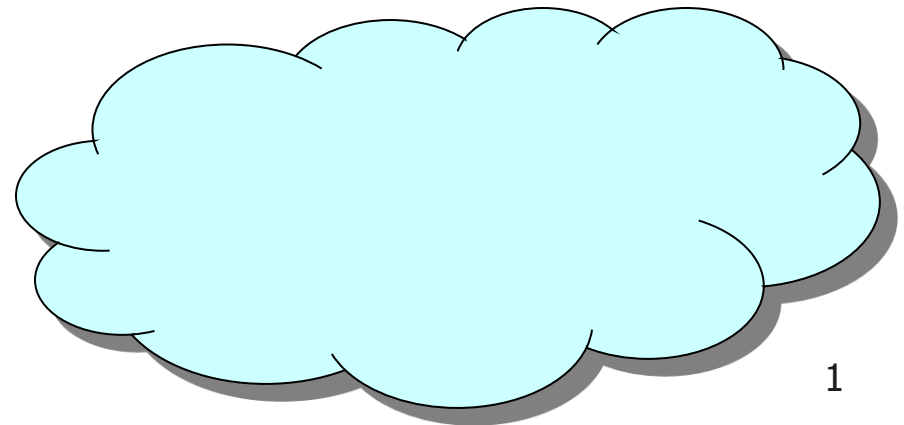
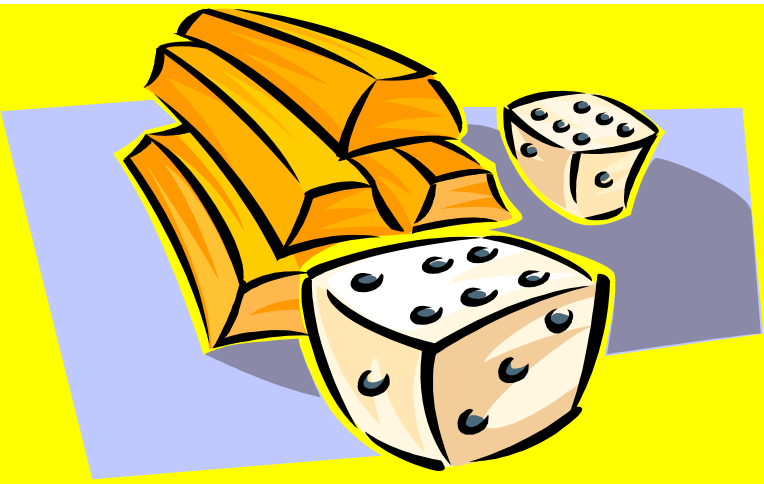




Safe Handling and Use of Liquid Nitrogen







Characteristics of Nitrogen

- 78% of Atmosphere
- Colorless, Odorless, Tasteless and Nontoxic
- Boils at -320 degrees Fahrenheit (-196 C)
- Non-Flammable
- WILL NOT SUPPORT LIFE
- Gas is slightly lighter than air



Liquid Nitrogen Facts

- 1 cubic foot of liquid nitrogen will expand to 696 cubic feet of 100% gaseous nitrogen at 70° F
- The nitrogen gas can displace the oxygen in the area, leading to asphyxiation
- Cryogenic liquids should always be stored in well-ventilated spaces

Oxygen Deficiency

- Liquid nitrogen, when returned to the gaseous state, can displace oxygen from the air under the right conditions.
- It may be prudent to install oxygen monitors in areas where liquid nitrogen is stored and ventilation is minimal.

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"Roberta will now explain how nitrogen displace oxygen"



Characteristics of Oxygen

- Normal Concentrations:
 - The normal oxygen concentration in air is about 21% by volume. This provides for a safe working environment with respect to the oxygen required to support life.
 - Oxygen concentration below 19.5% is considered an oxygen deficient environment

Characteristics of Oxygen Deficiency

- Physiological Effects:
 - Asphyxia develops slowly as the oxygen content of air is gradually reduced from 21%.
 - The victim will not be aware of a problem and generally will not recognize the symptoms of gradual asphyxia from decreasing oxygen levels.



