A Guide to Safe Handling of Compressed Gases in the Laboratory

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A Guide to Safe Handling of Compressed Gases in the Laboratory

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Using compressed gases in the laboratory can be a dangerous situation if they are handled improperly. Many gases can be explosive, flammable, corrosive, and toxic. Because the gases are under high pressure in tanks and cylinders, any release of gas can spread quickly and endanger lab personnel—including the possibility of injury from explosion or asphyxiation. Less harmful safety risks include physical injuries from mishandling tanks, especially to the hands, feet, and lower back.

Because of these risks, standards have been established for transporting, using, and handling compressed gas tanks and cylinders. These regulations include:

Department of Transportation 49 CFR

- 49 CFR 171—general information
- 49 CFR 172—hazardous materials tables
- 49 CFR 178 – shipping container requirements

OSHA 29 CRF 1910

Comprehensive rules that discuss gas types, how to ensure the safety of tanks, handling and storage as per the Compressed Gas Association (CGA), pressure relief devices, and other safety recommendations

NFPA 55 Compressed Gases and Cryogenic Fluids Code

Handling and proper storage of tanks, safety data sheets, personnel training, operating procedures and best practices, employee training, other safety recommendations

Handling and Transportation

The safety process starts when a full compressed gas cylinder is delivered to a facility. All tanks and cylinders must be carefully inspected before they are accepted. Safety caps should be in place. Regulators should not be attached. Do not accept tanks that look damaged or poorly maintained (for example, oxidation or pitting). Prior to installation, inspect all

piping, regulators, and stems. Be sure that tanks are marked with clear, easy-to-read labels that identity the type of gas, with the certification date from the vendor. Do not rely on the color of the cylinder to identify the gas (color codes vary from supplier to supplier). Status (full, empty, in service) should also be identified and visible even after installation. Ask for the material safety data sheets (MSDS) for each type of gas being received. Refuse to accept any tanks or cylinders that don't meet these requirements (and don't try to fix or repair them yourself).

Once received, compressed gas cylinders must be secured in a vertical position. This includes during transport, storage, and use. It is highly recommended tanks are only moved using wheeled carts that are designed for this purpose. Carts are available from gas vendors and other laboratory supply companies. Check that the safety caps are screwed on securely. To minimize physically moving the cylinder, move the cart close to the cylinder and then carefully "walk" the cylinder on to the cart and fasten it securely with straps or chains so that it cannot slide, tilt, or fall over. Carts should always be used to move cylinders, even for short distances.

Even though they seem sturdy and safe, cylinders should always be handled carefully, without hurry. Cylinders that are dropped, or strike other tanks or hard surfaces, could explode, creating serious damage or even loss of life. Never drag cylinders or roll them in a horizontal position. Never lift a cylinder by the cylinder cap or by using magnets. If a cylinder must be moved manually, tilt it slightly sideways and roll it carefully along its bottom edge, maintaining good grip. Be sure the path of travel is clear of obstacles; use a spotter if needed for negotiating ramps or lift gates.

Caps, Valves, and Regulators

Cap all cylinders when not in use; this protects the valve stem and prevents any accidental release of the compressed gas, even if the cylinder falls. Do not try to force or fix any cylinder connection that is not working properly. If a connection is malfunctioning, it is likely broken or not the proper connection/valve for that cylinder. Never try to repair, pry, hammer, or "unstick" any valves, regulators, or pressure-relief devices. If it does not open easily by hand, call the gas distributor, even if this means a work delay. Trying to repair a defective cylinder on your own could

result in a dangerous condition, including the potential for an explosion or violent gas release. Arrange for the gas vendor to come immediately to pick up any defective cylinders.

To prevent leaks, be sure main valves are closed when the cylinder is not in use, even if it is empty. Air that enters an empty cylinder can also bring in moisture and other contaminants that can lead to corrosion of the cylinder, or possibly even an explosive chemical reaction. Any pressure in the regulators should also be released when the cylinder is not in use. Every time a cylinder is brought into service, a leak test should be performed to confirm there are no leaks present when the cylinder is connected.

