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EHS-323 COMPRESSED GAS CYLINDER GUIDELINES

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1.0 Introduction

1.1 Purpose

This document provides instructions on the safe storage, handling, use and disposal of compressed gas cylinders. These cylinders and their contents pose unique risks and if handled improperly can have devastating consequences.

1.2 Scope

This document is applicable to all Emory faculty, staff, students, and others who work with, or near, compressed gas cylinders (excludes gases used as refrigerants).

1.3 Definitions

Combustible Materials. Solids or liquids that can easily ignite and burn when exposed to fire or heat. Examples include wood, paper, cloth, rubber, plastic, oil, grease, lubricants, oil-based paints, and fuels (kerosene oil, diesel, gas).

Compressed Gas. Any material or mixture that is a gas at 20°C (68°F) or less at an absolute pressure of 101 kPa (14.7 psia) and that has a boiling point of 20°C (68°F) or less at an absolute pressure of 101 kPa (14.7 psia) and that is liquefied, non-liquefied, or in solution, including those gases that have no other health or physical hazard properties and exerts in the packaging an absolute pressure of 280 kPa (40.6 psia) at 20°C (68°F).

Corrosion or Pitting. Loss of wall thickness in a cylinder by corrosive media.

Cuts, Gouges, or Digs. Deformations in a cylinder caused by contact with a sharp object to cut into or upset the metal of the cylinder, decreasing the wall thickness at that point.

Dents. Deformations in a cylinder caused by it coming into contact with a blunt object, where the thickness of the wall is not reduced.

Dissolved Gas. A non-liquefied compressed gas which is dissolved in a solvent. Acetylene is the only common dissolved gas.

kPa. Kilopascal.

Liquefied Compressed Gas. A gas, which when packaged under pressure is both a liquid and a gas, at 20°C (68°F). Examples include natural gas, liquified petroleum gas (LPG), methane, anhydrous ammonia, propane, and chlorine.

Manifold. Gas distribution system that transfers product through multiple outlets/inlets to compressed gas containers.

Nesting. A method of securing cylinders upright in a tight mass using a contiguous three-point contact system whereby all cylinders in a group have a minimum of three contact points with other cylinders or a solid support structure (e.g., a wall or railing). See section 5.0 on Compressed Gas Cylinder Storage for more information.

Non-Liquefied Compressed Gas. A gas, which when packaged under pressure is entirely

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gaseous at 20°C (68°F). Examples include air, oxygen, nitrogen, helium, and argon.

Regulator. Mechanical device used to control the discharge pressure of a compressed gas from a container.

Pressure Relief Device. A safety device installed on gas valves for high- and low-pressure cylinders to prevent the pressure from rising above a predetermined maximum.

PSI. Pounds per square inch.

PSIA. Pounds per square inch absolute, where the pressure is relative to a vacuum rather than the ambient atmospheric pressure.

PSIG. Pounds per square inch gauge, where the pressure is relative to atmospheric pressure.

Safety Data Sheets (SDS). Written or printed information concerning a hazardous material prepared in accordance with the provisions of Title 29 of the U.S. (United States) Code of Federal Regulations (29 CFR) Part 1910.1200.

Ventilation (adequate). When specified for the prevention of fire during normal operation, ventilation shall be considered adequate when the concentration of the gas in a gas-air mixture does not exceed 25 percent of the lower flammable limit.

Valve. A type of device used to control the flow of gases and liquids.

Valve Protection Cap (or Cylinder Cap). Rigid removable cover provided for container valve protection during handling, transportation, and storage.

1.4 Training Requirements

Only properly trained personnel are allowed to handle and use compressed gases. Training must include a review of this document, as well as any gas manufacturer/supplier information, SDSs, or any additional information pertinent to the compressed gases and equipment being used.

2.0 General Safety

2.1 Personal Protective Equipment (PPE)

Ensure that personnel handling or using compressed gas cylinders wear PPE appropriate for the specific hazards of the cylinder or its contents, including:

- Eye protection – Safety glasses (gasketed/sealed, preferred) or goggles.
- Foot protection – Closed-toe or steel-toe shoes/boots.
- Face protection – Face shield (used in combination with safety glasses or goggles).
- Hand protection – Gloves (based on the chemical or physical hazards of the gas).