"Oxygen detector says the air is okay up here"



Characteristics of Oxygen Deficiency

- Oxygen Deficiency Precautions:
 - All cryogenic liquids should be used and stored in well-ventilated areas.
 - Filling between containers, leaking valves, and liquid tank venting are some examples that could lead to an oxygen deficient atmosphere.

Handling Liquid Nitrogen

- Always read the container label prior to use
- Cryogenic liquid containers must always be stored in the upright position
- Cryogenic liquids should not be handled in open pail-type containers or in unapproved dewars.
- Transfer of liquid into warm lines or containers must be done slowly to prevent thermal shock and possible buildup of pressure.



Handling Liquid Nitrogen

- Precautions:

- Always wear safety equipment, including heavy loose fitting leather or cryogenic gloves, and eye and face protection.
- High concentrations of escaping gas should not be allowed to collect in an enclosed area.
- Avoid prolonged breathing of cryogenic liquid vapors .



Handling Liquid Nitrogen

- Avoid rough handling of liquid containers
- Liquid cylinders should only be moved with proper handling equipment.
- Prior to use, ensure the fittings on the regulator match the fittings on the liquid container
- Never use adaptors
- Never attempt to change or remove any fittings

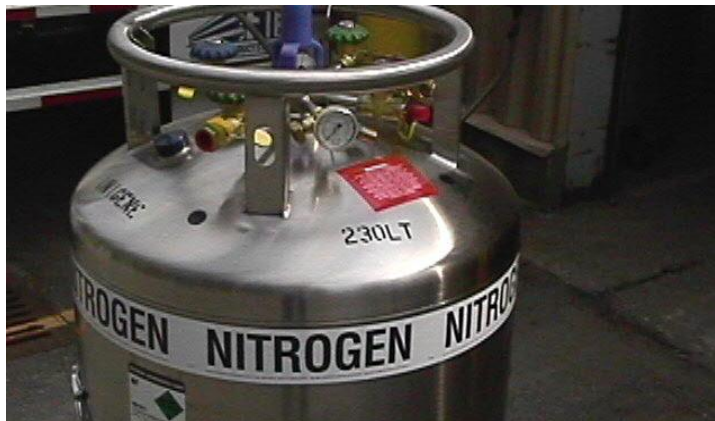




Containers for Holding Liquid Nitrogen After Dispensing

- Thermos[®] bottles are approved containers
- Use only containers specially designed to hold liquid nitrogen-Check with the manufacturer of the container to ensure it is approved for holding liquid nitrogen

Different Types of Liquid Cylinders





Cryogenic Liquid Containers (aka Liquid Cylinders)

- **Advantages:**

- Contain large volumes of gas

- Provides a source of Cryogenic Liquids which can be easily handled

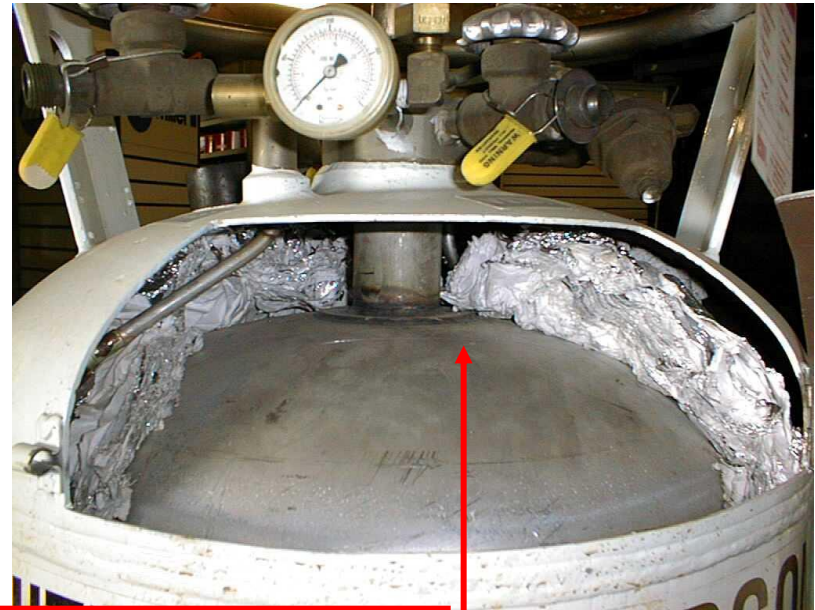
- **Two general types:**

- Low Pressure-For dispensing of liquid only.

