Title: **Compressed Gases and Cryogenic Liquids**			
EH&S – 1-4	Revision: 5/6/08	Date 1993	Pages 11

PURPOSE: To provide guidelines concerning the safe handling, transport, storage and use of compressed gas cylinders and cryogenic liquids. Compressed gases can pose both physical and potential chemical hazards. The gases contained in these cylinders vary in chemical properties, ranging from inert and harmless to toxic and explosive. The high pressure of the gases constitutes a serious hazard in the event that the cylinders sustain physical damage and/or are exposed to high temperatures.

SCOPE: Hospital wide.

DEFINITIONS:

Compressed gas: A gas or mixture of gases having an absolute pressure exceeding 40 psi at 70 degrees F (21.1 degrees C); or, a gas or mixture of gases having an absolute pressure exceeding 104 psi at 130 degrees F (54.4 degrees C) regardless of the pressure at 70 degrees F; or, a liquid having a vapor pressure exceeding 40 psi at 100 degrees F (37.8 degrees C) as determined by ASTM D-323-72.

Cryogenic liquid: liquid with a normal boiling point below -130^{o}F (-90^{o}C). Common industrial gases transported, handled and stored in the liquid state at cryogenic temperatures are Argon, Helium, Hydrogen, Nitrogen, and Oxygen. Liquified natural gas (LNG), methane and carbon monoxide are also handled as cryogenic liquids, but aren't typically classified as industrial gases.

Dewars: Liquid dewar flasks are non-pressurized, vacuum-jacketed vessels, similar to a Thermos bottle. Dewars are designed with either loose-fitting caps or pressure relief valves, that prevents air and moisture from entering, yet allows excess pressure to vent.

Flammable gas: A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or, a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit; or, one for which the United States Department of Transportation (DOT) requires their red flammable gas label.

Toxic gas: A gas that has a median lethal concentration in air of 2,000 parts per million or less by volume of gas; or, a gas which the DOT requires the white poison label.

PROCEDURES (Compressed Gases):

I. Identification

A. All compressed gases received, used or stored must be labeled according to the United States Department of Transportation regulations. In addition, each cylinder must be marked by label or tag with the name of its contents. The primary identifier of cylinder contents is the label. Color should not be used to identify contents. Material Safety Data Sheets (MSDS) must be obtained and maintained by Hospital users for all compressed gases.

B. Empty cylinders must be marked EMPTY or MT and stored apart from full cylinders while waiting to be removed.

II. Responsibility

A. Compressed gas cylinders should be handled only by experienced and properly instructed personnel.

B. The user responsible for the cylinder and for its installation should check the identity of the gas before use. If the cylinder content is not identified, if hydrostatic test date is past due, or if the cylinder is in any way damaged, the cylinder should be returned to the supplier.

III. General Handling Procedures

A. Cylinders must be securely fastened to prevent them from falling or being knocked over. Suitable racks, straps, chains, stands or other devises are required to support cylinders.

B. Cylinder valves are to be protected with the standard cap when not in use (empty or full). Regulators are to be protected with covers where there is likelihood of damage.

C. Cylinders should not be exposed to excessive dampness, or to corrosive chemicals or fumes.

D. Cylinders are not to be exposed to temperature extremes nor stored in the vicinity of combustibles.

E. Transfilling of oxygen cylinders is only permitted in the EMS Department by properly trained staff.

F. No repair or alterations are to be made to cylinders or accessories.

IV. Specific Handling Procedures

A. Before using a cylinder, slowly "crack" the valve to clear dust or dirt, being sure the opening is not pointed toward anyone. Suitable precautions should be taken when toxic or flammable gases are involved. Do not stand in front of the regulator gauge glass when opening the valve. This “cracking” practice does not apply to “E” oxygen cylinders.

B. Never use a cylinder without a regulator. Always use the correct pressure regulator.

C. After attaching the regulator, and before the cylinder is opened, check the adjusting screw of the regulator to see that it is released. Never permit the gas to enter the regulator suddenly.

D. Never try to stop a leak between a cylinder and regulator by tightening the union nut unless the valve has been closed first.

E. Never strike an electric arc on a cylinder.

F. Never use a damaged cylinder.

G. Never force a cap or regulator.

V. Transporting Cylinders

A. For cylinders that are threaded to accept protective valve caps, the valve caps shall be secured in place before transporting.

B. Avoid dropping and striking cylinders together. The cylinder should not be lifted by the cap.

C. Use a cradle for hoisting, never a lifting magnet or sling.

D. Use a suitable hand truck with the cylinder firmly secured. Avoid dragging, sliding or rolling cylinders.

E. Cylinders must be secured in a positive fashion with straps or chains while being transported to, and when in, motor vehicles.

