Northern Illinois University

Compressed Gas Cylinder Safety Program

Department of Environmental Health and Safety

April 27, 2020
Rev. 0

Review and Updates

Date	Reviewed by	Changes Made
10/10/2019	Mary Schlagel	Initial draft
4/27/2020	Dave Scharenberg	Final draft

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Compressed Gas Cylinder Program

Purpose

Compressed gas cylinders are used at Northern Illinois University (NIU) primarily for academic, research and maintenance purposes. Compressed gas cylinders can present a variety of hazards due to their pressure and/or contents. Improper use, handling, storage or transportation can cause injury, death or physical damage to property. Therefore, the purpose of the Compressed Gas Cylinder Program (Program) is to outline safe practices and procedures to ensure compressed gas cylinders are safely used to support campus operations.

Regulatory References

This Program is designed to comply with applicable regulations and complement existing NIU policies and procedures. These include:

Policies

- NIU Health and Safety Policy
- NIU Facilities Management and Campus Services Safety Policy
- NIU Laboratory Safety Committee Compressed Gas Cylinder Policy
- NIU Materials Management Compressed Gas Cylinder Procedure

Codes and Regulations

- 56 IL Admin Code Part 350 Health and Safety Code
- OSHA 29 CFR 1910.101 General requirements (Compressed Gases)
- OSHA 29 CFR 1910.102 Acetylene
- OSHA 29 CFR 1910.103 Hydrogen/Liquid hydrogen
- OSHA 29 CFR 1910.104 Oxygen/Liquid oxygen
- OSHA 29 CFR 1910.105 Nitrous oxide
- OSHA 29 CFR 1910.253 Oxygen-fuel gas welding and cutting
- OSHA 29 CFR 1926.350 Gas welding and cutting
- DOT 49 CFR 171-179 Hazardous Materials Regulations
- NFPA 55 Compressed gases and Cryogenic Fluids Code

Note:
OSHA – Occupational Safety and Health Administration
DOT – Department of Transportation
NFPA – National Fire Protection Association

Scope

The scope of this Program outlines procedures specific to the safe handling, use, transportation and storage of compressed gas cylinders on university property in accordance with the NIU Health and Safety Policy.

Application

This Program applies to all non-academic/research operations at NIU including all satellite campuses.

Responsibilities

Environmental Health and Safety (EH&S)

- Develop and update this Program as needed to reflect current regulations and campus operations.
- Provide training, guidance and consultation.
- Perform periodic audits to monitor effectiveness and compliance.

Department Heads and Supervisors

- Ensure employees comply with requirements outlined in this Program.
- Ensure employees receive proper training and maintain such records.
- Identify and correct hazards associated with the handling, transportation and storage of compressed gas cylinders.

Employees

- Participate in this Program as required.
- Use equipment properly and maintain in good condition
- Attend and participate in all necessary training.
- Identify and correct hazards associated with the handling, transportation and storage of compressed gas cylinders.

Types of Compressed Gases

The Globally Harmonized System (GHS) of classification and labeling of chemicals defines "Gases under Pressure" as gases that are contained in a receptacle at a pressure of 200 kPa (gauge) or more, or which are liquefied or liquefied and refrigerated. Gases under pressure will be identified with the following pictogram:

The types of compressed gas can be divided into three categories, each with unique characteristics.

- Non-Liquefied Gas: is a compressed, pressurized or permanent gas. These gases do not become liquid when they are compressed at normal temperatures or even very high pressures. Common examples are oxygen, nitrogen, helium, and argon.

- Dissolved Gas: can also be compressed. A common example of dissolved gas is acetylene. Care should be taken when using acetylene for applications such as welding. Consult your supervisor before using acetylene.
- Liquefied Gas: can become liquid at normal temperatures when inside a cylinder under pressure. When gas is removed from the cylinder, enough liquid evaporates to replace it, keeping the pressure in the cylinder constant. Common examples include anhydrous ammonia, chlorine, propane, nitrous oxide, and carbon dioxide.

Specific Hazard Classes

Flammable Gases

No cylinders are to be stored near highly flammable solvents, combustible waste material, unprotected electrical connections, gas flames, or other sources of ignition. Common examples of flammable gases include acetylene, hydrogen, methane, propane, carbon monoxide, and isobutane.