- High Pressure-For dispensing of liquid and gas

Construction of Liquid Containers

- Liquid containers are made *somewhat* like Thermos[®] bottles with a vacuum space and special insulation, but they are not Thermos bottles[®]



Annular Space



Construction of Liquid Container

- Even with the vacuum and insulation, heat leaks in to the cylinder causing the cryogenic liquid to vaporize and build pressure.
- The vaporization rate will depend on several factors including the product itself, ambient temperature, condition of the cylinder's vacuum, etc.

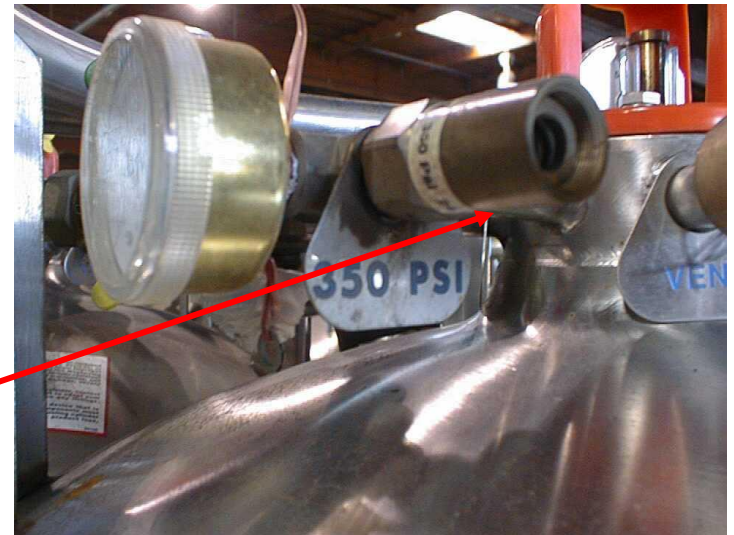


Cryogenic Liquid Containers (Liquid Cylinders)

- Dewars are open, nonpressurized and manufacturer approved vessels for holding cryogenic liquids
- A regular Thermos[®] bottle is not an approved cryogenic container!!

Pressure Relief Devices

- The liquid-to-gas conversion rate is about 2.3% per day under perfect conditions, so the actual vaporization rate experienced can vary.
- If gas product is not used, pressure will build until it is released by a control valve.
- Note that this is a high pressure container, with the gauge marked for 350 psig.





Pressure Relief Devices

- Hearing a slight hiss from a liquid cylinder is usually the normal operation of its pressure relief device.
- Liquid cylinders should always be stored and used in areas with appropriate natural or mechanical ventilation.
- Never adjust, block, plug or attempt to repair anything on a liquid cylinder.



Pressure Relief Device Formula

- 4L 292 = 350 safety
- 4L 200 = 235 safety
- Pressure relief devices are prescribed based on the following formula for vacuum-insulated cylinders.
 - (Cylinder service pressure X 1.25) – 15psi = Maximum Pressure Relief Device Rating.
 - Example (200x1.25) – 15psi = 235psi

Liquid-to-Gas Conversion

- Liquid is converted to gas at about 2.3% per day even under ideal container conditions.
- If the liquid is not used regularly, the vessel will be empty in a certain amount of time.



Storage in Cold Rooms

- Contrary to popular belief, storage of liquid containers in cold rooms will not slow down the liquid to gas conversion.
- Storage in cold rooms can create an oxygen deficient atmosphere if the room does not have adequate ventilation to remove the nitrogen gas generated.





