1.0 INTRODUCTION

1.1 Currently there are more than 200 different substances commonly shipped in compressed gas cylinders. Compressed gases may be divided into two major groups, liquefied and nonliquefied, depending on their physical state in the container under certain temperature and pressure and their range of boiling points. A cryogenic liquid is a refrigerated liquefied gas having a boiling point colder than -130□F (-90□C) at 14.7 psia (101.3 kPA, abs). A third grouping is dissolved gas. Acetylene (acetylene gas dissolved in acetone or dimethyl formamide) is the only widely used gas in this grouping.

1.2 Compressed gases are often lumped into families based on a common source, similar use or related chemical structure. The most common family designations and examples of gases found in each are

1.2.1 Atmospheric gases: nitrogen, oxygen, helium, and the rare gases (neon, krypton, xenon and radon). Sometimes hydrogen and carbon dioxide are also assigned to this family.

1.2.2 Fuel Gases: Primarily LPG, LNG (methane) and acetylene. Hydrogen may also be considered a fuel gas.

1.2.3 Refrigerant Gases: The halogenated hydrocarbons (freons), ammonia and methane are examples.

1.2.4 Poison Gases: The semiconductor gases (arsine, phosgene, and phosphine) and hydrogen sulfide are examples.

1.2.5 Gases with no Family Ties (but are commercially important): Carbon monoxide, sulfur dioxide, fluorine and carbon dioxide are examples.

1.3 Cylinders of compressed gases and cryogenic liquids can be extremely hazardous if misused. Besides the hazard associated with high pressure, the chemical hazard of the cylinder contents must be considered. In addition, some of these materials, especially the cryogenic fluids, are extremely cold when released. Certain precautions must be observed in storage, handling, and use of these materials in order that minimize these hazards.

2.0 PURPOSE AND SCOPE

2.1 The purpose of this procedure is to outline minimal guidelines for the use, handling, and storage of compressed gas and cryogen cylinders at DRI.

2.2 This procedure applies to all employees, temporary workers and contractors who work with or around compressed gases and cryogenic liquids at DRI facilities or on DRI field projects.

2.3 This information found in this procedure covers the more common laboratory practices for the use and storage of compressed gas or cryogenic fluids. For situations not covered in this procedure, or if you have any questions about the content of this procedure, contact EH&S for assistance prior to commencement of work.

2.4 This procedure does not cover the U.S. Department of Transportation (DOT) regulations pertaining to the transportation of compressed gases or cryogenic fluids via highway, rail, water or air found in Title 49 Code of Federal Regulations 171-180, the DOT regulations for the driver

and the motor vehicle carrying compressed gases by highway, or Transport Canada (TC), the International Maritime Organization (IMO) or the International Civil Aviation Organization (ICAO) transportation regulations.

3.0 RESPONSIBILITY

3.1 Supervisors in areas where compressed gas and/or cryogen cylinders are used or stored are responsible for:

3.1.1 verifying that the guidelines for their use, handling and storage are followed in areas under their supervision.

3.1.2 notifying the EH&S Department of any new processes which will change the current inventory, including but not limited to increases in amount and/or types of gases or cryogenic liquids.

3.2 The employee, temporary worker and contractor who handles, uses or stores compressed gas or cryogenic liquids is responsible for the following this procedure.

3.3 The EH&S Department is responsible for permitting the use, handling and storage of compressed gases/ and cryogens, as required, with the State Fire Marshal's Office and the local fire department jurisdiction.

4.0 LABORATORY STORAGE of GASES & COMPRESSED LIQUIDS

4.1 Hazardous materials use permits are required for the NNSC, the SNSC and the Stead hangar. Permits are issued for the entire facility, not for individual labs; therefore, gases and cryogens are aggregated by hazard class for permitting purposes. Laboratory chemical inventories are used to determine if a hazard class of gas or cryogen must be reported to the State Fire Marshal. Aggregate use or storage of compressed gases and cryogens at DRI facilities exceeding the amounts listed below must be permitted (Article 1 Uniform Fire Code, Section 105, Permits).