- At no time shall a flame be used to detect a leak. A soapy water solution or approved commercial leak detection solution shall be used.
- Inside buildings, stored oxygen shall be separated from flammable gas cylinders by a minimum of 20 feet or separated by a fire-resistant partition with a height no less than that of the cylinders.
- Post "No Open Flames" signage on access doors to areas that use or store flammable gases.

Poison Gases

- Before using a poison gas, all label information and Safety Data Sheets (SDS's) associated with the use of the particular poison gas shall be read. Users shall be familiar with the hazards and health effects of the gas which they are using, and procedures to be followed in the event of an emergency.
- Poison gases shall only be used in force-ventilated areas, preferably in hoods with forced ventilation, or outdoor.
- Poison gas cylinders shall be of a size that will ensure the complete usage of the cylinder within a reasonable period of time.

Corrosive Gases

- Cylinders containing corrosive gases shall not be stored for more than six months.
- Remove regulators after use and flush with dry air or nitrogen.
- Metals become brittle when used in corrosive gas service; check equipment and lines frequently for leak.
- Use a diaphragm gauge with corrosive gases that would destroy a steel or bronze gauge. Check with the gas supplier for recommended equipment.

Cryogenic Liquids and Gases

Cryogenic liquids and their boil-off gases rapidly freeze human tissue and cause embrittlement of many common materials. All cryogenic liquids produce large volumes of gas when they vaporize and may create oxygen-deficient conditions. The following information applies to the use and handling of cryogenics. Common examples of common cryogenic liquids include liquid oxygen, nitrogen, hydrogen, neon, and helium.

- Use appropriate personal protective equipment, including insulated gloves, lab coat, and eye protection (goggles and face shield) during any transfer of cryogenic liquid.
- In the event of skin contact with a cryogenic liquid, do not rub skin; place the affected part of the body in a warm water bath (not to exceed 40°C [105°F]). If a burn is significant, seek medical attention.
- Use only equipment, valves, and containers designed for the intended product, service pressure, and temperature.

- Inspect containers for loss of insulating vacuum. If the outside jacket on a container is cold or has frost, some vacuum has been lost. Empty the contents into another cryogenic container and remove the damaged unit from service. Repairs shall be made by the manufacturer or an authorized company.
- Transfer operations involving open cryogenic containers must be conducted slowly to minimize boiling and splashing of the cryogenic fluid.
- Ice or other foreign matter shall not be allowed to accumulate beneath the vaporizer or the tank. Excessive ice buildup could result in the discharge of excessively cold gas or structural damage to the cryogenic container or surroundings.
- All cryogenic systems, including piping, must be equipped with pressure relief devices to prevent excessive pressure build-up. Pressure reliefs must be directed to a safe location. Do not tamper with pressure relief valves or the settings for the valves.
- Hot air, steam, or hot water shall be used to thaw frozen equipment. Exception: Do not use water to thaw liquid helium equipment.

Fuel, High Pressure and Oxidizing Gases

Fuel gases often use a combination of flammable and oxidizing gases. Use of fuel gases must comply with applicable regulations listed above.

High Pressure gases can be rated up to 3,000 pounds per square inch (psi). Typical uses for high pressure gases include:

- Inert welding gas mixtures
- Cryogenics
- Non-toxic gas distribution
- Medical gas distribution
- Emergency oxygen services

Oxidizing gases are non-flammable but in the presence of an ignition source and fuel can support and vigorously accelerate combustion. Do not use oil in any apparatus where oxygen will be used. Gauges and regulators for oxygen shall bear the warning “Oxygen – Use No Oil.”

Oxidizing gases include:

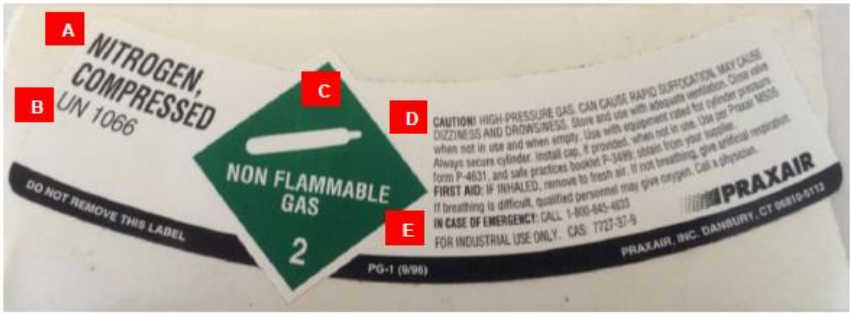
- Oxygen
- Chlorine
- Fluorine
- Nitrous Oxide

