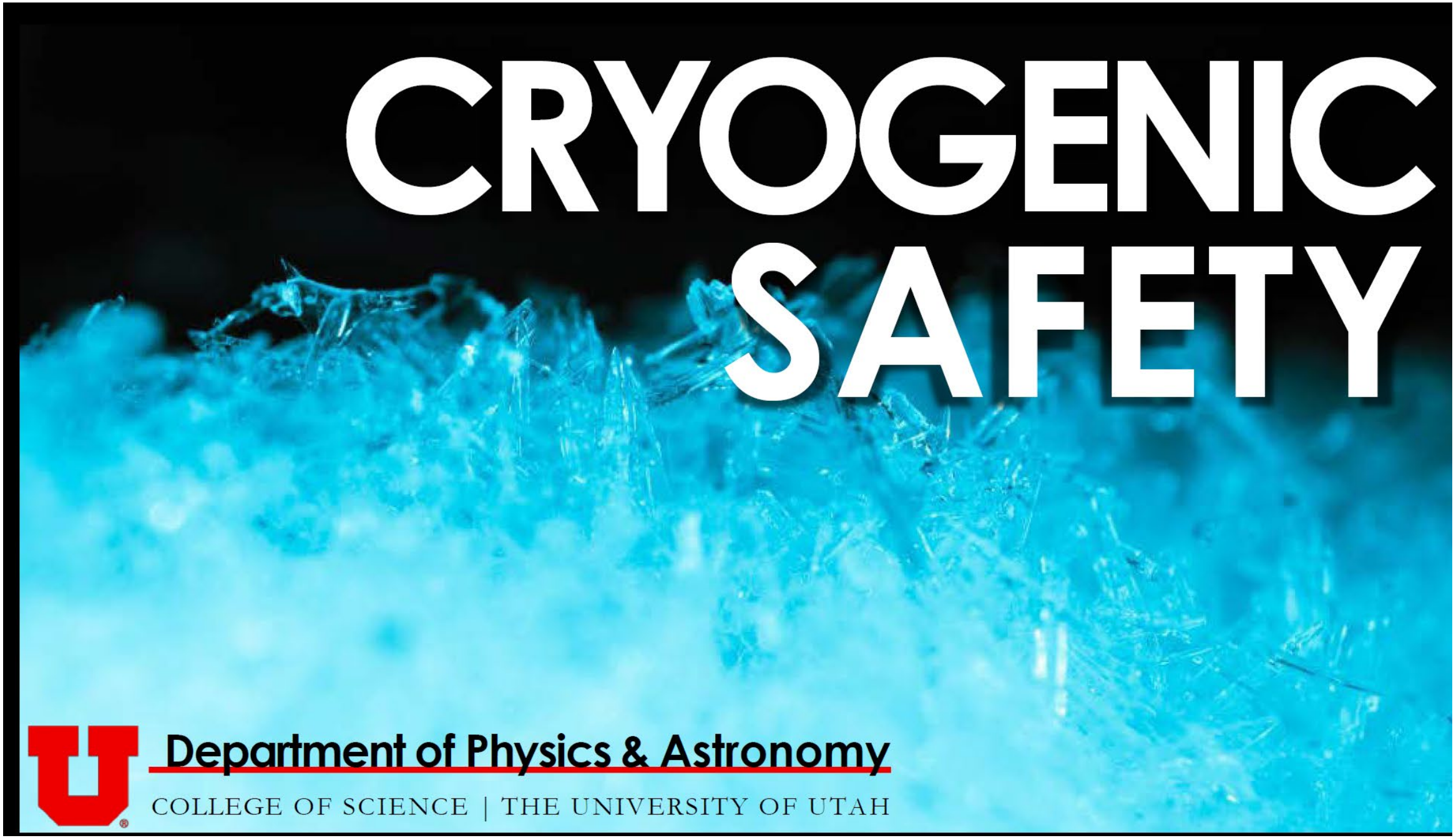


Department of Physics & Astronomy

COLLEGE OF SCIENCE | THE UNIVERSITY OF UTAH

INTRODUCTION

Cryogenics is the science of ultra low temperatures. These low temperatures are achieved by the liquefaction of gases.

The gases which are most widely used in industry and research are hydrogen, helium, nitrogen, fluorine, argon, oxygen and methane.

In our department, you'll most often be working with liquid **helium** and **nitrogen**.