UFC Table 105-A—Permit Amounts for Compressed Gases[1]

Type of Gas	Amount (ft^3)[2]
Corrosive	200
Flammable (except cryogenic fluids and LPG)	200
Highly Toxic	Any Amount
Inert and Simple Asphyxiant	6,000
Irritant	200
Other Health Hazards	650
Oxidizing (including oxygen)	504
Pyrophoric	Any Amount
Radioactive	Any Amount
Sensitizer	200
Toxic	Any Amount
Unstable (reactive)	Any Amount

[1] See UFC Articles 49, 52, 63, 74, 80 and 82 for additional requirements

[2] Cubic feet measured at standard temperature and pressure

UFC Table 105-B—Permit Amounts for Cryogens[1]

Type of Cryogen[1]	Inside Building (gal.)	Outside Building (gal.)
	x 3.785 for liters	
Corrosive	Over 1	Over 1
Flammable	Over 1	60
Highly Toxic	Over 1	Over 1
Nonflammable	60	500
Oxidizer (including oxygen)	10	50

[1] See UFC Article 75

4.2 Any addition of a new compressed gas or cryogenic liquid in a listed area, addition of a new use area, or any increase in quantity to be used or stored requires a permit amendment. Contact EH&S prior to adding new gases/cryogens, use areas or increasing inventory levels.

4.3 Uniform Fire Code regulations (see Tables 8001.15-A and 8001.15-B) limit the amount of certain hazard classes of gases per fire control area as follows:

Flammable	750 cubic feet[1,2]	Liquefied flammable gas	15 gallons[1,2]
Oxidizer	1,500 cubic feet[1,2]	Liquefied oxidizer gas	15 gallons[1,2]
Cryogenic, oxidizer or flammable	45 gallons	Pyrophoric	50 cubic feet[2,3]
Unstable reactive 4	10 cubic feet[2,3]	Carcinogenic	810 cubic feet[2,4]
Unstable reactive 2	750 cubic feet[1,2]	Irritant Gases	810 cubic feet[2,4]
Unstable Reactive-3	50 cubic feet[1,2]	Sensitizer	810 cubic feet[2,4]
Highly Toxic	12 cubic feet[5]	Corrosive Gases	810 cubic feet[2]
Toxic	810 cubic feet[2]		
Other Health Hazards	810 cubic feet[2,4]	Radioactives[6]	
		Alpha Emitters	0.2 mCi
		Beta Emitters	20 Ci
		Gamma Emitters	14 Ci

[1] Quantities may be doubled in 100 % sprinklered buildings.

[2] Quantities may be increased by 100% when stored in approved storage cabinets; gas cabinets or exhausted enclosures specified in UFC 8001.3.2, 8003.3.1.3.2 and 8003.3.1.3.3.

[3] Permitted in sprinklered buildings only. None is allowed in unsprinklered buildings.

[4] Quantities in sprinklered buildings are not limited when exhaust ventilation in accordance with UFC 8003.1.4, 8004.1.11, 8004.2.2.2 and 8004.2.3.3, as applicable to the material condition, is provided

[5] Permitted only when located in approved gas cabinets, exhausted enclosures or gas rooms. See UFC 8003.3.1.32, 8003.3.1.3. and 8003.3.1.3.4.

[6] The use of radioactive gases requires approval by the UNR Radiation Safety Committee

5.0 GENERAL REQUIREMENTS

5.1 A cylinder should always carry a legible label or stencil identifying the contents. Tags attached to the cap are not a satisfactory method of identification. Return cylinder to supplier without using if the contents are not properly identified.

5.2 Do not deface or remove any markings, labels, decals, tags or stencil marks used for identification of cylinder contents.

5.3 Empty cylinders and cylinder storage areas should be clearly marked with appropriate labels and signs. Assigned storage spaces shall be located where cylinders will not be damaged by passing or falling objects, or subject to tampering by unauthorized persons.

