

CRYOGENIC SAFETY



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 cryogenics
 - 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 cryogenics
 - Helium 1 to 757
 - Nitrogen 1 to 696
 - Oxygen 1 to 860

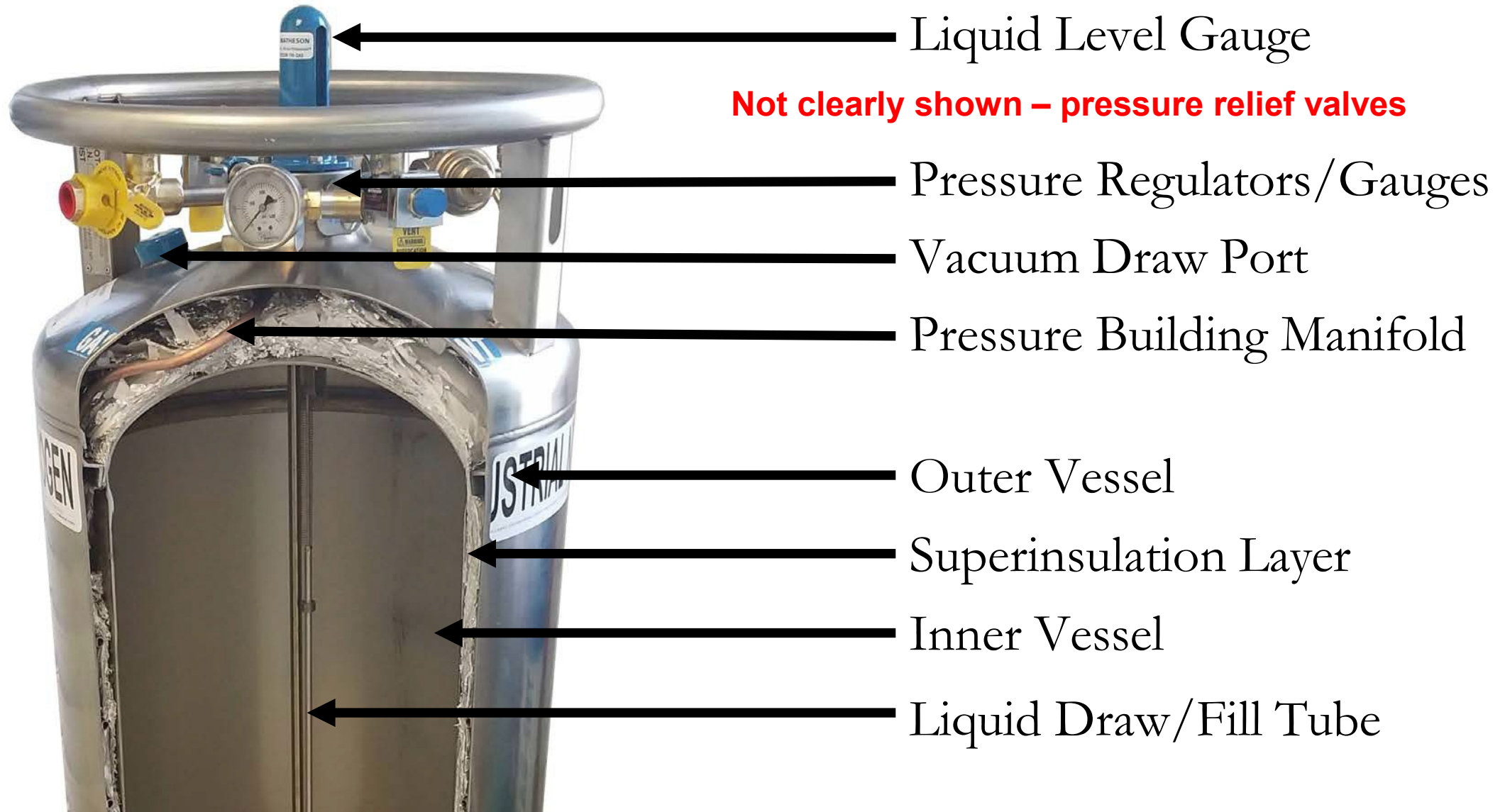
STORAGE OF CRYOGENIC LIQUIDS

- 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



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.