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2.2 Safety Data Sheets (SDS)

Always review the SDS prior to using any compressed gas. SDSs can be accessed through the Safety Data Sheet (SDS) link on the EHSO website or the manufacturer. New or updated compressed gas SDSs should be submitted to EHSO at indhvg@emory.edu for inclusion in the online database.



Figure 1. Example of Gas Cylinder Label

2.3 Labeling

Ensure all compressed gas cylinders are clearly identified (i.e., labeled/marked) with the container contents, physical and health hazards, and the status of the cylinder (i.e., full, in-use, empty; see Figures 1 and 2).

- Do not accept or use containers whose content labels are not legible. Instead, separate the containers and return them to the supplier.
- If labels or markings become worn, obtain replacement labeling from the supplier or purchase from an approved vendor.
- Never use color to identify the cylinder contents.



Figure 2. Example of a Cylinder Status Tag

3.0 Compressed Gas Cylinder Use

Follow regulatory requirements, manufacturer guidelines and industry best practices when handling and using compressed gas cylinders.

- Only use compressed gas cylinders in well-ventilated areas.
- Do not expose compressed gas containers to temperature extremes.
 - Never apply a flame or heat directly to any part of a compressed gas cylinder.
 - Should ice or snow accumulate on a container, thaw at room temperature or with water at a temperature not exceeding 125°F (51.7°C).
- Do not use gas cylinders in locations where they might become part of an electrical circuit (i.e., keep away from electrical panels, disconnects, etc.).
 - Maintain at least 3-feet from electrical panels/disconnects and at least 1-foot, from electrical outlets or conduit, unless permitted otherwise by regulation or EHSO/Fire Safety.
- Use the correct tools to remove valve protection cap, open/close valves, and attach/remove manifolds/regulators/fittings – see Figure 3. Contact EHSO at ehso@emory.edu or the compressed gas supplier, if unsure of the proper tools needed.
- Keep valve protection caps securely in place unless the cylinders are in use or are connected for use.
- Ensure a suitable pressure-regulating device (PRD) is installed when the following conditions exist:
 - Gas is admitted to a system of lower pressure rating than the supply pressure, or
 - The system rating can be exceeded due to the gas capacity of the supply source.
- Properly install check valves and/or traps to prevent backflow where there is a possibility that a reverse flow of incompatible gases could occur.



Figure 3. Example of Valve Protection Cap Wrench

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4.0 Compressed Gas Cylinder Regulators

When installing a pressure regulator on a compressed gas cylinder, certain precautions and manufacturer's recommendations should always be consulted prior to setting up connections.

- Always check the CGA (Compressed Gas Association) numbers on the cylinder and the regulator to make sure that they match before making connections.
- **Never** force valve connections, use an incompatible regulator, alter a regulator, or use an adapter to make a regulator fit a cylinder.
 - The CGA number is marked/stamped on the flat portion of the cylinder just below the valve or on the shoulder of the cylinder.
 - The CGA number is typically found on the regulator nut or underneath the dials.
 - Consult the gas supplier or the CGA Standard V-1, Compressed Gas Cylinder Valve Outlet and Inlet Connections, to determine the required valve types and CGA connections for a specific application.
- Clear the valve before connecting to the regulator to prevent dust or dirt from entering the regulator.
 - Stand to the side of the cylinder away from the valve outlet, and “crack” the valve by momentarily opening the valve, then closing it immediately.
 - Do not “crack” the valve of a cylinder that contains toxic gases.
- Perform a leak test once the regulator is attached using a mild soap solution, a compatible commercial leak test solution, or a leak detection instrument.
 - Note: Ordinary soap solution may contain oils that are unsafe when used with oxygen cylinders. Leak detection liquids are available from commercial welding companies, compressed gas suppliers, etc.
- Open valves slowly and always point the outlet away from personnel.
 - Valves with hand-wheels can be opened with torque wrenches designed for such use.
 - Valves without hand-wheels can be opened with the wrench provided or recommended by the gas supplier.
 - Keep wrenches/other recommended tools and any necessary PPE nearby while the container is in use. This will allow the valve to be quickly closed in the event of an emergency.
- Maintain a safe position when opening a regulator.
 - Stand to the side of the regulator face with the valve between you and the regulator.
 - Do not reach in front of or stand in front of the regulator face when opening the valve.
 - Ensure that the regulator is angled slightly upward, but not directed towards other personnel.
- Before removing a regulator:
 - Close the container valve.
 - Relieve the regulator of gas pressure by turning (i.e., opening) the adjusting screw; and
 - Reclose the adjusting screw.