5.4 Cylinders should not be kept in unventilated enclosures, such as lockers or cupboards. Ensure cylinders are stored and used in a dry, well ventilated area.

5.5 Cylinders should be stored out of direct sunlight and away from other sources of heat. A cylinder should never be subjected to a temperature above 125°F (52°C). Conversely, do not store cylinders where temperatures can drop to below freezing as this can cause the cylinder metal to become brittle resulting in metal fatigue and failure.

5.6 Do not tamper with the safety relief device in valve or cylinder or attempt to repair or alter a cylinder, valve, or safety relief device.

5.7 Cylinder valves should be closed at all times except when cylinder is in active use.

5.8 Do not place a cylinder where it might become part of an electric circuit. Never strike an arc on a gas cylinder.

5.9 Cylinders of oxidizing gases, including oxygen (except those on a welding cart that is in use on a regular basis) must be stored at least 20 feet (6.1 m) away from any flammable gas or separated by a 5 foot (1.5m) high 30 minute (minimum) fire resistant wall. Oxidizing gases must also be stored away from combustible materials.

5.10 To avoid the potential for fire, do not use tubing constructed of organic materials, such as rubber, on cylinders of oxidizing gases. Acetylene should never be brought into contact with unalloyed copper, except in a blowpipe or torch.

5.11 Cylinders, other than lecture bottles, that are not connected or in use, should be fitted with a valve protection cap.

5.12 Cylinders of toxic gases, such as ammonia and hydrogen chloride, may require special permits and storage/use equipment. Contact EH&S prior to ordering these materials.

5.13 Gases should be ordered/used in the smallest cylinder practical.

5.14 Never use compressed gas as a means of drying glass/plastic wear or to remove dust/debris. If house compressed air is to be used for cleaning, the pressure must be reduced to less than 30 psi and effective chip guarding and personal protective equipment must be used (29 CFR 1910.242(b)).

5.15 Leaking Cylinders

5.15.1 If a cylinder leaks (for ICC - 41 cylinders, venting is normal) and if the leak cannot be corrected* by tightening a valve gland or packing nut, close the valve and attach a tag stating the cylinder is unserviceable. (***NOTE: Never** attempt repairs while the system is under pressure.)

5.15.2 If safe to do so, remove the defective cylinder to a well ventilated location and notify EH&S and your supervisor.

5.15.3 If moving the cylinder is not possible or safe, evacuate the area and call the EH&S emergency only number, (775) 742-6330.

5.16 Never attempt to refill a cylinder.

6.0 WHEN CYLINDERS ARE DELIVERED

6.1 Gases, including cryogenic liquids, must be segregated by hazard class (oxidizer, flammable, nonflammable, etc.) prior to placing into storage racks. Attempt to keep individual gases together within their hazard class, placing new bottles behind those already in storage when possible. Remember that oxidizing gases must be separated from flammable gases by at least 20 feet if not separated by a 5-foot high 30-minute fire rated wall.

6.2 Each bottle must be chained for seismic purposes. The chain should be placed about equidistant between the cylinder neck and floor in a single chain system or approximately 1/3 and 2/3 from the bottom of the cylinder in a double chain system. Shorter bottles will need to be racked separately from taller (K-sized) cylinders to ensure proper chain placement.

6.3 Each bottle in storage should have a “Full, In Use, Empty” tag attached. Cylinders received without tags should be tagged by receiving personnel.

7.0 MOVING CYLINDERS

7.1 Select the cylinder needed and remove from rack. Be sure a “Full, In Use, Empty Tag” is attached. Verify that other cylinders in rack are tightly chained as cylinders are removed.

7.2 Valve protection caps should be in place when cylinders are transported, moved, or not connected for use. **NEVER** move a cylinder with a regulator attached.

7.3 Never use a valve cap to lift a cylinder.

7.4 Avoid dragging, rolling or sliding cylinders or attempting to move one any distance by hand.

7.5 Transport the cylinder using an approved gas or cryogen cylinder handcart, as applicable. Ensure the cylinder is properly secured during transit.