Labeling

- Compressed gas cylinders shall be legibly marked for the purpose of identifying the gas content with either the chemical or the trade name of the gas. Such marking shall be by means of stenciling, stamping, or labeling, and shall not be readily removable. The marking shall be located on the shoulder of the cylinder.
- If the labeling on the gas cylinder becomes unclear or defaced so that the contents cannot be identified, the cylinder should be marked “contents unknown” and the manufacturer must be contacted regarding appropriate procedures for removal.

- Color-coding is not a reliable means of identification; cylinder colors vary by supplier, and labels on caps have no identification value because many caps are interchangeable
- Cylinders must bear an identification tag stating the name of the gas or mixture and illustrating one of three conditions: Empty, In-Use or Full.
- Mixed gases must be clearly labeled with the contents of the cylinder.
- Know the contents of each cylinder that you are using. Preferred labeling includes the identity of the material, statement of hazard, and the associated signal word.

As depicted in the photo for Nitrogen, labeling must list contents, concentrations, hazards classes, safety precautions and the manufacturer or supplier:



A Name of Product, B Material identification number, C Hazard diamond,
D Hazards and precautions, E Contact information

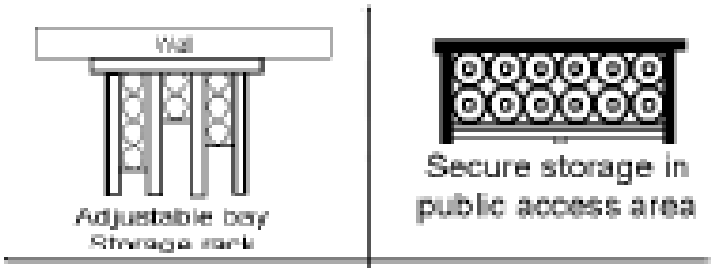
Storage

Proper storage is critical for the safe usage of compressed and liquefied gases. Cylinder storage areas should be prominently posted with hazard information regarding the gases stored.
The NFPA 704 diamond with a cylinder indicated in the "specific hazard" (white) section of the diamond and the corresponding flammability, health and reactivity hazard sections also marked is an accepted method of signage. Other storage requirements are outlined below:

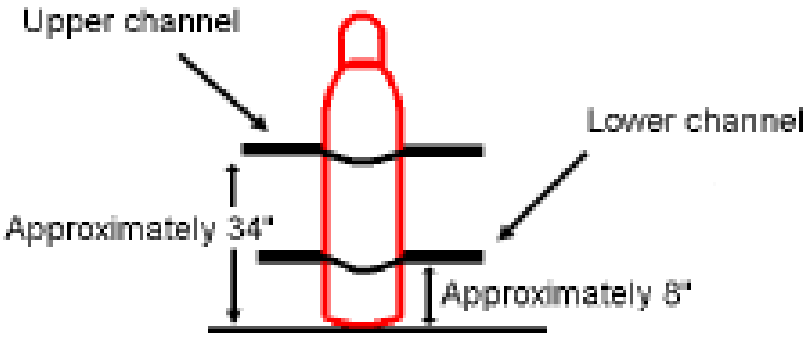
- Protect cylinders from contact with ground, ice, snow, water, salt, corrosion, and high temperatures.
- Store cylinders in a clearly identified, dry, well-ventilated storage area away from doorways, aisles, elevators, and stairs.
- Store cylinders in an upright position.
- Shall be capped when not in use or attached to a system (if the cylinder will accept a cap)
- Store cylinders of the same hazard class in the same area (i.e. poisons/highly toxic, flammables, inerts, corrosives, oxidizers, and cryogenic gases).