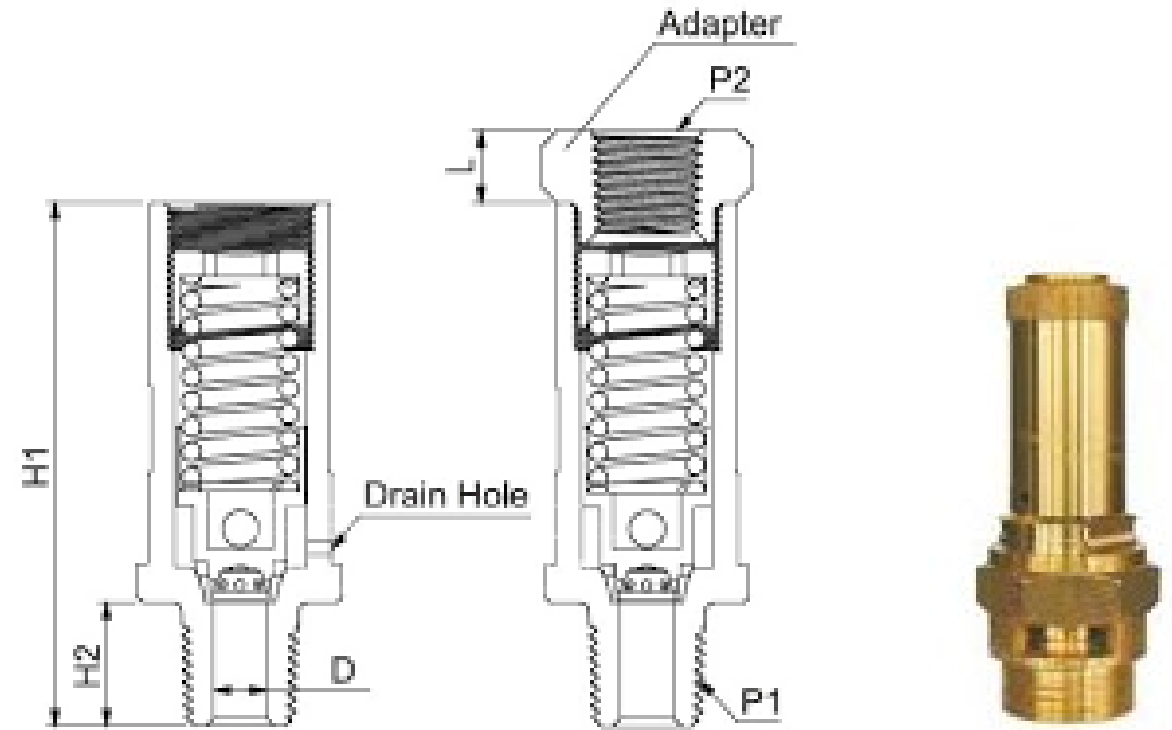
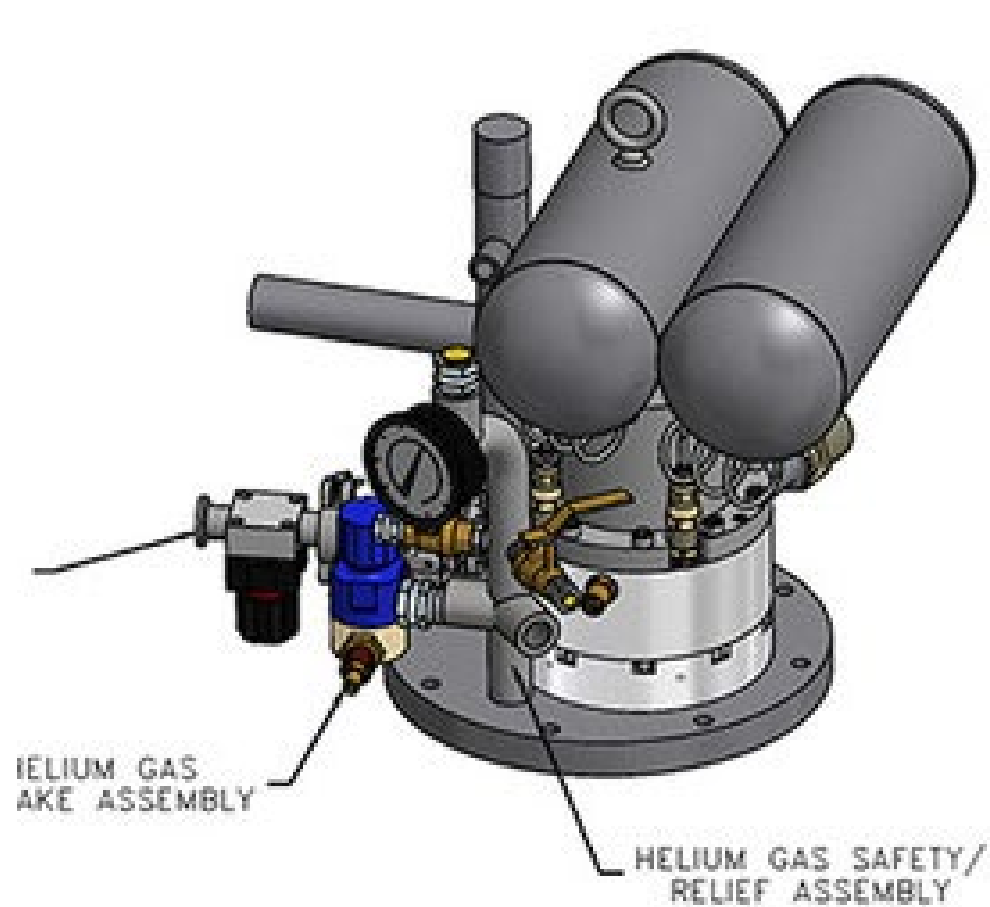
SPECIAL PRECAUTIONS WITH LIQUID HELIUM