7.6 Avoid dropping cylinders or allowing them to strike violently against other cylinders.

8.0 INSTALLING/SECURING CYLINDERS

8.1 Install individual cylinders with chain restraints (preferable) or bench straps. Small cylinders should be stored upright in ring stands or other secure devices. Six packs should be secured by braking devices or other methods to prevent unwanted movement. Cylinders should be appropriately secured regardless of whether they are full or empty.

8.2 Compressed gas containers, cylinders, tanks and systems that could be exposed to physical damage shall be protected by guard posts or other means.

8.3 Compressed gas containers, cylinders, tanks and systems in storage shall be separated from materials and conditions which present exposure hazards to or from each other.

8.4 Labels or identifying markings on cylinders should face out or signs indicating the contents should be posted where they can readily be seen by emergency responders.

8.5 Markings used for piping of compressed and liquefied gases and cryogenic fluids shall consist of the content's name and include a direction of flow. These marking shall be provided at each valve; at wall, floor or ceiling penetrations; at each change of direction; at a minimum of every 20 feet or fraction thereof throughout the piping run.

8.6 When low melt point materials, such as aluminum, copper, some brass alloys, or nonmetallic materials are used for piping systems conveying flammable, pyrophoric or oxidizing gases, such piping systems shall be protected with one of the following:

8.6.1 Isolation from fire exposure by fire-resistive construction or other approved means;

8.6.2 Isolation from fire by gas cabinets;

8.6.3 Protected from fire exposure by an automatic fire-extinguishing system; (Typical design is a dedicated smoke or heat detector which then activates a dedicated fire extinguishing system for the gas cylinder(s) and line(s).)

8.6.4 Located so that any release resulting from failure of the piping system will not unduly expose persons, buildings or structures; or

8.6.5 Provided with a readily accessible shutoff valve or valves which will shut off the source gas to the piping system in event of leakage. (UFC 8001.4.3.4 Flammable, oxidizing and pyrophoric gases)

8.7 Additional regulations exist for the supply piping and installation of health hazard ranking 3 and 4 gases. Contact EH&S for details.

9.0 USE OF COMPRESSED GASES AND LIQUIDS

9.1 Removable type valve protection caps should remain in place until content is to be withdrawn or cylinder is to be connected to a manifold.

9.2 Use cylinders in an upright position.

9.3 Do not use a cylinder of compressed gas without reducing the pressure through a regulator attached to the cylinder valve.

9.4 Use regulators and pressure gauges only with gas for which they were designed and intended. Do not use adapters or modify connectors to circumvent this rule. Make sure the threads on a regulator or union correspond with those on the cylinder valve outlet. Do not force mismarked connectors.

9.5 Use spark resistant tools when installing regulators onto cylinders of flammable gas.

9.6 Do not tamper with cylinders or valve parts such as the safety nut or stem packing nut.

9.7 Never use oil or grease on valves or attachments of cylinders of oxygen or other oxidizing gases, such as nitrous oxide. Avoid handling oxidizing gas cylinders and apparatus with oily hands, gloves, or clothing.

9.8 If your clothing becomes saturated with oxygen, leave the area, avoid ignition sources, remove clothing and air our. Even clothing rated as fire resistant may ignite if saturated with an oxidizer gas.

9.9 Cylinders containing acetylene should never be used with regulators; fittings or piping that contain copper or brass which directly contact the gas.

9.10 Open cylinder valves slowly with valve outlet directed away from all personnel. The main cylinder valve should always be opened before opening the downstream regulator needle valve.

9.11 Once installed, test system for leaks. If gas leaks are detected, shut down system, relieve pressure and tighten connections until leaks are corrected. If you cannot correct the problem, lock and tag out the system until repairs can be made by trained personnel.

9.12 Use compressed gases only in a well-ventilated area. Toxic, flammable and corrosive gases should be handled only be personnel trained in their hazard properties and their use may require additional ventilation and special permits.