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5.0 Compressed Gas Cylinder Storage

Compressed gas cylinders must be secured against accidental movement (i.e., falling over), protected from physical damage and unauthorized use, and located away from exit routes, elevators, high traffic walkways, unprotected platform edges, electrical circuits, open flames, and high temperatures.

- Store cylinders upright (vertical position, valve end up), unless cylinders are designed for horizontal storage.
- Label compressed gas cylinder storage areas, rooms or cabinets as “Compressed Gas” or similar, and post “No Smoking” signage where flammable gases are stored.
- Group cylinders according to hazard class and separate full and empty cylinders.
- Placard storage buildings and fenced outside areas according to the hazard class using the NFPA 704 Diamond.
- Inside storage areas must be well-protected, well-ventilated, dry locations, with adequate room to accommodate and move the various gas cylinders, including allowances for maintaining proper segregation. Selected locations must:

- Be away from exits and exit pathways, elevators, stairs, aisles or corridors, or locations where heavy moving objects can strike or fall on them.
- Be at least 20 feet away from highly combustible materials.
- Limit storage of LP-gas to 300 pounds or less, including empty containers.

- Outside storage areas must be secured to prevent unauthorized access. The locations should be clearly identified, well-ventilated, dry and protected from mechanical or physical damage. Selected locations must:
 - Have adequate room to accommodate the various gas cylinders, including allowances for proper segregation.
 - Not expose cylinders to temperature extremes (> 125°F) and not allow water to accumulate.
 - Be at least 5 feet from any doorway or opening in a building that has two means of egress.
 - Be at least 10 feet from any doorway or opening for a building that has only one means of egress.
 - Be at least 20 feet from fuel dispensing areas.
- Secure cylinders using one of the following stable support methods appropriate for the size/diameter/quantity of cylinders to be stored:
 - Ventilated gas cylinder cage – see Figure 4.
 - Floor stands – see Figure 5.
 - Floor racks – see Figure 6.
 - Wall brackets – see Figure 7.
 - Workbench or table brackets – see Figure 8.



Figure 4. Example of Vertical Cylinder Cage



Figure 5. Examples of Floor Stands



Figure 6. Example of a Floor Rack



Figure 7. Example of Wall Mount Cylinder Bracket

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- Where multiple cylinders are stored and space is limited, nesting of the cylinders may be allowed with EHSO approval (contact EHSO at ehso@emory.edu) provided the following are also met – see Figure 9:
 - Cylinders are grouped by hazard class and cylinder status.
 - The initial row of cylinders is appropriately secured to a wall mount bracket designed for the number of cylinders stored in the first row.
 - All subsequent rows of cylinders are nested where each cylinder is touching two or three other cylinders, and
 - The entire group of nested cylinders is secured with a strap (not a chain) to the wall (not the wall bracket).



Figure 8. Example of Workbench or Table Cylinder Bracket

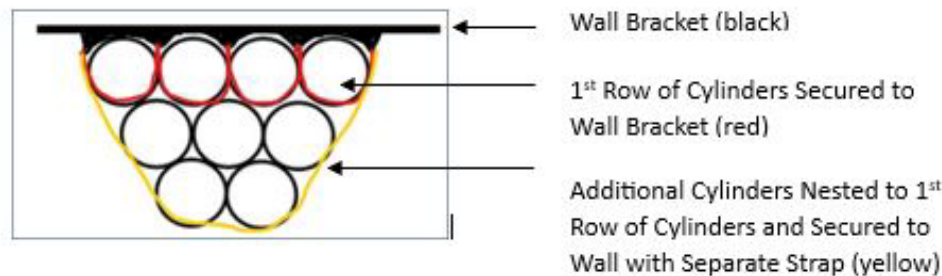


Figure 9. Explanation of Nesting Allowed (following EHSO approval)

- Restrain cylinders to stable supports using non-combustible straps, metal clamps or chains. At a minimum, the straps, clamps or chains must be tightly fastened at approximately 2/3 the height of the cylinder (i.e., secured above the midpoint but below the shoulder). When properly restrained, the cylinder should not move and there should not be any play in the strap, clamp or chain.
 - (Best practice) Secure cylinders in two locations – one strap, clamp or chain 1/3 from the top of the shoulder of the cylinder and one strap, clamp or chain 1/3 up from the bottom of the cylinder.