Cryogenic Liquid Containers (Liquid Cylinders)

- Always check the type of container that is being delivered or before use.
- One lab had ordered low pressure and received high pressure by mistake. The lab personnel assumed it was low pressure and began to use it. This could have resulted in an unsafe condition. Low pressure has an operating pressure of 22 psig!!!
- High pressure operates at 230 psig or above. Always check the pressure gauge to determine the type of container.



Content Gauge on Liquid Cylinders

The container **contents** gauge is a float-type liquid level sensor that indicates the level of the liquid.

The gauge is an indication of approximate container content, and should not be used for judging the weight of the container.

Containers are always filled by Weight!



Cryogenic Liquid Containers (Liquid Cylinders)

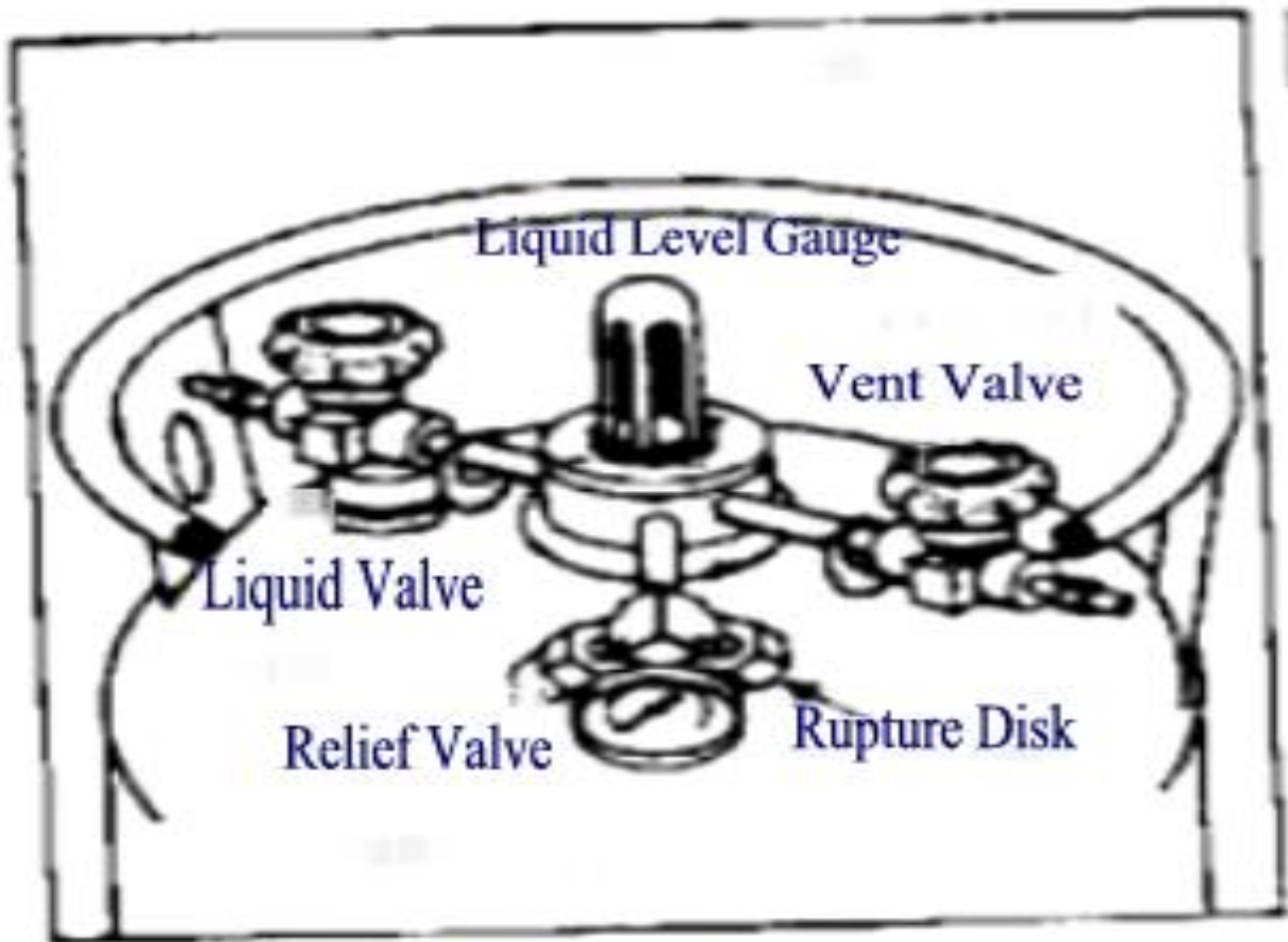
- Make sure you know the type of container that is used by your lab!!
- **Low pressure** is used only for the delivery of LIQUID, not gas
- It's operating pressure is 22 psig
- Caution Signs should be posted in the area warning that liquid nitrogen is being stored and used.