9.13 All cylinders of flammable gas should be grounded before opening and when in use. Noncombustible gases, such as nitrogen and carbon dioxide, should be grounded if used in an explosive atmosphere.

9.14 Only pressure tubing and piping designed to withstand pressure should be used for any gas under pressure. Remember; do not use tubing constructed of organic materials, such as rubber, with oxidizing gases.

9.15 Place a liquid trap between the cylinder and reaction mixture to prevent back siphonage.

9.16 Upon first using a cylinder, remove the “full” portion of the cylinder tag to indicate the cylinder is “In Use”.

9.17 Close the main cylinder valve as soon as it is no longer necessary to have it open.

9.18 Cylinders not in use should have the regulator removed and the valve protection cap attached. Before a regulator is removed from a cylinder, close the cylinder valve, the bleed (release) the pressure from the regulator. Remove the regulator and replace the valve protection cap.

9.19 Empty cylinders or those not needed should be removed from laboratory use areas and placed back into the storage rack for pick up by the vendor. In general, it is recommended that residual gas be left in a used cylinder of nonliquefied gas to prevent contamination. Do not let the pressure drop below the pressure of the system of less than 25 psig (135 kPA).

10.0 CRYOGENIC SYSTEMS

The most severe hazard of cryogenic systems is the possible confinement of even small amounts of cryogenic liquid. Closed cryogenic systems will quickly become pressure systems when trapped cryogenic fluids warm up and cause pressure build-up. Any system that contains valves or fittings that could possibly separate cryogenic fluid from a direct connection with the atmosphere is a closed system.

10.1 Requirements for Closed Cryogenic Systems

In addition to the requirements applying to all pressure systems, cryogenic systems must have:

10.1.1 Independent pressure relief devices for each component or segment of tubing that can be isolated by valves.

10.1.2 Independent pressure relief for each closed space that is in contact with cryogenic temperatures (e.g., vacuum insulation spaces). This is because air may leak in, liquefy, and accumulate in these spaces.

10.1.3 Low temperature rating of relief valves or thermal isolation for relief valves to prevent ice formation, which will disable the relief valve.

10.1.4 Assurance of air exclusion for flammable cryogens and for cryogens capable of solidifying air.

10.1.5 No pressurized components subject to low temperature embrittlement.

10.1.6 Compatible shrink rates of materials.

10.1.7 Adequate ventilation provisions in case of large scale spills or continuous venting (which may include the need to install oxygen deficiency alarms).

10.2 General Requirements for Liquid Nitrogen, Liquid Argon and other Cryogenic Liquid Handling

Small scale use of inert cryogenics that are not confined (e.g., the filling of cold traps with liquid nitrogen) poses few hazards. The following rules apply to such use:

10.2.1 Wear eye protection appropriate to the hazard. When pouring liquid nitrogen or argon from a Dewar, use safety glasses with side shields. However, when transferring liquid nitrogen or argon from a pressurized cryogen liquid cylinder, use a face shield.

10.2.2 Wear loose fitting gloves (e.g., welding gloves) when working on systems with exposed components at cryogenic temperatures to assure that skin will not freeze to cold pipes or metal parts. Gloves need to be loose fitting so they can be thrown off readily if cryogen is spilled into them. This assures that the cryogen will not be trapped against the skin. Small spills of liquid nitrogen or argon on the skin will evaporate without damage unless the liquid is trapped against the skin.

10.2.3 Wear long cuffless pants over high topped shoes to ensure cryogenic liquid does not pool in pant cuffs or enter shoes during a spill or leak scenario.

10.2.4 Do not use cryogens in unventilated spaces, such as closets or experimental caves, without exhaust ventilation.

10.2.5 When transferring cryogenic liquids from pressurized containers with hoses or tubing, be sure to verify that there are pressure relief devices between all valves because it is easy to trap the cryogen in the transfer hose or in the tube between two valves. In such a case, the hose will rupture and whip around out of control.