PROPERTIES OF CRYOGENIC FLUIDS

- Extremely low temperatures
- Large ratio of expansion in volume from liquid to gas
- Most cryogenic liquids are odorless and colorless when vaporized to gas

PROPERTIES OF CRYOGENIC FLUIDS

- Boiling points of common cryogens
  - Helium -452.1 °F (-268.9 °C)
  - Nitrogen -320.4 °F (-195.8 °C)
  - Oxygen -297.3 °F (-182.9 °C)

- Liquid-to-gas expansion ratios of common cryogens
  - Helium 1 to 757
  - Nitrogen 1 to 696
  - Oxygen 1 to 860

STORAGE OF CRYOGENIC LIQUIDS

- Cryogenic fluids are stored in well insulated containers to minimize loss due to boil off
- The most commonly used container for handling cryogenic fluids is the **Dewar flask**
- Dewars are non pressurized, vacuum-jacketed vessels

TYPES OF CRYOGENIC DEWARS

CROSS-SECTION OF A CRYOGENIC DEWAR

Liquid Level Gauge

Not clearly shown – pressure relief valves

Pressure Regulators/Gauges

Vacuum Draw Port

Pressure Building Manifold

Outer Vessel

Superinsulation Layer

Inner Vessel

Liquid Draw/Fill Tube

PRECAUTIONS WHEN HANDLING CRYOGENS

- Cryogenic containers must not be dropped or tipped on their sides; this can cause a partial or complete loss of vacuum in the outer jacket.

- Frost spots may appear in case of loss of insulating vacuum. A vessel in this condition must be removed from service. Repairs must be handled by the manufacturer.

- **Never** use a hollow tube/rod as a dipstick. A warm tube will boil the cryogen and the change in pressure will cause the liquid to spout from the top.

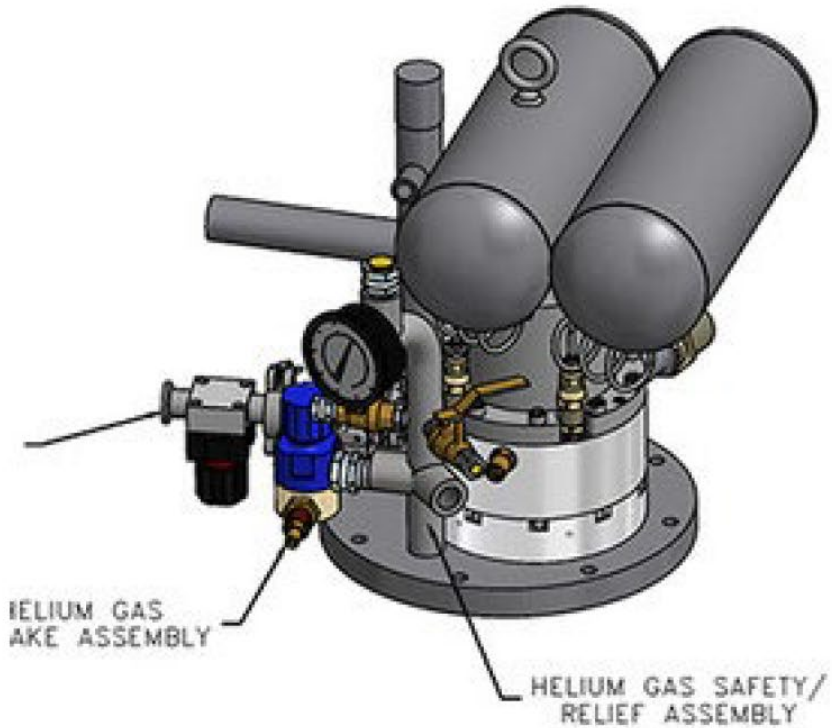
SPECIAL PRECAUTIONS WITH LIQUID HELIUM

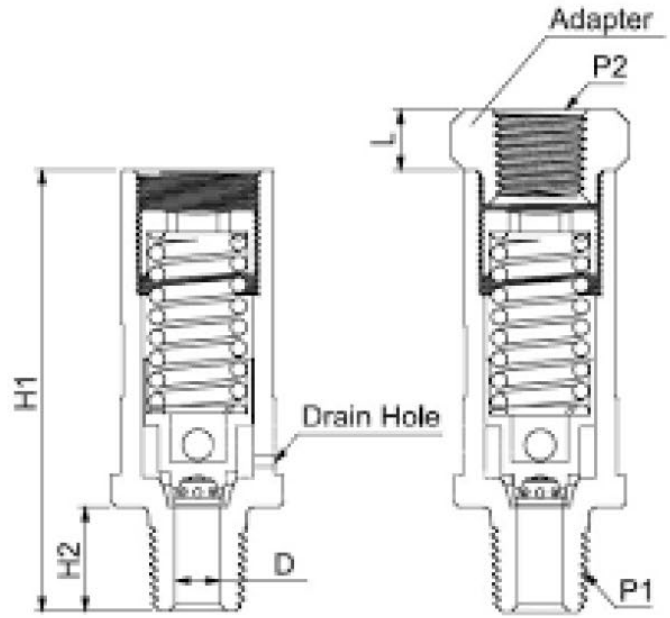
- Liquid helium is **extremely** cold and air readily liquifies and solidifies when exposed to the extremely low temperature