VI. Storage

A. Due to varying requirements based on quantity of gases stored, EH&S shall be consulted for specific room construction requirements.

B. Cylinder storage areas should be prominently posted with the names of the gases to be stored. A sign shall be displayed on each door stating “Caution, Oxidizing Gas(es) Stored within. No Smoking.”

C. When gases of different types are to be stored at the same location, cylinders should be grouped by type of gas and the groups arranged taking into account the type of gas contained (e.g., flammable gases may not be stored next to oxidizing gases).

D. Storage rooms should be dry, cool, and well ventilated. Cylinders should not be stored at temperatures above 51 degrees C. (125 degrees F.) or near radiators or other sources of heat. Cylinders shall not be stored near highly flammable or combustible substances.

E. Cylinders stored in the open must be protected against weather extremes.

F. Cylinders shall be protected from any object that will produce a cut or other abrasion in the surface of the metal. Do not store near elevators or gangways, or in locations where heavy moving objects may strike or fall on them.

G. For cylinders that are threaded to accept protective valve caps, the valve caps shall be secured in place when stored.

H. Do not store gas cylinders with pressure on the regulator.

I. Cylinders should be kept secure, to avoid falling over.

VII. Procedures for Placement and Use of Oxygen Cylinders Outside Designated Storage Rooms

A. Storage of oxygen with a total volume compressed equal to or less than 300 cubic feet (cu ft) shall comply with the requirements of this section. Any quantities greater than 300 cu ft require specific storage enclosures and procedures, as outlined in previous section.

B. Cylinder capacities by type are:

D	13 cu ft
E	22 cu ft
M	107 cu ft
G	187 cu ft
H or K	244 cu ft

C. Patient care areas are limited to storing up to 12 total oxygen “E” cylinders (including both full and “empty” cylinders). Empty and full cylinders must be stored separately and kept secured in either a rack or mobile carrier. Storage areas must be appropriately labeled, for empty and/or full cylinders.

D. Individual cylinder storage associated with patient care areas, not exceeding 22,500 sq ft, shall not be required to be stored in enclosures.

E. When small-sized (B, D, or E) cylinders are in use, they shall be attached to a cylinder stand or to a therapy apparatus of sufficient size to render the entire assembly stable.

F. An individual cylinder placed in patient room for immediate use by a patient shall not be required to be stored in an enclosure.

G. Cylinders shall not be chained to portable or movable apparatus such as beds and oxygen tents.

H. Cylinders shall be protected from abnormal mechanical shock, which is liable to damage the cylinder, or valve.

I. Cylinders shall not be stored near elevators, or in egress corridors.

J. Cylinders shall be protected from tampering by unauthorized persons.

K. Free standing cylinders shall be properly chained or supported in a proper cylinder stand or cart.

VIII. Emergencies and Special Procedures

A. In the event of a leak or suspected leak of a *toxic or flammable* gas, evacuate the building or area. Activate the fire alarm by pulling the nearest fire alarm box. Immediately notify University Police at 911 stating what is leaking and where.

B. Use soapy water to detect leaks. Connections employing flammable or toxic gases are to be leak tested with Leaktec or equivalent.

C. *Acetylene* should not be utilized in lines or hoses at a pressure exceeding 15 psi.

D. Oil, grease or other flammable material is not to be permitted to come in contact with the valves, regulators, gauges or any fittings of an *oxygen* cylinder. Oil and grease in the presence of oxygen under pressure may ignite violently. Do not handle cylinders with oily hands or gloves. Never use oxygen as a substitute for compressed air.

E. "No Smoking" signs should be placed near *flammable* gas cylinders. Fire-suppression equipment using carbon dioxide or dry chemicals should be available. Spark-proof tools should be used when working with flammable gas cylinders.

F. Consideration must be given as to the need for electrically bonding cylinders containing *flammable* gases.

G. Areas where *corrosive* gases are filled or used should be equipped with emergency showers and eyewashes.

H. Wear chemical splash goggles when handling compressed gases which are *irritants, corrosive or toxic.*

IX. Obtaining Cylinders

A. Obtaining cylinders 5 days per week, Mon. –Fri. 8:30 AM – 4:30 PM

1. Place a Lawson requisition (RQ 10) from location = GASES using the following procedures:

    a. Enter the hospital item number for the cylinder(s) requested.
    b. Enter the quantity required.
    c. Press add to generate requisition number.
    d. Verify the accuracy of the requisition.
    e. Press release. (Note: Pick tickets are generated at 7:00 AM and 12:30 PM in Hospital Receiving.)