11.0 RETURN OF CYLINDERS TO STORAGE AREA

11.1 If the cylinder is empty, remove the "In Use" portion of the cylinder tag. Otherwise leave the tag intact to indicate that it is not empty.

11.2 Move the cylinder back to the main laboratory storage area following the procedure listed in Section 7.0 and return to storage or empty storage areas (as appropriate) following the instructions in Section 6.1 and 6.2.

12.0 PERSONAL PROTECTIVE EQUIPMENT REQUIRED

12.1 Foot protection meeting the most current ANSI Z41 standard for safety shoes is required when moving gas or cryogenic liquid cylinders.

12.2 Safety glasses or other face and eye protection should be employed when installing or removing the regulators as well as when using compressed gases, compressed liquids or cryogenic liquids.

12.3 Gases under pressure are cold. This is especially true when handling cryogenics such as liquid nitrogen or carbon dioxide. Cryogen gloves should be worn when the possibility of skin contact exists.

12.4 Clothing (even that rated as fire-resistant) may be readily ignited in an oxygen rich atmosphere. If your clothing becomes saturated, remove it and hang it our in the open.

13.0 GLOSSARY

13.3 ***Asphyxiant gases*** (including inert gases such as argon, carbon dioxide, helium, krypton, neon, nitrogen and xenon***)*** can displace oxygen in air and can cause rapid suffocation due to oxygen deficiency. Inert gases handled as cryogenic liquids can, if released, generate extremely large volumes of inert gas, rapidly displacing oxygen. Therefore, any time there is a leak or spill of an inert gas cryogen, there is a serious hazard of oxygen deficiency in the area. Nonflammable liquefied gases, such as carbon dioxide, sulfur hexafluoride, and nitrous oxide also pose the hazard of asphyxiation by reducing the oxygen content in air if large quantities are spilled or released. Gases heavier than air, such as carbon dioxide and sulfur hexafluoride are much heavier than air and can accumulate in low-lying areas.

13.3 ***A carcinogen*** is any substance which meets one of the following criteria:

13.2.1 It has been evaluated by the International Agency for Research on Cancer Monographs (IARC) and found to be a carcinogen or potential carcinogen, or

13.2.2 It is listed as a carcinogens or potential carcinogen in the latest edition of the Annual Report on Carcinogens published by the National Toxicology Program (NTP), or

13.2.3 It is regulated by OSHA as a carcinogen.

13.2 ***A compressed gas*** is a material that is shipped in a compressed gas cylinder and acts as a gas upon release at normal temperature and pressure or is used or handled as a gas.

13.2.1 A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or

13.2.2 a gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or

13.2.3 A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-323-72.

13.3 ***A control area*** is a space bounded by not less than a one-hour fire-resistive occupancy separation within which exempt amounts of hazardous materials may be stored, dispensed, handled, or used (as defined in the Uniform Fire Code (UFC)).

13.3 ***A corrosive gas*** is a gas that can cause visible destruction of, or irreversible alterations in, living tissue (e.g., skin, eyes, or respiratory system) by chemical action.

13.4 ***A cryogenic liquid*** is a refrigerated liquefied gas having a boiling point colder than -130□F (-90□C) at 14.7 psia (101.3 kPA, abs).

13.5 ***An exhausted enclosure*** is a gas cabinet, lab hood, or enclosed compartment that is connected to an approved negative-pressure exhaust duct system.

13.6 ***A flammable cryogenic*** is a cryogenic fluid that is flammable in its vapor state.

13.7 ***A flammable gas*** is a gas that can be ignited in air.

13.7.1 A gas that, at ambient temperature and pressure, forms a flammable mixtures with air at a concentration of 13 percent by volume or less; or

13.7.2 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.

13.8 ***A gas cabinet*** is an exhausted enclosure used to store or use gas cylinders that meets the requirements specified in this chapter.

13.9 ***A hazardous gas*** is a gas that is included in one or more of the following hazard categories: corrosive, flammable, health hazard, oxidizer, pyrophoric, reactive, or toxic.