- Solidified gases may plug pressure relief passages and relief valves, creating a safety hazard

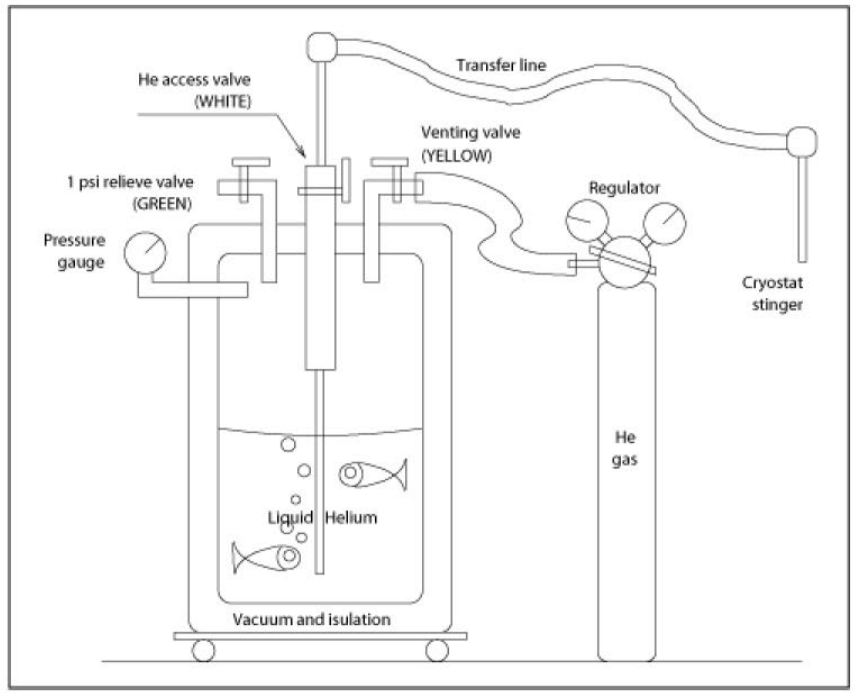
- The fill and vent ports of helium dewars must be kept closed at all times (except during filling) to prevent blockages from forming in the exit passage and a resultant pressure build up

Pressure relief valves. If pressure in a dewar is excessively high check the valve. Use it to relief pressure manually using, screw driver, gloves, glasses





Transfer Liquid He (or Nitrogen). This can also be a set up for flow cryostat.



GOOD

BAD

1) Start slow. Take time to cool equipment
2) The cylinder with the pressurizing gas must be secured to wall or other stationary object.

OXYGEN DEFICIENCY

- Cryogenic liquids must be handled in well-ventilated areas to prevent excessive concentrations of gas in enclosed spaces
- The gas vented/released from experimental equipment is also an asphyxiation hazard and should be well-vented
- Oxygen level detectors should be installed in spaces where there is chance of build up of gases causing oxygen deficiency
- **Remember:** nitrogen gas is heavy and will pool on the floor, but helium gas is light and will pool on the ceiling

FROST BURNS

- Contact with cryogens (both liquid and chilled vapor) can quickly cause burns similar to thermal burns caused by high temperature.
- Cryogens can cause embrittlement of the exposed body surface because of high water content of the human body
- Extreme blistering and tissue damage can result
- Splashing of cryogens can result in permanent eye damage

PRECAUTIONS WHEN HANDLING CRYOGENS

Gloves must **always** be worn when working with cryogenic liquids.

Safety glasses must be worn for eye protection. Face shields are recommended for face protection.

Aprons are recommended to protect against splashing. At the very least, never wear shorts or open-to ed shoes when working with cryogens.

Watches, rings or similar items should not be worn as they can trap cryogenic liquid on the skin if spilled

Gloves for cryogenic liquids

Safety versus convenience trade off.
If gloves are not convenient, things cab dropped resulting in accident.

1) Get gloves of few sizes to match everybody in your group.

2) Leather ski gloves looks as a good compromise.

PRECAUTIONS WHEN HANDLING CRYOGENS

- A hand cart or trolley must be used to transport large cryogenic dewars

Transporting cryogenic containers in elevators.