2. Receiving will deliver the cylinder and place in the full cylinder holder.

3. Empty tanks shall be removed from the empty cylinder holder and returned to Receiving at that time.

4. All regulators must be removed from the cylinders by the requesting units prior to pickup.

5. Please direct any inquiries to Hospital Receiving at 4-2636

B. Obtaining cylinders off hours (4:30 PM to 8:30 AM, Mon. – Fri.) and Weekends

1. Contact the ADN at 4-3908 to get access to the Loading Dock for pick up of cylinders.

2. The ADN will contact Security to open cylinder storage area.

X. Accepting Cylinders from Vendors

A. All cylinders will be inspected by Receiving staff for the following, prior to acceptance:

1. Correct and Intact labeling- Labels must correspond with contents of cylinder and must be legible.

2. Damage – Any cylinders with mud, dirt, rust, or debris will be deemed unacceptable and will be refused by the Receiving staff and sent back. A replacement will be issued by the vendor.

PROCEDURES (Cryogenic Liquids)

I. Hazards/Special Properties

A. **Frostbite** - Cryogens are extremely cold and can cause instant, severe frostbite. Cryogen vapors can freeze the skin or eyes faster than liquid contact, and even faster than metal contact. Direct contact with cryogenic liquids, uninsulated cryogenic pipes or equipment can cause freeze burns and tissue damage. The fluid in eyes will freeze in contact with a cryogen, causing permanent eye damage.

B. **Oxygen Enrichment** - When transferring liquid nitrogen through uninsulated metal pipes, the air surrounding a cryogen containment system can condense. Nitrogen, which has a lower boiling point than oxygen, will evaporate first. This can leave an oxygen-enriched condensate on the surface that can increase the flammability (combustibility) of materials near the system, creating potentially explosive conditions. In order to minimize the fire hazard potential, equipment containing cryogenic fluids must be kept clear of combustible materials.

C. **Asphyxiation** - Air is composed of 78% nitrogen and 21% oxygen, with the remaining 1% as trace gases. If liquid nitrogen is vaporized so as to reduce the oxygen percentage below 19.5%, there is a risk of oxygen deficiency. In confined or poorly ventilated areas (such as a laboratory, transport elevator or storage area), the expanding gas will displace oxygen, presenting an asphyxiation hazard to staff working in the area. Simple asphyxiants such as nitrogen do not have good warning properties. Staff might not feel "light-headed," but could pass out without any warning and then die without regaining consciousness. To prevent asphyxiation hazards, the room must be well ventilated when using cryogens.

D. **Pressure Buildup and Explosions** - Without adequate venting or pressure-relief devices on the containers, pressures can build up on cryogen evaporation. Cryogens boil as they sit in their storage vessels by absorbing heat energy from the warmer surroundings. The gas boiling out of the liquid must either expand or the pressure will increase. Users must make certain that cryogenic liquids are never contained in a closed system. Use a pressure relief vessel or a venting lid to protect against pressure build-up.

E. **Material Brittleness** – Cryogenic liquids cause many common materials such as carbon steel, plastic and rubber to become brittle or possibly fracture under stress.

F. **Fogging** – Most cryogenic liquids are odorless, colorless and tasteless when vaporized to the gaseous state. However, they have a built-in warning property because the cold boil off gases condense the moisture in the air, creating a highly visible fog. The fog normally extending over a larger area than the vaporizing gas.

II. General Handling Procedures

A. Cryogenic liquids are extremely cold. Contact of cryogenic liquid to the skin or eyes may cause serious freezing injury (frostbite). Very small amounts of cryogenic liquid vaporize into large amounts of gas – they have a high liquid-to-gas expansion ratio. For example one liter of liquid nitrogen becomes 24.6 cubic feet of gas.

B. Ensure that the Material Safety Data Sheet (MSDS) for the cryogen used is made available to affected staff.

C. Remove metal jewelry/watches on your hands and wrists before working with cryogens. If exposed to cryogenic liquids or boil-off gases, jewelry can freeze to the skin.

D. Wear protective clothing. Cover all exposed skin by wearing long sleeve shirts, long pants (cuff-less), a long sleeve lab coat, well-fitted leather shoes (no sneakers or sandals) and gloves. Gloves should be loose-fitting, lightweight, flexible, and insulated to allow for quick removal if cryogenic fluids are spilled on them. Wear a cryogen apron when a splash potential exists or when large quantities of cryogens are handled.

E. Protect your eyes by wearing safety goggles whenever working with cryogen fluids. Full face shields shall be used in the following situations: when a cryogen is poured; for open transfers; or if fluid in an open container may bubble.