- Must be segregated into “FULL” or “EMPTY” groups at locations or in racks for each category.
- All cylinders whether full or empty must comply with NFPA and DOT labeling requirements and OSHA hazard communication requirements. Contents of cylinders should be readily identifiable during inspection. A safety data sheet (SDS) must be available for all gases and gas mixtures.
- Cylinders less than 18 inches tall may be secured by approved stands or wall brackets.
- Inert gases are compatible with all other gases and may be stored together.
- Oxidizers and fuel gases must be separated by at least 20 feet, or a noncombustible wall at least 5 feet high with at least a half-hour fire rating.
- Cylinders, especially oxygen, must be kept at least 20 feet from highly combustible or flammable materials.
- Oxidizers and flammables must be kept at least 20 feet from all sources of ignition.
- Store cylinders so that they are used in the order in which they were received, i.e. first in – first out.
- Do not store cylinders longer than one year without use. Return them to the supplier or give it to another laboratory or shop on campus that will use it up.
- Secure with a chain or appropriate belt above the midpoint, but below the shoulder. Best practice is having both an upper and lower chain. This will reduce the potential of the cylinder falling over. See the following diagrams for reference.

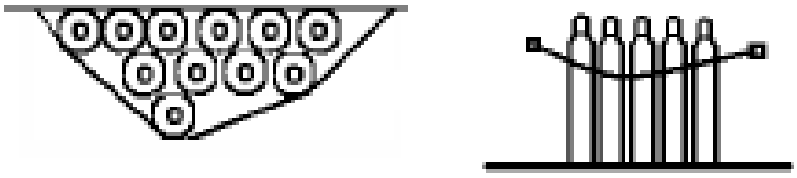
Best Practice



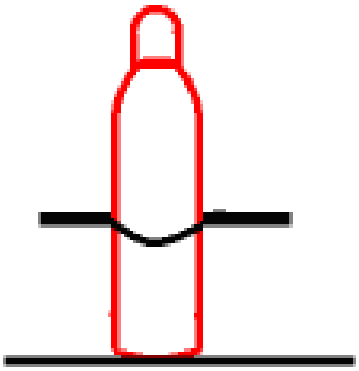
Individually supported
cylinders



Poor Practice



Cylinders not adequately supported



Cylinder not adequately supported

Safe Handling and Transportation

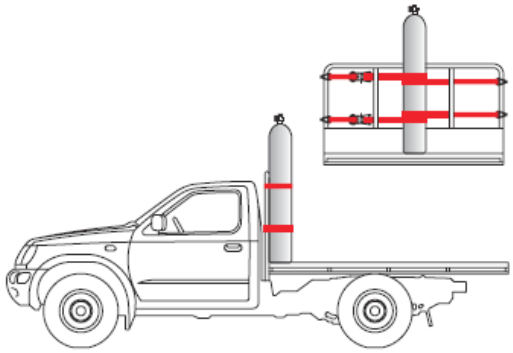
Before moving cylinders within a building:

- Valves must be closed with caps in place.
- Regulators must be removed.
- Inspect the cylinder for existing damage prior to attempting transport.
- Secure cylinders in a cylinder cart with a chain to move to new location.
- Use platforms or cradles that keep cylinders upright and secured when lifting with mechanical equipment. Do not lift cylinders by their valve cap.
- Do not drag or roll cylinders horizontally.
- Use a hand truck to avoid dragging, rolling or sliding cylinders
- Once the cylinder is placed on a cylinder hand truck, ensure it is secured by a strap rack, heavy gauge chain or clamp to prevent falling.

Transporting cylinders between floors of a building shall be done by elevator. The elevator car is a small enclosed space. Should the cylinder leak, gas could quickly fill the car, potentially overcoming passengers with toxic or oxygen-displacing gas. Therefore, no person shall travel in the elevator with the gas cylinder. The cylinder trolley shall be secured to the elevator hand rail to prevent it from falling over. Ideally a sign should be used across the entrance of the elevator to prevent others from entering while the cylinder is in transit. A second employee must be at the receiving floor to collect the cylinder. Secure the cylinder immediately once arriving at the usage location.

Before moving cylinders by vehicle:

- Do not carry gas cylinders of any kind in the passenger compartment of a vehicle. Should a gas leak develop the occupants could be overcome by toxic or oxygen-displacing gas, resulting in serious injury or death. Direct sunlight or excessive temperatures can result in a release of the cylinder contents.
- Always transport gas cylinders in vehicles where the cargo section is separate from the passenger section (i.e., not one continuous space).
- Inspect the cylinder for existing damage prior to attempting transport.
- The valve cap must be on the cylinder to protect the valve stem.
- Applicable DOT requirements for labeling, marking, and placarding must be met when transporting gas cylinders.
- The cylinder must be secured in an upright position in the back of the vehicle to prevent cylinder damage, particularly to the valve stem, during transport.
- Do not smoke during transport. Do not be the source of ignition to a flammable gas leak.
- Take a direct route to the new location. Do not make any intermediate stops. Avoid heavy traffic.
- Remove the cylinder from the vehicle upon arrival to the destination. Place it in proper storage.
- Treat “empty” tanks the same as full tanks since residual gas may still remain.