Cryogenic Liquid Containers (Liquid Cylinders)

Head pressure

- Results when heat leaks into the container
- The safety valve will periodically release this pressure
- If the safety valve malfunctions, a backup disk will rupture and relieve the pressure
- The rupture of the backup disk will produce a loud sound and may release a large quantity of liquid and gas. Evacuation of the area is required to prevent asphyxiation



Low Pressure
Liquid Container
Components



Low Pressure Liquid Container Components

- **Liquid Withdrawal Valve**

Liquid is withdrawn through this valve

- **Pressure Gauge**

Displays internal pressure of the container

- **Contents Gauge**

A float-type liquid level gauge-indicates approximate level of liquid



Low Pressure Liquid Container Components

- **Vent Valve**

Primarily used in the fill process to vent the vapor space while filling. Can be used to vent unwanted pressure during storage and use

- **Pressure Relief Devices (2)**

Protect vessel from over-pressurization

- Re-seating spring-loaded relief valve releases at 22 psig
- Burst disk rated to protect the inner vessel



Low Pressure Liquid Container Components

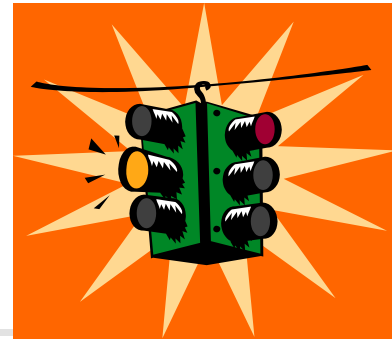
- Outlet Restraints

These are to prevent the dangerous practice of changing outlet connections at user sites. These restraints may be twist ties, wire, or other.

Removal of these restraints will void all product warranties!!

Changing outlet connections is an extremely dangerous practice and can result in serious injury or death if an incompatible product is introduced into a user's system

Warning!!!!



- Never plug, restrict, or remove any relief device.
- Never attempt to cap or seal a venting relief device in any way.
- Ice or frost buildup on a pressure relief valve can be removed with a damp cloth. (Wear proper Personal Protective Equipment (PPE) when removing the frost.)

Moving Liquid Cylinders

- Liquid cylinders range in different weights and sizes. They are heavy and cumbersome, especially when filled with liquid nitrogen.
- They may require for two people to handle in order to do so safely.
- Containers can cause crushing injury to the feet. Wear proper shoes. Tennis shoes and open toed shoes are not proper foot protection!!

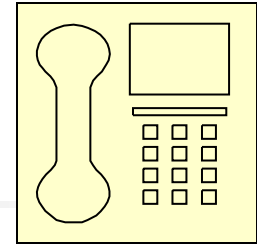


Moving Liquid Cylinders



- Never try to roll liquid cylinders by using the Liquid Level Gauge tube.
- Note the proper stance and use of the cylinder's halo ring for moving.