6.0 Compressed Gas Cylinder Transportation

- Use caution when transporting cylinders to prevent them from striking against each other or against other hard surfaces.
- Before moving a cylinder, ensure that the regulator is removed, the valve is closed, and the valve protection cap is in place.
 - If the cylinder is on a vehicle or cart intended for the purpose of transporting the cylinder, the regulators do not have to be removed, provided the vehicle or cart is designed to hold the cylinders in an upright position, the cylinder is properly secured and protects the cylinder valves and regulators.



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- Transport cylinders in an upright position on a cylinder cart or cylinder hand truck equipped with a means to secure the cylinder to the cart/hand truck (i.e., chain or strap). When moving a cylinder, a short distance, it is acceptable to tilt and roll the cylinder on its bottom edge.
 - Never drag cylinders or roll them in a horizontal position.
 - Never lift a cylinder using the valve protection cap or by using a magnet.
- Use a freight elevator, whenever possible, to transport a filled gas cylinder between multilevel buildings. If there is no freight elevator, use the passenger elevator.
- Never allow other people to enter the elevator when transporting cylinders.
- When transporting gas cylinders containing an asphyxiant gas, a “buddy system” should be used.
 - Arrange to have someone meet the cylinder at the elevator on the destination floor.
 - Ensure no one is in the elevator and place the cylinder (secured on a cylinder cart) in the elevator. Note: cryogenic liquid tanks / dewars come with a wheeled base and do not need a cylinder cart.
 - Secure a “Do Not Enter: Hazardous Transport in Progress” sign so that it is clearly visible to any person attempting to enter the elevator.
 - Push the button for the desired floor and exit the elevator. Do not remain in the elevator while transport is in progress.
 - The person meeting the elevator should remove the cylinder from the elevator and transport the cylinder to its destination.
 - Remember to use caution when removing items from the elevator. Small wheels can get stuck and the use of excessive force to dislodge the wheels can lead to tipping of the cylinder.

Figure 10. Example of Cylinder Hand Truck

7.0 Compressed Gas Cylinder Disposal

- Never dispose of compressed gas cylinders as conventional waste.
- Return empty, damaged, or leaking gas cylinders to the gas supplier or distributor, as soon as possible.
 - Keep valves closed and have valve protection caps securely in place.
 - Follow proper labeling and storage segregation.
- Request a waste pickup of non-returnable lecture bottles, calibration gas cylinders or other non-returnable compressed gas cylinders through EHSO via the online Waste Collection System:
 - Visit EHSO’s primary website, www.ehso.emory.edu.
 - Scroll to the bottom of the page and select “Request Waste Collection.”
 - Enter your Emory credentials and follow the instructions provided.
- Request an emergency or large volume pickup request by contacting EHSO at chemwaste@emory.edu with complete details to coordinate the disposal.

8.0 Inspection and Maintenance

Regularly inspect and maintain gas cylinders, regulators, pressure relief valves and other associated compressed gas equipment.

- Follow gas supplier and manufacturer inspection/maintenance schedules of regulators, manifolds, pressure relief valves, etc. and maintain documentation.
- Perform visual inspections of compressed gas cylinders daily and before each use for

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the following:

- Corrosion and pitting
- Dents, cracks, and grooves
- Bulges or distortions
- Leaks
- Thread or neck defects
- Contact the equipment supplier or manufacturer if repairs are needed for valves, manifolds or other related equipment.

