KECK GRADUATE INSTITUTE
of Applied Life Sciences

Gas Cylinder Safety

General

- Compressed gas cylinders are routinely used without incident
- Cylinders may easily be a hazard if they are mishandled
- Stories abound about cylinders where the valve was broken and the cylinder took off bounding around the room or through brick walls
- Many common gases have explosive and toxic potential for cylinder sizes found in our laboratories and shops
- A 9"x51" cylinder filled with pressurized butane gas can create an extremely flammable cloud 200 cubic feet in volume
- Lecture bottle cylinder, at 2"x12", can release 30 cubic feet of butane

Safe Handling

- Ensure **contents** of cylinders are **properly identified**
- Don't accept **unidentified cylinders** and don't rely on color codes; read the label
- Don't destroy or remove **identification tags** or labels
- Check to see cylinder valves are protected with **protective caps**
- **Leave caps on** until the gas is about to be used.
- **Move cylinders** only with a suitable hand truck
- **Do not roll or drop** cylinders, or let them bump violently against each other.
- **Secure cylinders** with a chain or strap positioned around the **upper third** of the cylinder
- **Small cylinders** may be put on their side and blocked to prevent rolling
- **Clear cylinder valves** of any dust or dirt before attaching proper regulators
- Some regulators are only for specific gases; **regulators should not be interchanged**
- Do not **force connection fittings** and never **tamper with safety devices** in cylinder valves or regulators
- **Release adjusting screw** on regulator before opening cylinder valve
- **Stand to the side** of the regulator when opening cylinder valve
- **Open cylinder valve slowly**

- Use **protective gloves and eye wear** when handling cylinders containing cryogenic (super-cold) gases
- **Store** cylinders in a **well-ventilated** area away from all sources of heat or flames
- Do not **store flammable gases** next to exit or oxygen cylinders
- Before returning cylinder, close the valve and **replace the protective cap**
- Separate empty and full cylinders during storage
- Mark **empty cylinders** "EMPTY" or "MT"
- Know **safety and first-aid requirements** for gases being used.
- Review Safety Bulletins, MSDS sheets, and read the warning labels

Working Safely with Cryogenics

What is Cryogenics?

Cryogenics is the study and use of materials at extremely low temperatures. The term “cryogenics,” according to the National Institute of Standards and Technology (NIST), applies to all temperatures less than –150°C (–238°F).

Compounds that are normally gases at room temperature condense to liquids at extremely cold temperatures. Gases can also be condensed to liquids by exposing them to very high pressures. Common cryogenic liquids are liquid nitrogen (LN2), liquid oxygen and liquid helium. Applications that use cryogenics include tool/metal tempering, nuclear research, electromagnetism work and multiple laboratory techniques. Surgeons are using cryogenics to treat Parkinson’s disease, destroy brain tumors and arrest cervical cancer. Rocket engines are fueled by liquid oxygen, as are cutting and welding torches. Because of the nature of cryogenic liquids, special precautions must be taken when working with them.

Effects of Cryogenics on Materials

The extreme temperatures of these liquids cause most solids to become more brittle. Materials such as carbon steel, plastics and rubber should not be used with cryogenic liquids because they can fracture or shatter extremely easily.

Physical Effects of Exposure

Contact with cryogenic liquids to the eyes or the skin can cause serious frostbite injuries. Tissues that have been frozen will be painless while still frozen and may look waxy and yellow in hue. Thawed frostbitten skin will be very painful, red and swollen and can become infected.

Any flesh that comes in contact with a cryogenically cooled material can stick to that material, similar to the way some children stick their tongues to flagpoles in the winter. Where cryogenics is involved, however, metallic materials are not the only ones that cause this risk. It is important to remember that even nonmetallic materials are

extremely dangerous to touch. Removal of the skin from any material can cause tearing of the flesh when attempted. To minimize the chances of freezing materials to skin, all watches and jewelry on the hands and wrists should be removed. When cryogenic liquids warm and revert to their gaseous state, oxygen can be displaced. Oxygen-deficient atmospheres can cause dizziness, nausea, vomiting, unconsciousness, confusion and death. However, not all symptoms will necessarily be present depending on the rapidity of the gas expansion. Unconsciousness could occur without any preceding signs of danger.

First Aid

If the body has been exposed to either a cryogenic liquid or gas, the tissues should be restored to normal body temperature by running warm liquid (108°F) over the affected part. Water should never be more than 112°F and the affected part should not be rubbed at any time. This can cause further damage to the area. The victim should get emergency care as quickly as possible to minimize further damage and for damage assessment.

If a person is overcome by loss of oxygen while working with cryogenic liquids, that person should be moved to a well-ventilated area immediately. A self contained breathing apparatus (SCBA) may be required for rescue so the rescuer does not also fall victim. Artificial respiration should be applied if breathing has stopped. If the person is having difficulty breathing, oxygen should be supplied. Emergency medical help should be summoned.

Personal Protective Apparel

Personal protective equipment is critical when working with cryogenics. Always wear chemical splash goggles and face shields during the transfer and handling process to guard against splashes and the possibility of vessel rupture causing flying debris.

Loose fitting, insulated gloves made to withstand extremely low temperatures should also be worn. The gloves should fit loosely enough so that if a splash occurs inside the gloves they can be thrown off easily and rapidly.

To protect all parts of the skin, long-sleeve shirts and trousers are also recommended. Pant legs should go over the tops of footwear so spills cannot get into boots or shoes and cause extreme tissue damage before the footwear can be removed.

If working in an oxygen-deficient atmosphere, you must use an oxygen-supplying respirator, such as an airline respirator with an egress bottle or a self-contained breathing apparatus (SCBA.) A cartridge-style respirator would not be appropriate because the problem with the atmosphere is the loss of oxygen, which cannot be added by filtration.

Environmental Controls and Cryogenic-Specific Equipment

Because these liquids vaporize extremely rapidly, a different danger surfaces as they warm up. They are capable of producing huge amounts of gases, which could produce explosions or vessel ruptures. Containers should never be plugged or covered. This interferes with the needed venting of the container to prevent explosions.

Only use containers that are made specifically for cryogenic liquids, such as Dewar flasks. Dewar flasks consist of two flasks, with one inside the other. There is a space between the two flasks, which provides a layer of insulation. This insulation keeps the liquid from warming quickly and causing rapid expansion of the gas. And while these products are made to specifically withstand the stress of extreme temperature changes, they should still be filled very slowly to protect the containers from excessive internal stress that can cause damage and weaken the container.

Cryogenic containers should not be filled past 80% of capacity to account for the expansion of gases.

This rapid expansion of gas can lead to asphyxiation (except for oxygen) in an enclosed area. The gases can displace the oxygen and a person can be overtaken rapidly. Most cryogenic liquids—including liquid nitrogen—become colorless, odorless and tasteless gases, which makes them undetectable to human senses. Air with less than 18% oxygen can cause dizziness and continued lower levels quickly progress to unconsciousness and death. Always work with these liquids in a well-ventilated, open area.

If it is impossible to work with cryogenic liquids in an open area, air monitoring devices are available to measure oxygen levels. These are available in personal, handheld or fixed models. These units will alarm when oxygen levels get below 19.5%, alerting anyone in the room of the oxygen-deficient atmosphere before dangerous levels are reached.

Cryogenic liquids boil at room temperatures. This boiling can cause eruptions and splashes, so tongs need to be used when removing anything immersed in the liquid.