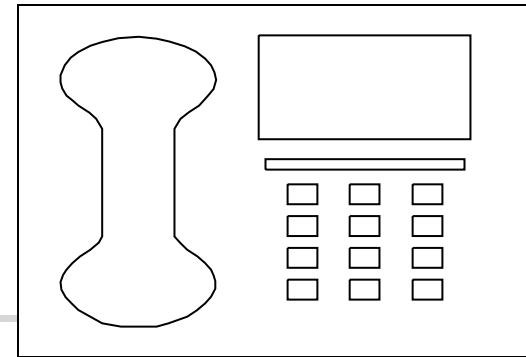
Emergencies



- If there is a large spill or rupture of a container, call 911, warn others in building
- **Evacuate!! There may be oxygen deficiency in the area of the spill!!**
- If there is injury to the body from liquid nitrogen, seek immediate medical assistance



Emergencies



- If liquid is splashed in the eyes, flush with water for at least 15 minutes. Seek immediate medical attention. **Call 911**
- Skin contact may cause frostbite and burns. Soak affected part in tepid water and seek immediate medical attention. **Call 911**
- Skin contact is a medical emergency. Lack of prompt medical attention may result in amputation!!!

CALL 911



Personal Protective Equipment (PPE) for Cryogenics

- If you fill cryogenic liquids the possibility of cryogenic liquid coming in contact with the skin is reduced with the use of proper Personal Protective Equipment (PPE).
 - Full Face Shield with safety glasses
 - Heavy, Loose Fitting leather or Cryogenic Gloves
 - Long Sleeve Shirt, or Arm Protection
 - Pants should be cuff-less
 - Do not tuck pants into shoes, boots.

Liquid Nitrogen Burn



Liquid Withdrawal



- **Caution!!**
- Always wear a full face shield, goggles, leather or cryogenic gloves, safety shoes, and aprons when transferring liquid.
- Ensure that the liquid cannot collect in pants cuffs or travel down into shoes. Do not tuck cuffs into pants! Cuff gloves over sleeves.
- Transfer of liquids at pressures higher than 22 psig into open vessels such as small dewars can lead to excessive splashing. This could result in injury from freezing of the body part



Liquid Withdrawal

- Ensure that withdrawal hose is equipped with a phase separator to prevent splashing. Check with supervisor or supplier.
- Never dispense liquid into an unapproved container, such as a Thermos[®] bottle. It will shatter!

Trouble Shooting





Trouble Shooting



- **Issue:** Gas vents intermittently through safety relief valve
- **Possible cause:** Probably normal operation. Gas generated due to heat leak into cylinder causes head pressure to build
- **Recommended Activity:** Ensure inactive containers are stored in well ventilated area. Rotate inventory





Trouble Shooting

- **Issue:** Gas vents continuously through safety valve
- **Possible Cause:** Possible relief valve failure or excessive heat leak
- **Recommended Activity:** Remove container or vent the exhaust to a well ventilated area. Relieve product through vent valve. Check to see if safety relief valve is frozen open. Contact supervisor or supplier for assistance



Trouble Shooting

- **Issue:** Gas vents during use through safety relief valve
- **Possible Cause:** Set point on regulators exceeds safety relief valve setting
- **Recommended Activity:** Reduce set point on pressure building regulator-Contact supervisor or supplier for assistance



Trouble Shooting

- **Issue:** Pressure in the container is low
- **Possible Cause:** Leak from container
- **Recommended Activity:** Use appropriate leak detection fluid to check for leaks in connections. Examine container for signs of frost. If leaks are on container itself, contact supervisor or supplier



Trouble Shooting

- **Issue:** Pressure in the container is low
- **Possible Cause:** Pressure building valve is not fully opened
- **Recommended Activity:** Open valve fully



Trouble Shooting

- **Issue:** Pressure in the container is low
- **Possible Cause:** Pressure building regulator not set high enough
- **Recommended Activity:** Adjust to increase pressure-contact supervisor or supplier



Trouble Shooting

- **Issue:** Pressure in the container is low
- **Possible Cause:** Pressure building valve is open
- **Recommended Activity:** Close the valve if frost is visible on the pressure building vaporizer near the bottom of the tank-contact supervisor or supplier



