps or storage dewars is a serious concern.
- Boiling and splashing always occur when charging or filling a warm container with cryogenic liquid or when inserting objects into these liquids. Perform these tasks slowly to minimize boiling and splashing. Use tongs to withdraw objects immersed in a cryogenic liquid.
- Stand back and avoid putting head/face directly above the dewar, fill container, or other areas where cryogenic liquids are boiling off.

Operational controls:
- Never use hollow rods or tubes as dipsticks.
-- When a warm tube is inserted into liquid nitrogen, liquid spouts from the bottom of the tube due to gasification and rapid expansion of liquid inside the tube.
-- Wooden or solid metal dipsticks are recommended.
-- Avoid using plastics that may become very brittle at cryogenic temperatures.
- Use hot air, steam, or water to thaw frozen equipment. Caution: Do not use water to thaw liquid helium equipment.

- Never dispose of cryogenic liquids in confined areas or places where others may enter. Dispose of liquid nitrogen outdoors in a safe place.
-- Pour the liquid slowly on gravel or bare earth where it can evaporate without causing damage.
-- Do not pour the liquid on pavement or laboratory tile.
- Never pour cryogenic liquids down the drain - it would severely damage the plumbing.

Transferring cryogenic liquids between containers:
- Fill containers SLOWLY to minimize the internal stresses that occur when any material is cooled.
- Do not overfill containers. Fill only to the bottom of the neck tube.
- Minimize boiling and splashing of cryogenic liquid when transferring to an open container such as a dewar.
- Use a phase separator or special filling funnel to prevent splashing and spilling when transferring cryogenic liquids into or from a dewar or refrigerator.
- Partly cover the top of the funnel to reduce splashing.
- Use only small, easily handled dewars for pouring liquid.
- For the larger, heavier containers, use a cryogenic liquid withdrawal device to transfer liquid from one container to another.
- When liquid cylinders, or other large storage containers, are used for filling, follow the instructions supplied with those units and their accessories.

## Spill Response

Review the EH&S "Emergency Guide" Blink web page before beginning work in a UC San Diego laboratory. Know where every copy of this document is posted and its contents:
> http://blink.ucsd.edu/safety/emergencies/preparedness/guide.html

Learn how to evaluate and safely handle chemical spills in your laboratory by reviewing "How to Handle Chemical Spills in Laboratories Blink web page":
> https://blink.ucsd.edu/safety/research-lab/chemical/spills/index.html

Ensure that your laboratory has a spill kit and where it is located. Review the :Small-Scale Chemical Spill Kits" Blink web page for further information:
> https://blink.ucsd.edu/safety/research-lab/chemical/spills/kits.html

Important safety note: Cryogenic materials can present difficult challenges depending on the material. Asphyxiation and/or extreme cold are just some of the risks. If you are unsure or feel uncomfortable cleaning up a spill, contact EH&S right away. DO NOT attempt to clean a spill beyond your level of comfort or expertise.

## Exposure Response

Chemicals may enter the body through four routes: inhalation, ingestion, injection, or contact with the skin and eyes. With each route of exposure, the likelihood of injury depends on the toxicity of the chemical involved, the concentration of the material, and the duration of contact.

For all exposures:
1. Seek immediate medical attention.
2. Call Campus Police at (858) 534-4357 (534-HELP) and request an ambulance if transportation is necessary.
3. Call the Poison Control System (800) 222-1222) if additional information is needed.
4. If you're injured, experience a hazardous material exposure, or develop a job-related illness as a result of your UCSD employment, follow the procedures outlined on the "Worker's Compensation" Blink web page:
> http://blink.ucsd.edu/go/workerscomp

Refer to the "Emergency Preparedness Procedures, Chemical or Radiation Spill" on Blink for generic emergency response procedures:
> http://blink.ucsd.edu/safety/emergencies/preparedness/guide.html

Before beginning work with chemicals, review the relevant Safety Data Sheet and appropriate chemical safety resources as listed in the Training/Approval section of this document. Develop specific procedures for emergency response and chemical exposure or injury to staff, including any special first aid measures required for the relevant chemical.

Additional special instructions for Department of Chemistry / Biochemistry personnel only:
1. Report serious incidents immediately: Call 9-1-1
2. Immediately secure any incident scene from all access and preserve all evidence for no less than 24 hours.

## Hazardous Waste Disposal

Cryogenic liquids must be managed as hazardous waste as per the UC San Diego EH&S Blink web page "How to Store and Dispose of Hazardous Chemical Waste":
> http://blink.ucsd.edu/safety/research-lab/hazardous-waste/chemical.html

IMPORTANT NOTE: Generating cryogenic liquid waste is not a common activity. If you need assistance, contact EHS.

## Referenced Resources

References:

* Laboratory Safety Guideline, Harvard University, 2019
> https://www.ehs.harvard.edu/sites/default/files/lab_safety_guideline_liquid_nitrogen_and_argon.pdf

** Liquid Nitrogen Storage of Cryovials Safety, George Washington University
> https://labsafety.gwu.edu/liquid-nitrogen-storage-cryovials-safety

***State Fire Marshal's Alert, February 22, 2006, University Campus Liquid Nitrogen Cylinder Explosion
> https://www.tdi.texas.gov/fire/documents/fmred022206.pdf

Liquid Cylinder Operation YouTube video, Chart Industries
> https://youtu.be/Ha3_MFZ_MaM

Guidance for the safe operation of liquid nitrogen freezers for cryo-preservation, Air Products Inc., Safetygram 49
> Google search and download PDF file

Resources:

A Guide to The Globally Harmonized System of Classification and Labeling of Chemicals ¿ U.S. Dept. of Labor, OSHA:
> https://www.osha.gov/dsg/hazcom/ghsguideoct05.pdf

Regulations:

Occupational Exposure to Hazardous Chemicals in Laboratories (Laboratory Standard) California Code of Regulations (CCR), Title 8, §5191:
> https://www.dir.ca.gov/title8/5191.html

Personal Protective Devices California Code of Regulations, Title 8, §3380:
> https://www.dir.ca.gov/title8/3380.html

Injury & Illness Prevention Program (IIPP) California Code of Regulations, Title 8, §3203:
> https://www.dir.ca.gov/title8/3203.html

UCSD PPM 516-5 Chemical Safety:
> https://blink.ucsd.edu/_files/safety-tab/research/chemical/516%205%20chem%20safety.pdf