13.10 ***A health hazard*** is a classification for a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principals that acute or chronic health effects could occur in exposed persons. Health hazards include chemicals which are carcinogens, toxic or highly toxic materials, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoetic system, and agents which damage the lungs, skin, eyes or mucous membranes.

13.11 ***A highly toxic gas*** is a gas that has a median lethal concentration (LC_{50}) in air of 200 ppm by volume or less of gas, when administered by continuous inhalation for one hour or less, or if death occurs with one hour, to albino rats weighing between 200 and 300 grams each.

13.12 ***An irritant gas*** is a gas which is not corrosive, but which causes a reversible effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant it, when tested on the intact skin of albino rabbits by methods of 16 CFR 1500.41 for four hours' exposure or by other appropriate techniques, it results in an empirical score of 5 or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other approved techniques.

13.13 ***A liquefied gas*** is a gas, which in a packaging under the charges pressure, is partially liquid at a temperature of 68□F (20□C).

13.14 ***A nonliquefied gas*** is a gas, other than in solution, which in a packaging under the charges pressure is entirely gaseous at a temperature of 68□F (20□C).

13.15 ***An other health hazard*** is a hazardous material which affects target organs of the body, including, but not limited to, those materials which produce liver damage, kidney damage, damage t the nervous system, act on the blood to decrease hemoglobin function, deprive the body tissues of oxygen, or affect reproductive capabilities, including mutations (chromosomal damage) or teratogens (effects on fetuses).

13.16 ***An oxidizing gas*** is gas that initiates or promotes combustion in materials, either by catching fire itself or by causing a fire through the release of oxygen or other gases.

13.17 ***An oxygen deficient atmosphere*** is one where the available oxygen is less than 19.5 percent by volume.

13.18 ***A pyrophoric gas*** is a gas that may spontaneously ignite in air at or below 54□C (130□F). Specific gases may not ignite in all circumstances or may explosively decompose.

13.19 ***A sensitizer gas*** is a gas that causes a substantial proportion of the exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure tot he chemical.

13.20 ***A toxic gas*** is a gas that has a median lethal concentration (LC_{50}) in air of more than 200 ppm, but not more than 2,000 ppm by volume of gas, when administered by continuous inhalation for one hour or less, or if death occurs with one hour, to albino rats weighing between 200 and 300 grams each.

13.21 ***An Unstable (reactive)*** is a chemical, other than an explosive, which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

13.21.1 ***Class 4:*** Materials which, in themselves, are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. This class included materials which are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.

13.21.2 ***Class 3:*** Materials which, in themselves, are readily capable of detonation or explosive decomposition or explosive reaction, but which require a strong initiating source or

which must be heated under confinement before initiation. This class included materials which are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

13.21.3 ***Class 2:*** Materials which, in themselves, are normally unstable and readily undergo violent chemical change, but do not detonate. This class included materials which can undergo chemical change with rapid release of energy at normal temperature and pressure and which can undergo violent chemical change at elevated temperatures and pressures.

14.0 REFERENCES

14.1 Title 29 Code of Federal Regulations 1910.101-105.

14.2 Title 29 Code of Federal Regulations 1910.242(b).

14.3 Title 29 Code of Federal Regulations 1910.253.

14.4 Article 49 Uniform Fire Code, Section 4901.7, *Cylinders.*

14.5 Article 74 Uniform Fire Code, *Compressed Gases*.

14.6 Article 75 Uniform Fire Code, *Cryogenic Fluids.*

14.7 Article 80 Uniform Fire Code, *Hazardous Materials*.

14.8 Handbook of Compressed Gases, Compressed Gas Association, Inc.

14.9 CGA P-1, *Safe Handling of Compressed Gases in Containers*, Compressed Gas Association, Inc.

14.10 CGA P-12, *Safe Handling of Cryogenic Liquids*, Compressed Gas Association, Inc.

14.11 NFPA 45: *Standard on Fire Protection for Laboratories Using Chemicals*, National Fire Protection Association.