Regulators are important safety devices on cylinders that must be in good working order. Regulators control the delivery pressure of the gas from the cylinder so that it can be delivered at the optimum pressure for the work being performed. Requirements for regulators vary according to gas type and cylinder size. It's good practice to double-check that the correct regulator is being used for the gas and cylinder. It should also have the appropriate pressure range for the work being performed. Ideally the regulator should be twice as high as the required pressure. Use pressure regulators that are equipped with pressure relief devices and vent them if appropriate given the type of gas being used.

Two types of regulators are available for pressurized tanks: single-stage or two-stage. Single-stage pressure regulators are used when inlet pressure is steady throughout the application. With a two-stage pressure regulator, the first stage decreases the inlet pressure to a pre-set level; the second stage then further reduces this pressure to the desired pressure needed for the work that is being performed.

It is very important to keep regulators (especially for oxidant gases) free of surface oil and grease. These surface contaminants will combust in the presence of pure oxygen (this also reaffirms the importance of leak tests). Regular maintenance of cylinders, valves, regulators, and other devices is best performed by the original manufacturer or provider.

Storage of Compressed Gas Cylinders

Cylinders must be stored in a well-ventilated, above-grade, weather-proof storage area that is a safe distance from combustible materials, ignition sources, or intense heat. Store them according to hazard classification. Store the oldest cylinders at the front, so they can be used first. Gas types should be separated from incompatibles. For example, flammable gases should be separated from oxidizing gases.

Separation of incompatible gas cylinders can be achieved by open space (20 or more feet is recommended), fireproof partitions, or approved storage units.

Because they conduct electricity, metal cylinders must be kept away from electrical circuits, open flame, sparks, etc. Never place a cylinder close to an electrical conductor, such as metal pipes, that could accidentally carry current.

Storing cylinders in areas that exceed 130°F (54°C) violates Department of Transportation regulations. Gas expands when heated and increases pressure in the cylinder, increasing the risk of explosion. Tanks should not be stored where they will be in direct sunlight. Personnel sometimes overlook the fact that direct sunlight can increase temperatures in storage areas to well above 100°F—a potentially dangerous situation if compressed gas cylinders are stored there.

During transportation, compressed gas cylinders must be stored in an upright position. Don't store tanks on gas carts and do not strap cylinders together. Secure each tank with a chain, strap, or bracket to a stationary surface, such as a bench or a wall. Two straps, one at about one-third of the cylinder height and the other at two-thirds of the cylinder height, are recommended to keep the tank from tipping or sliding. Cylinder clamps are available that are specifically designed for fastening tanks to a bench top.

When cylinders are empty, mark them as "empty" and arrange for the supplier to pick them up. Cylinders that contain "safe to breath" gases like oxygen, nitrogen, and argon may be vented to allow residual gas to escape. If you choose to vent the residual gas, please consult your safety officer or gas provider regarding the best procedure. Vending oxidants (for example, oxygen) in a hazardous environment is not recommended. Cylinders that contain flammable or toxic gases cannot be vented and may need to be disposed of as hazardous waste.

Education = Safety

The most important step in the safe handling of compressed gas cylinders is to create an overall safety plan that is based on sound knowledge of the Department of Transportation (DOT), OSHA, and NFPA regulations concerning the handling, storage, transportation, and use of compressed gas cylinders. These standards will be the basis for any comprehensive safety plan.

Employees who handle compressed gas cylinders should be familiar with the regulations in detail. Gases are classified according to their physical and chemical properties—therefore staff must also have a deep understanding of these properties and the risks that they present in a laboratory or storage setting.

Much of this knowledge comes from the material safety data sheets (MSDS) that vendors provide for each gas, including their safety hazards. These sheets, as well as other reference materials, should be placed in several areas in the workspace to provide easy access to this information. In the event of an emergency, this material must be available for first responders and safety personnel.

Lab directors or safety directors must follow the DOT, OSHA, and NFPA regulations and MSDS information (as well as other laboratory safety guidelines and resources) to develop a comprehensive safety plan (including an emergency response plan) that can be taught to employees, posted in the laboratory, practiced periodically, and updated when needed.

Train all employees and provide each worker with a copy of the safety plan. This will include a safety and response plan for each gas. Requirements should also be established for use of personal protective equipment, safe handling of compressed gas cylinders, the ergonomics of safe lifting and handling, and keeping aisles and pathways clear of obstacles or clutter.