- 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

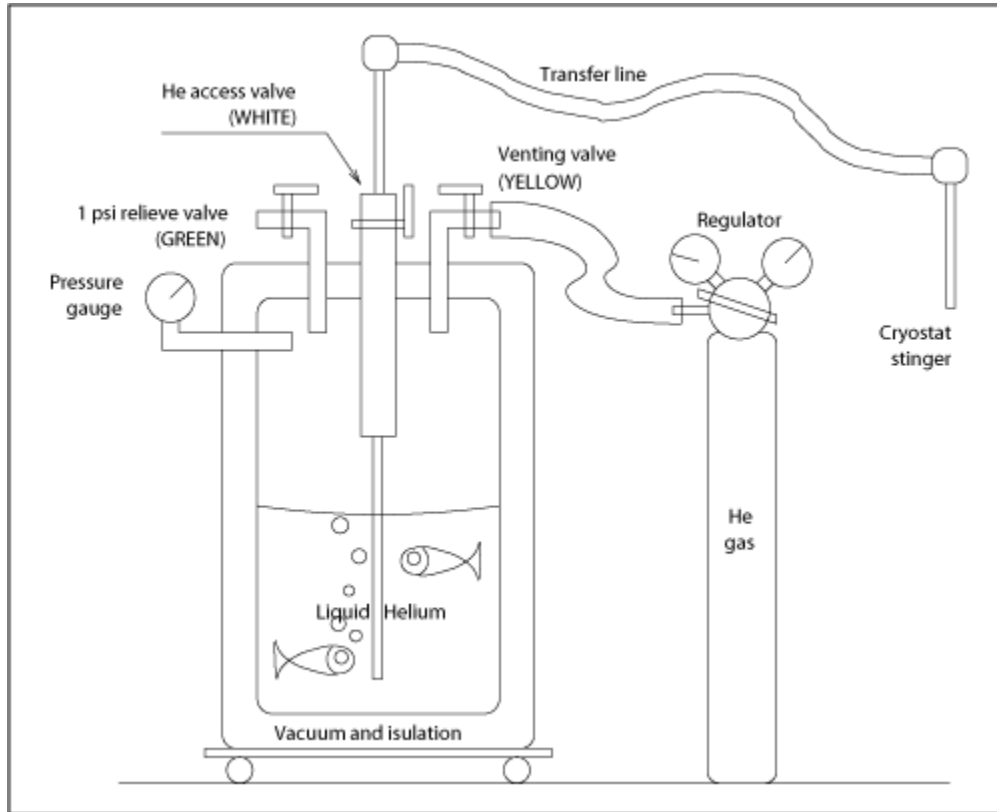
SPECIAL PRECAUTIONS WITH LIQUID HELIUM

- Always store and handle liquid helium under positive pressure (if possible) or in a closed system to prevent the infiltration and solidification of air or other gases
- Storage dewars, whether full or empty, must be moved gently and carefully to avoid unsafe build-up of pressure
- In case of spill of large quantity of fluid, evacuate the area **immediately**

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 cryogenics (both liquid and chilled vapor) can quickly cause burns similar to thermal burns caused by high temperature.
- Cryogenics 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 cryogenics 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 is recommended to protect against splashing. At the very least, never wear shorts or open-toed shoes when working with cryogenes.
- 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 can be dropped resulting in an accident.

- 1) Get gloves of few sizes to match everybody in your group.
- 2) Leather ski gloves look as a good compromise.



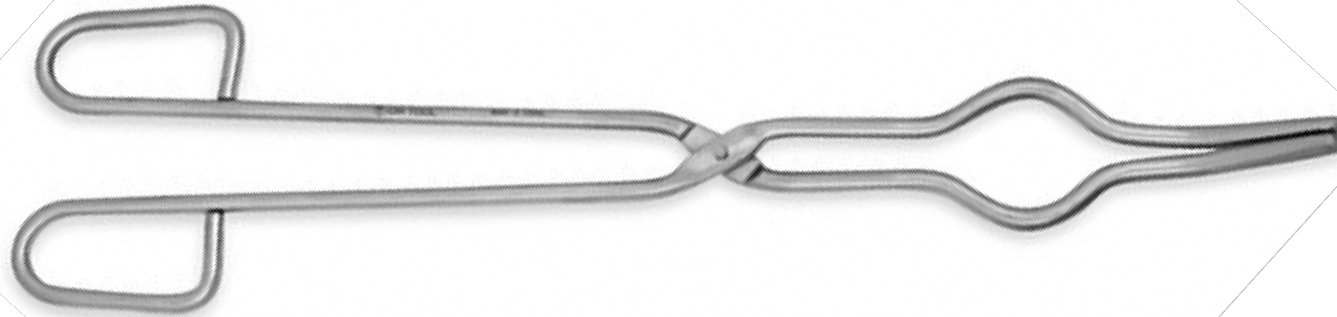
PRECAUTIONS WHEN HANDLING CRYOGENS

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



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 cryogenics. These materials are considered unsuitable for use with cryogenics
- Metals which are suitable for cryogenic temperatures are copper, brass, bronze, monel, and aluminium