F. Handle cryogenic liquids carefully. Do not allow unprotected areas of skin touch objects cooled by cryogenic liquids. Use tongs to withdraw objects immersed in the liquid, and handle the object carefully.

G. Transfer or pour cryogens slowly to minimize boiling, splashing and spilling. Use proper transfer equipment, such as a phase separator or special filling funnel (the top of the funnel should be partly covered to reduce splashing). If the liquid cannot be poured, use a cryogenic liquid withdrawal device for the transfer (be sure to follow all instructions provided with the device).

H. Do not overfill containers. Do not use hollow rods or tubes as dipsticks since liquid could be release from the top of the tube. Instead, use wooden or solid metal dipsticks.

I. Store and use cryogenics in a well-ventilated area. In closed areas, gases can reduce the oxygen concentration and can result in asphyxiation. To avoid asphyxiation, an oxygen monitor is recommended when working with a cryogen in a confined space.

J. Do not permit smoking or open flame in any area where oxygen or hydrogen is stored, handled or used.

K. Because some organic materials (oil, grease, asphalt, kerosene, cloth, tar, dirt) can react violently with liquid oxygen, do not lubricate oxygen equipment with oil, grease or unapproved lubricants.

III. Handling Dewars and Refrigerators

A. Use containers specifically designed for low-temperature liquids, such as a dewar. Liquid dewar flasks are non-pressurized, vacuum-jacketed vessels, similar to a Thermos bottle. Dewars are designed with either loose-fitting caps or pressure relief valves, that prevents air and moisture from entering, yet allows excess pressure to vent. Do not connect the tank and the dewar tightly to avoid pressure build up in the dewar. Do not use any stopper or other device that would interfere with venting of gas.

B. Cryogenic containers are designed and made of materials that can withstand rapid changes and extreme temperature differences encountered in working with cryogenics. Fill containers slowly to minimize internal stresses that occur when any material is cooled.

C. When hand-carrying cryogen-containing dewar, ensure the dewar is your only load (don't carry anything else). Watch for people who may run into you, and ensure that the dewar is carried with both hands and as far away from your face as comfortably possible.

D. Ensure dewars are properly labeled with the identity of the cryogen. Do not mix different cryogens dewars.

E. Use care when filling portable dewars and do not overfill them.

F. Do not cover or plug the entrance opening of any dewar. Do not use any stopper or other devise that would interfere with venting of gas.

G. Keep containers upright at all times except when pouring liquids from dewars specifically designed for that purpose. Handle containers gently; rough handling can cause serious damage to dewars and refrigerators. Dropping the container can cause partial or complete loss of vacuum. Do not walk, roll or drag these containers across a floor; uses a dolly or handcart.

H. Keep containers clean and dry. Moisture, chemicals, strong cleaning agents may promote corrosion which should be removed promptly. 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.

IV. First Aid Procedures and Emergencies

A. Obtain medical assistance as soon as possible if cryogens contact anyone's skin. Immediately upon exposure, the frozen skin appears waxy and yellow and the burn usually is not painful. Then, it painfully swells and blisters while the skin defrosts. Assist affected staff to Employee Health or the Emergency Department.

B. Any clothing that may interfere with the circulation of blood to the frozen tissues should be removed in a slow, careful manner to prevent salvageable skin from being pulled off. Do not rub or massage the affected parts of the body. Rubbing may further damage the tissue.

C. Move affected person to a warm room, if possible.

D. As soon as practical, immerse the affected area in a warm water bath not to exceed 105 °F. Never use dry heat. The rewarming, or thawing, of affected area(s) should be done gradually. It may take up to 60 minutes to thaw the affected area(s) and bring back the natural color of the skin.

E. If the eyes are affected, flush them with warm water for at least 15 minutes.

F. Call University Police at 911 from campus phone (or 631-632-3333 from cell phone) in the event of a major release, spill or other emergency.

INQUIRIES/REQUESTS:

Environmental Health and Safety
L1-059 HSC
Zip 8017
Main Office: 444-6783
FAX: 444-6845

RELATED FORMS:

RELATED DOCUMENTS:

EMS Policy 9.0.0, Oxygen/Air Cascade System
Compressed Gas Association, CGA P-1, *Safe Handling of Compressed Gases in Containers.*
Compressed Gas Association, CGA P-2.7, *Guide for the Safe Storage, Handling and use of Portable Liquid Oxygen Systems in the Healthcare Facilities.*
NFPA Standard for Health Care Facilities, current version
Compressed Gas Association, CGA P-12, *Safe Handling of Cryogenic Liquids.*