9.0 Flammable Gases

- Use and store flammable gases in well-ventilated areas, away from oxidizers, open flames, sparks, and other sources of heat or ignition.
- Ensure that all lines and equipment associated with flammable gas systems are grounded and bonded.
- Store acetylene containers with the valve end up.
- Do not use acetylene in its free state at pressures exceeding 15 psig.
- To reduce the risk of explosion, do not open acetylene or other flammable gas cylinder valves more than ½ turn of the spindle.
- Do not take cylinders containing oxygen, acetylene, or other fuel gas into confined spaces.
- Maintain portable fire extinguishers (carbon dioxide or dry chemical types) or other fire protection or suppression systems at storage locations.
- Post “No Smoking” signage around the storage area of buildings or at entrances to storage locations.
- Use non-sparking tools.
- Follow proper storage outdoors or in unoccupied buildings:
 - Do not exceed 22,500 pounds of liquefied petroleum gas (LPG) in one storage area.
 - Maintain at least 20 feet of separation between storage areas of flammable gases.
 - For determination of quantity, consider full or partially full cylinders as full cylinders.
 - Separate LPG and acetylene by at least 20 feet. (Note: No separation is required if the storage quantity of LPG is less than 1000 pounds).
- Follow proper storage inside occupied buildings:
 - Do not store near arcing electrical equipment, open flames, or other sources of ignition.
 - Separate flammable compressed gas cylinders at least 20 feet from flammable and combustible liquids, highly combustible materials, and oxidizers.
 - If separation is not possible, isolate the flammable gas containers by a non-combustible barrier at least 5 feet high that has a fire resistance rating of at least ½ hour and extends at least 18 inches above the tallest container and laterally at least 18 inches beyond the sides of the containers.

10.0 Asphyxiant and Inert Gases

- Any gas that has the potential to displace oxygen in sufficient quantities can cause asphyxiation and may require installation of a gas detection system, as determined by

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an EHSO risk assessment. Examples of asphyxiant gases include nitrogen, argon, helium, methane, propane, and carbon dioxide.

- Inert gases are chemically inactive, odorless, tasteless, and colorless. Common inert gases include nitrogen and the rare gases, such as helium and argon.
- Contact EHSO at indhvg@emory.edu to perform a risk assessment where asphyxiant or inert gases are stored or used. The risk assessment will establish the necessary air exchange rate and provide a basis for determining whether adequate ventilation is present or whether additional controls are needed.

11.0 Corrosive and Toxic Gases

- Wear appropriate personal protective equipment (PPE) as required by the SDS and industry standards.
- Avoid contact with the skin or eyes or inhaling any corrosive gases.
- Store corrosive and toxic gases in accordance with local and/or building fire protection codes.
- Ensure emergency showers and double ocular eyewash equipment are available in areas where corrosive gases are stored or used.

12.0 Oxidizing Gases

- Oxidizing gases, including oxygen, are non-flammable but can support and accelerate combustion in the presence of an ignition source and a fuel.
- Ensure equipment is free from grease, oils, and other contaminants.
 - Do not handle cylinders with oily hands or gloves.
 - Use an oxygen-compatible material to clean all equipment that has been used with oxidizing gases.
- Store oxidizers separately from flammable or combustible materials.
 - Maintain a minimum distance of 20 feet, or
 - Establish a non-combustible barrier at least 5 feet high that has a fire resistance rating of at least ½ hour and extends at least 18 inches above the tallest container and laterally at least 18 inches beyond the sides of the containers.

13.0 References

Occupational Health and Safety Administration [OSHA], 1910 Subpart H, Hazardous Materials – *Compressed gases (general requirements)*, 29 CFR 1910.101.

Occupational Health and Safety Administration [OSHA], 1910 Subpart H, Hazardous Materials – *Acetylene*, 29 CFR 1910.102.

Occupational Health and Safety Administration [OSHA], 1910 Subpart H, Hazardous Materials – *Oxygen*, 29 CFR 1910.104.

Occupational Health and Safety Administration [OSHA], 1910 Subpart H, Hazardous Materials – *Storage and handling of liquefied petroleum gases*, 29 CFR 1910.110.

Occupational Health and Safety Administration [OSHA], 1910 Subpart Q, Welding, Cutting, and Brazing – *Oxygen-fuel gas welding and cutting*, 29 CFR 1910.253.



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National Fire Prevention Association [NFPA] – Liquefied Petroleum Gas Code, NFPA 58 (current).

National Fire Prevention Association [NFPA] – Standard for the Storage, Use, and Handling of Compressed and Liquefied Gases in Portable Cylinders, NFPA 55 (current).