Trouble Shooting

- **Issue:** Pressure in the container is too high
- **Possible Cause:** Leaking or improper setting of pressure building regulator
- **Recommended Activity:** Reduce regulator setting to achieve desired pressure level-contact supervisor or supplier



Trouble Shooting

- **Issue:** Pressure in the container is too high
- **Possible Cause:** Vacuum integrity failing
- **Recommended Activity:** If container walls are covered with frost, contact supervisor or supplier



Trouble Shooting

- **Issue:** Container top covered with frost
- **Possible Cause:** High product use
- **Recommended Activity:** Normal operation



Trouble Shooting

- **Issue:** Container has isolated spots of frost
- **Possible Cause:** Container may have been damaged, compromising integrity of insulation
- **Recommended Activity:** Contact supervisor or call supplier for replacement



Trouble Shooting

- **Issue:** Container surface is uniformly covered with frost
- **Possible Cause:** Vacuum integrity compromised
- **Recommended Activity:** If accompanied by a high rate of product venting through the safety relief valve, or high rate of pressure increase, call supplier

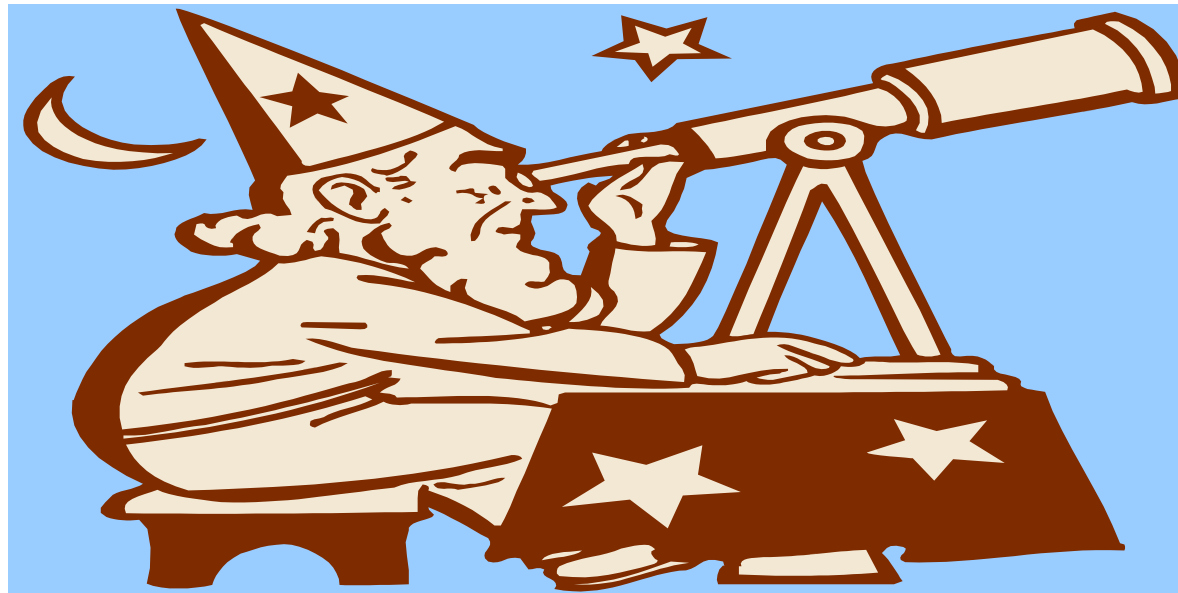


References and Assistance

- Airgas East (800-524-7427)
- Airgas (Formerly AirProducts) Safetygram-27, Cryogenic Liquid Containers
- Compressed Gas Association (703-412-0900)
- MSDS on Liquid Nitrogen- DES Web site
www.inform.umd.edu/des
- DES at 301-405-3961

Questions?

Contact the Department of Environmental
Safety (315)787-2350 or E-mail at
ssk19@cornell.edu





Please be SAFE

THE END