Hopefully the comprehensive safety plan will prevent any serious accidents. However, in the event of an emergency, laboratory personnel must be able to react quickly (for example, know where to find emergency equipment, such as fire extinguishers, eyewash, etc.). Enforce the safety plan at all times and practice it regularly to ensure the safest workspace possible (and quick and correct responses, should an emergency occur).

Eliminate Cylinder Risks with In-House Gas Generation

Although compressed gas tanks and cylinders are commonly used in workplace settings, they present several disadvantages:

- Safety risks—as discussed above, high-pressure cylinders can be dangerous and require careful handling, transportation, and storage
- Changing cylinders can interrupt testing and waste valuable time
- Cylinder orders can be delayed
- Cylinder prices often go up
- Extra administrative work dealing with contracts, deliveries, and negotiated costs

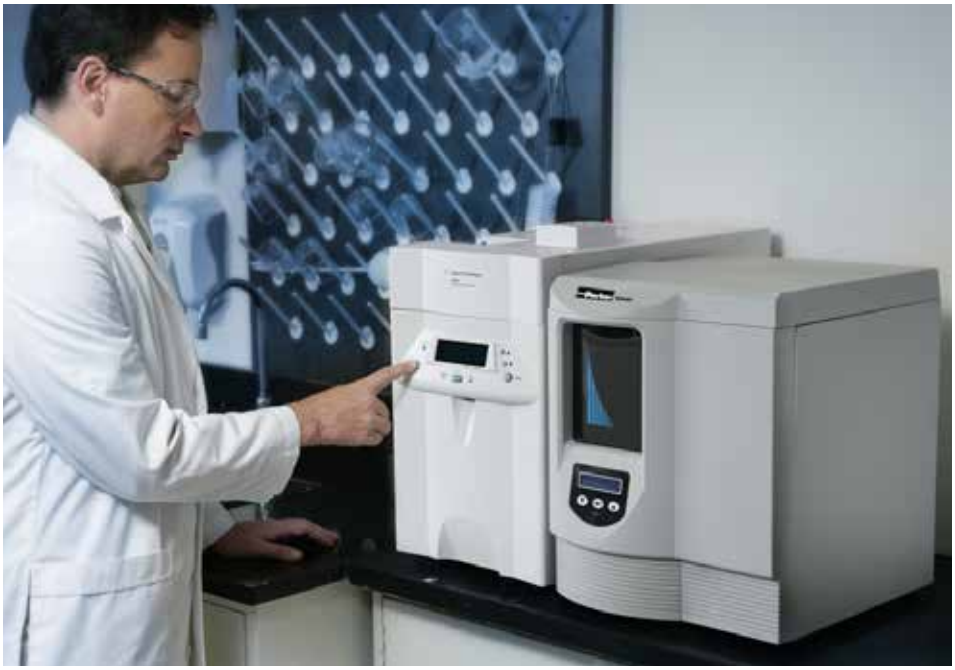
The safety risks of compressed-gas cylinders (and the administrative and regulatory hassles) can be eliminated by switching to an in-house gas generator, which uses compressed air to generate purified nitrogen and zero air on a 24/7 basis, whenever needed. Advantages include:

- Safety—in-house generators operate at low pressures and store small volumes of pressurized gas, eliminating risk of rapid release of gas
- Eliminates risks of handling and storing heavy gas cylinders
- Gas delivery is automatic, reliable, and relatively inexpensive
- Cost of operation is very low, compared to high-pressure gas cylinders
- Built-in leak detection
- Eliminates need for periodic inspection of cylinders
- Exceeds OSHA 1910.103 and NFPA 50A safety guidelines
- Can reduce insurance rates

Parker offers in-house generators are available for each gas as well as multiple-gas generators.

The cost of operating an in-house gas generator is extremely low, since the only raw materials are air and electricity. Running and maintaining a gas generator system typically costs only a few hundred dollars a year. Return on investment takes about 12 months, depending on the specific usage and required purity. This is a significant ongoing savings compared to the recurring costs of cylinders. When considering factors such as energy used, maintenance, cylinder cost, demurrage, labor, order processing, shipping, invoice processing, and inventory control, operating a tank delivery system is about ten times more expensive than using in-house gas generation.

To learn more about in-house gas generation, visit www.parker.com/balston or call 978-858-0505 to speak with a Parker Balston engineer.



A Parker Hydrogen Generator

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