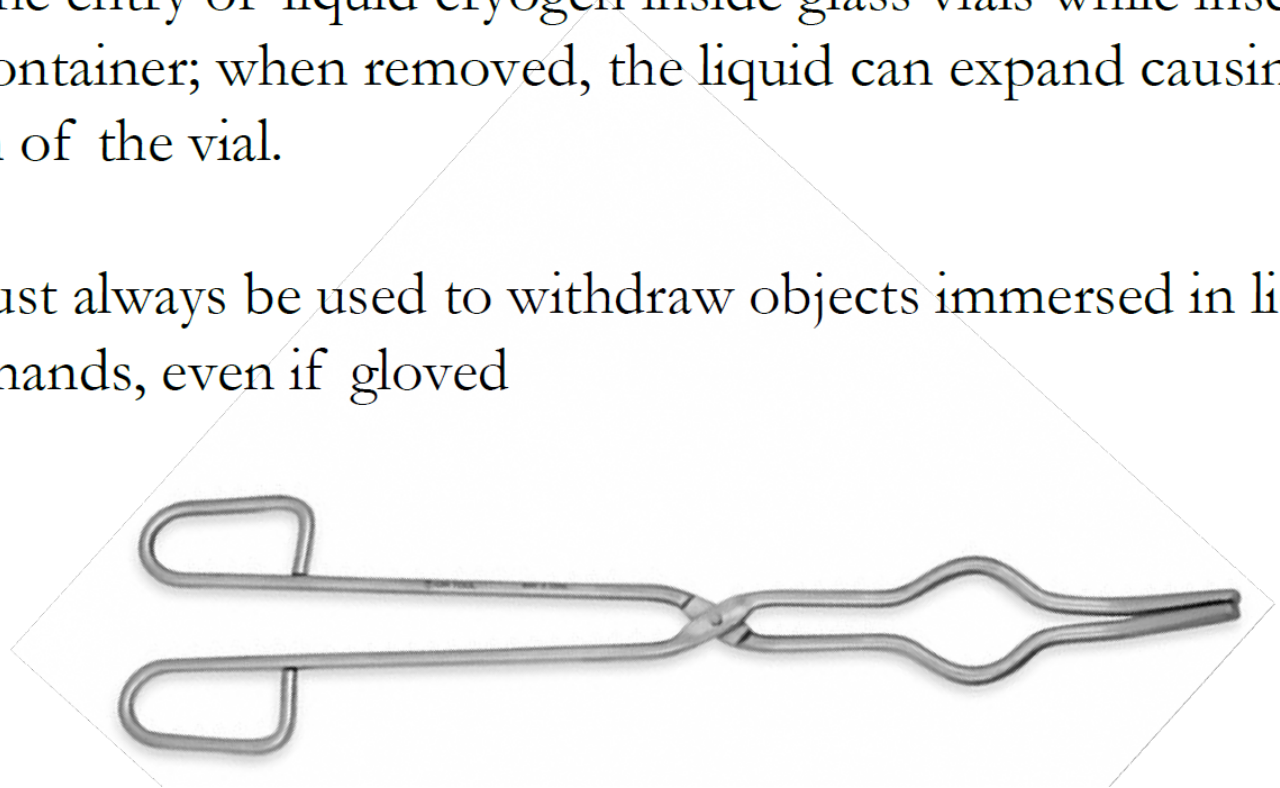
(Safety precaution: A large cryogenic leak or spill may lead to suffocation
This should be a two people operation.

1) Place the dewar in the elevator. The should be no people inside the elevator
2) Step outside and press the bottom for the receiving floor
3) The second person waits on the receiving floor and retrieves the dewar.

PRECAUTIONS WHEN HANDLING CRYOGENS

- Prevent the entry of liquid cryogen inside glass vials while inserting into a storage container; when removed, the liquid can expand causing the explosion of the vial.

- Tongs must always be used to withdraw objects immersed in liquid. Never use your hands, even if gloved



MATERIAL HAZARDS

- Ordinary carbon steels, most alloy steels, rubber, and plastic become brittle when subjected to the low temperatures of cryogens. These materials are considered unsuitable for use with cryogens

- Metals which are suitable for cryogenic temperatures are copper, brass, bronze, monel, and aluminium

We do not have a separate evacuation alarm system for cryogenic safety.

1) In the event of a major cryogenic spill in the B2 basement labs, use the chemical spill alarm system available in your labs. Leave the basement in you hear the alarm!
2) If you are an instructor of a teaching lab, in the event of a cryogenic spill evacuate the room. You expect to limit amount of liquid nitrogen used for this lab.
3) The procedure for initiating a building-wide alarm and evacuation is still to be developed.

To be added

1) Safe operation of the He closed-cycle cryogenic systems. At the moment, the training is to be decided by the groups

2) Safe operation of the centralized He liquification facility (B2) and centralized Liquid nitrogen facility.

(They are not yet opearional)