Cylinders Transported in Upright Position

Proper Use

Take the following precautions to prevent injuries caused by the improper use of compressed gases:

- Know and understand the gases associated with the equipment being used.
- Do not mix gases in a cylinder.
- Do not permit cylinders to become part of an electrical circuit.
- Use non-sparking tools (brass) when working with flammable/explosive materials.
- Prevent sparks and flames from contacting cylinders.
- Never strike an arc on a cylinder. Never introduce another product into the cylinder.
- Do not discharge the contents from any gas cylinder directly towards any person.
- Do not force cylinder valves connections that do not fit. If the threads do not match, return the cylinder to the vendor. Teflon tapes can never be used on cylinder or regulator connections.
- Open cylinder valve slowly and carefully after the cylinder has been connected to the process. Use check valves to prevent reverse flow into the cylinder.
- Close the cylinder valve and release all pressure from the downstream equipment. Disconnect the cylinder anytime there an extended non-use period is expected. Cap the cylinder when not in use.
- Never use a compressed gas in any confined space.
- Never work alone when using compressed gas.
- Never use compressed gas to dust off clothing. This could cause injury to the eyes or body and create a fire hazard. Clothing can become chemically saturated and burst into flames if touched by an ignition source such as a spark or cigarette.
- If the cylinder's valve does not operate properly, do not attempt to force the valve to turn. The cylinder should be returned to the vendor or the Material Distribution Center. Employees must not attempt to repair cylinders or cylinder valves or to force stuck or frozen cylinder valves.

Valves and Regulators

- Use regulators approved for the specific gas.
- Tampering with safety relief devices in cylinder valves is not permitted
- Repair or alter of cylinders, valves, or other safety relief devices is strictly prohibited.
- All cylinder valves shall be kept closed at all times, except when the cylinder is in use.
- The vendor needs to be notified if any condition has occurred which may have permitted any foreign substance to enter a cylinder or valve.
- Approved pressure regulating devices must be used in all cases when gas pressure in a system is lower than cylinder pressure.
- All cylinder valves shall be opened slowly to prevent ice formation. Appropriate tools shall be used to tighten or loosen tank valves. If the valve will not readily open, return the cylinder to the vendor.
- Before a regulator is removed from a cylinder, the cylinder valve shall be closed and all pressure released from the regulator and system.
- Be sure the regulator pressure control valve is relieved (or closed) before attaching to the cylinder.
- Remove all pressure from regulators that are not currently used.
- Use pressure relief valves in downstream lines to prevent high pressure buildup in the event that a regulator valve does not seat properly and a tank valve is left on.
- Pressurize regulators slowly and ensure that valve outlets and regulators are pointed away from all personnel when cylinder valves are opened.
- Leave the wrench in place on the cylinder valve, when needed, to open the main valve. Use adequately sized wrenches (12 inches long) to minimize ergonomic stress when turning tight tank valves. Cylinders with "stuck" valves need to be returned to the vendor for repair.
- Fully open valves during cylinder use. A fully open valve improves the internal seal and helps prevent packing leaks.
- Use a cylinder cap hook to loosen tight cylinder caps. Never apply excessive force to pry off caps.
- Regulators, gauges, hoses, and other appliances used with a particular gas or group of gases must not be used on cylinders containing gases having different chemical properties unless approved in writing by the vendor.

Training Requirements

Hazardous Communication (HazCom) training must be completed by new employees prior to the use or transportation of compressed gas cylinders. Facilities personnel contact EH&S for assistance. Academic personnel contact the Office of Research Compliance, Integrity & Safety (ORCIS) for assistance.

It is also recommended that anyone who transports, stores or uses compressed gas cylinders at NIU receive training in the proper use and handling of compressed gas cylinders. New employees should contact their supervisor for assistance.